

ISBN: 978-93-91387-26-6

**RECENT TRENDS IN MULTIDISCIPLINARY
RESEARCH (RTMR-2023)**

EDITORS

**Dr. C. SHANMUGA PRIYA
Ms. SEEMA SHUKLA**

ASSOCIATE EDITORS

**Dr. K. SELVABHUVANESWARI
Dr. R. SEBASTHI PRIYA
Ms. VIJETHA BHAT**

MAY 2023

**Association of Global Academician and
Researchers(AGAR) Publications,
Tamil Nadu, India.**

RECENT TRENDS IN MULTIDISCIPLINARY RESEARCH (RTMR-2023)

ISBN: 978-93-91387-26-6

EDITORS

**Dr. C. SHANMUGA PRIYA
Ms. SEEMA SHUKLA**

ASSOCIATE EDITORS

**Dr. K. SELVABHUVANESWARI
Dr. R. SEBASTHI PRIYA
Ms. VIJETHA BHAT**

MAY 2023

**Association of Global Academician and Researchers (AGAR)
Publications,
Tamil Nadu, India.**



Vaniyambadi, Tirupattur District, Tamil Nadu, INDIA

<https://salihapublications.wordpress.com/>

[E.mail:salihapublications2016@gmail.com](mailto:salihapublications2016@gmail.com)

Cell: +91 8667862635.

MESSAGE FROM EDITOR-I



It is indeed a pleasure and honour to be part and involvement to releasing the book entitled “**Recent Trends in Multidisciplinary Research (RTMR-2023)**” by Association of Global Academician and Researchers (AGAR), Tamil Nadu. This remains as a history due to its tremendous response across the globe. I am indeed grateful to the members of the association for providing me an opportunity and for reposing faith in me. All this has been made possible with their guidance. My thanks to the faculty members, Research scholars and students who have contributed the chapters to this dynamic publication. I am very thankful to Dr. I. Niyas Ahamed, President of AGAR for assisted me in times of need. I am very fortunate and blessed to be part of this prestigious publication.

With Regards,

Dr. C. Shanmuga Priya,
Assistant Professor & Head,
Department of English,
SRM Institute of Science and Technology,
(Deemed to be University),
Tiruchirappalli, Tamil Nadu.
E mail: shanpriya2873@gmail.com

MESSAGE FROM EDITOR - II



Dear Friends,

It is wonderful to see the Association of Global Academician and Researchers (AGAR), Tamil Nadu taking up an important experimental education and research strategies and at the same time an important problem in the society to publishing the book entitled on “Recent Trends in Multidisciplinary Research “(RTMR-2023).

The topic “Recent Trends in Multidisciplinary Research” gives much room to search for the latest trends in dealing with important education role and emerging research strategies. This publication offers more strategic, holistic education and research approach to integrate aspects from the different field of research. It will enlighten the broaden minds of the young researchers to search for new solutions to real life strategies.

Congratulations and God Bless Your Effort.

With Regards,

Ms. SEEMA SHUKLA.
Assistant Professor
Department of English,
Sn Govt Pg College
Khandwa ,Madhya Pradesh
E mail: seema123shukla@gmail.com

MESSAGE FROM ASSOCIATE EDITOR - I



Being a part of the publication of the book chapters collected in "Recent Trends in Multidisciplinary Research (RTMR-2023)" by the Association of Global Academician and Researchers (AGAR), Tamil Nadu, is both a joy and an honour. Due of the phenomenal response it received all across the world, this is still considered history. The association's members have my sincere gratitude for giving me this chance and having faith in me. Due to their leadership, everything has been made possible. Thank you to the professors and students who contributed the essays to this exciting magazine. I'd want to express my gratitude to Dr. I. Niyas Ahamed, President of AGAR, for helping me out when I needed it. Being a part of this is a huge blessing for me.

With Regards,

Dr. R. Sebasthi Priya,

Assistant Professor,

Department of Mathematics, University College of Engineering Tiruchirappalli,

Anna University-BIT campus

Trichy, Tamil Nadu.

MESSAGE FROM ASSOCIATE EDITOR - II



This book provides us with a snapshot of what is going on in this fascinating field, and I would like to congratulate all contributors on making their wonderful posts vibrant and full of material for this edition. I am sure readers can find material that is very helpful and interesting, and my sincere gratitude goes to the publisher, my fellow associates, and all those who have taken care to get this wonderful edition out of it.

This Contributed book entitled “**Recent Trends in Multidisciplinary Research (RTMR-2023)**” by Association of Global Academician and Researchers (AGAR), Tamil Nadu. I am very glad that all authors took the opportunity to exchange their knowledge, experiences and ideas and also made contacts and established further collaboration. This educational material, rich in events, provided more relaxing atmosphere during the meetings among colleagues in this pandemic situation.

With Regards,
Dr. K. Selva Bhuvaneshwari
Assistant Professor and HOD,
Department of Computer science and Engineering,
University College of Engineering,
Kanchipuram, Tamil Nadu.
E mail: bhuvaneshwari.ksb@gmail.com

MESSAGE FROM ASSOCIATE EDITOR - III



Research is “creative and systematic work” undertaken to increase the knowledge of humans, culture and society and devise new applications. Education can be thought of as the transmission of the values and accumulated knowledge of a society. It’s a great privilege and honour to be associated with this “**Recent Trends in Multidisciplinary Research (RTMR-2023)**” released by Association of Global Academician and Researchers (AGAR), Tamil Nadu. RTMR has facilitated the academicians and researchers to get connected and share their knowledge and dramatically provided an opportunity for collaboration with colleagues who are dispersed across time zones, countries, and continents. I thank the contributing academicians and researchers for making this great success.

With Regards,
Mrs.Vijetha Bhat

Assistant professor Department of Computer science and Applications
Canara College
Karnataka

Chapter No.	NAME OF THE CHAPTER	Page No.
1.	POTENTIAL CONSEQUENCES OF PLASTICS ON CHILDREN IN SCHOOLS: AN OVERVIEW <i>AI Umar, Yusuf Sarkingobir, Malami Dikko and Sanusi Sidi</i>	1
2.	A STUDY ON THE POWER OF COMPOUNDING IN INVESTMENTS <i>Anthony Savio Herminio da Piedade Fernandes</i>	27
3.	REVITALIZATION OF INDIAN TRADITIONAL (HERBAL) MEDICINE <i>T. Shri Vijaya Kirubha</i>	33
4.	CARBON DOTS NANOMATERIAL AND THEIR MULTIMODAL APPLICATIONS <i>C. Dhanush, N. Bhuvaneshwari & K. Kousalya</i>	53
	STUDIES ON THE ANTIMICROBIAL PROPERTIES OF OPSIN AND ENOLASE	

5.	PROTEINS FROM THE <i>FIDDLER</i> CRAB SPECIES <i>Harshini. S, Haritha. S and Shoba. K*</i>	78
6.	ENHANCING COGNITIVE LEARNING APPROACH WITH PSYCHOLOGICAL PERSPECTIVE AND ITS IMPLICATIONS <i>Dr.</i> <i>A.Kabilath Begum</i>	107
7.	INTERLACING AUTHOR AND TEXT: LITERARY RUMINATIONS ON MEANING-MAKING <i>Rima Namhata; P. Prayer Elmo Raj</i>	121
8.	MARINE ACTINOMYCETES AND THEIR APPLICATIONS <i>Bhagyashree. C. R and Ramalingappa. B</i>	148
9.	THE GEM OF PARENTING IN HENRY LAWSON'S <i>DOVER'S WIFE</i> , J. M. COETZEE'S <i>DISGRACE</i> , BADAL SIRCAR'S <i>THE LIFE OF</i> <i>BAGALA</i> , LARA'S <i>LIKE WATER FOR CHOCOLATE</i> AND ADICHE'S <i>PURPLE HIBISCUS</i> <i>B. SHANMUGA PRIYA</i>	162
10.	NEEM (<i>AZADIRACHTA INDICA</i> A. JUSS.) MICROBIOTA: ENDOPHYTIC BACTERIA AND	175

	RHIZOSPHERE MICROORGANISMS <i>Girish, K</i>	
11.	GREEN SUSTAINABILITY THROUGH HYDROPONICS: A SCIENTOMETRIC REVIEW <i>S.Rajeswari and K.Kanimozhi</i>	200
12.	EXTENDED-SPECTRUM B-LACTAMASE DETECTION IN BACTERIA <i>Jayalakshmi K.R and Ramalingappa. B</i>	252
13.	THE CURRENT OPPORTUNITIES AND FUTURE PROSPECTS OF MICROBIAL NANOTECHNOLOGY <i>Koushik.B.R, and Dr. Seema J Patel</i>	274
14.	BREAKING NEW GROUND: LEVERAGING ARTIFICIAL INTELLIGENCE FOR PRECISION MEDICINE IN NEURODEGENERATION RESEARCH <i>Priyanjalee Banerjee</i>	287
15.	EXPLORING NUMERICAL ANALYSIS IN ITS FIELD OF DIVERGENCE <i>D.Jeyanthi Prassanna</i>	314
	A REVIEW ON BACTERIAL MULTIDRUG	

16.	RESISTANCE <i>J. Albino Wins and M. Murugan</i>	325
17.	STRATEGIC HUMAN RESOURCE MANAGEMENT <i>V.RAJESWARI</i>	332
18.	MALDI-TOF MASS SPECTROMETRY AS A RELIABLE SPECTROSCOPIC TOOL TO DIFFERENTIATE <i>PLUMBAGO</i> SPECIES <i>T. Renisheya Joy Jeba Malar and M. Johnson</i>	352
19.	REGENERATIVE STEM CELL THERAPY <i>Inbavalli. K</i>	369
20.	A REVIEW ON ENVIRONMENTAL BIOTECHNOLOGY AND ITS APPLICATIONS <i>K. Prabu</i>	386
21.	MECHANISM OF OXIDATION OF HYDROQUINONE, BY N-CHLOROPIPERAZINE- 2,5-DIONE- A KINETIC STUDY	413

	K. Rajalakshmi	
22.	MYCOTOXINS BIOLOGICAL DETOXIFICATION OF MYCOTOXINS BY LAB (LACTIC ACID BACTERIA) Sowmya K L	432
23.	DISCUSING DIFFERENT LEVEL OF A WOMAN'S ACQUAINTANCE IN MANJU KAPUR'S A MARRIED WOMAN M. Usha Bharathi	464
24.	A STUDY ON BRAND PREFERENCE AND BRAND LOYALTY OF CUSTOMERS ON ONLINE SHOPPING APPS IN TENKASI DISTRICT T.S.SUBBULAKSHMI	471
25.	CULTURAL ALTERITY IN MAHESH DATTANI'S TARA Rochelle Maryann	484

26.	THE ROLE OF ARTIFICIAL INTELLIGENCE IN RESEARCH RELATED TO HEALTHCARE <i>Shaik Asha Begum, S. Joshna Rani and SK. Abdul Rahaman</i>	505
27.	BIOPLASTICS <i>Affrin Jahana R, R. Manogari, G. Vijaya and A. Parkavi</i>	521
28.	A STUDY ON VISITORS SATISFACTION TOWARDS TOURIST PLACE IN UDHAGAMANDALAM <i>R.Sivasankari</i>	535
29.	SIROP DE TABAC AND IT'S IMPLICATION IN MIXOLOGY <i>Kaustav Dutta</i>	549



BOOK CHAPTERS

Chapter – I

01

POTENTIAL CONSEQUENCES OF PLASTICS ON CHILDREN IN SCHOOLS: AN OVERVIEW

**AI Umar¹, Yusuf Sarkingobir², Malami Dikko³, Abdullahi
Sanusi Sidi⁴**

**1Department of Biochemistry, Sokoto State University, Sokoto,
Nigeria**

**2Department of Environmental Education, Shehu Shagari
University of Education Sokoto, Nigeria**

**3Sultan Abdurrahman College of Health Technology
Gwadabawa, Sokoto, Nigeria**

4Federal College of Education Gidan Madi Sokoto, Nigeria

Email: superoxidedismutase594@gmail.com

ABSTRACT

The main objective is to lay a composite foundation relating to effects of plastics in contact with students in schools. Plastics are polymeric products such as polystyrene, polyethylene, polyvinyl chloride, polypropylene etc. However, each and every plastic contains additives and possible attachments that can leach into food, air, water, etc within the environment. In the school environment, the plastics are utilized in various forms for the benefits of all, but on the other fold leaching of plastic additives and sorption chemicals are expected to pose health risk of various ranges to the children. Children are mostly affected because of curiosity, poor immunity, and developing body. Therefore, there is need for educating the public, school actors and the children on the overview of effects of plastics on humans, let alone children. Plastics turn to smaller units as a result of stress (mechanical, UV, etc.) to be able to pass into the body to cause several effects such as irritation, headache, birth defect. Albeit, most of the effects of plastics are due to few toxic monomers (such as styrene, vinyl chloride) and additives (such as phthalates, dioxin, bisphenols, heavy metals etc). Due to chemical structure in plastics some harmful chemicals could easily cling to the

plastic parent material and be conveyed along the way. In the body, microplastics and the likes are able to traverse the various tissues and cells and in turn leading to many effects such as oxidative stress, inflammation, cancer, etc. Vital parts such as reproductive system, liver, kidney, intestine, cardiovascular system, circulatory system etc. are all affected by plastics. To address the plastics, education and awareness of the students and the public are eminent; innovations, are among the measures to tackle the issues.

1. INTRODUCTION

Bottles, clothing, construction items, electronic materials, food packages, etc. are some examples of plastics application in school environment and other human endeavors (Alabi et al., 2019). Nowadays, plastics are very popular in all ways and ubiquitous. Several endeavors in human life are dependent on plastics positively. However, there are inherent behaviors of plastics that raise concern especially the possibility of causing serious effects on children because the polymers are composed of harmful chemicals in form of additives, monomers, and attachments (Spripada et al., 2022). Children are more affected to effects of plastics owing to their unique characteristics. Children have weak body immunity, developing and

growing body, curiosity, and other related idiosyncrasies that make them more vulnerable to plastic effects (Avio et al., 2016; Soumiya et al., 2018). In the school environment, plastics are used as teaching aids, learning materials, building materials, electronics, food containers, water storage and quasi that in turn affect children directly or indirectly. Therefore, it is important to lay an overview on the effects of plastics on children due to school or other contact to make the public aware and call for further actions to ameliorate the issue (Alabi et al., 2019; Kraftl et al., 2022). The main objective is to lay a composite foundation of effects of plastics in contact with students in schools.

2. DEFINITION AND TYPES OF PLASTIC

Plastics are large groups of materials that are polymers of long-chain molecular weight consisting of repeating units (monomers) and copolymers (additives) bundled together that have the unique capacity of being molded. Some of them are formed from renewable materials such as grains, vegetables and are regarded as bioplastics; other types of plastics are made from non-renewable materials like oil and are termed synthetic plastics. They are the conventional, prevalent, and most harmful nowadays (because it cannot be recycled in most

of the cases) (GESAMP, 2015; Alabi et al., 2019; Tait et al., 2020). Thermoset plastics are the ones that remain adamantly solid in such a way that it cannot be melted or altered after being formed. Chemical change leading to the formation of this type of plastic is irreversible. Therefore, the plastic is potentially non-recyclable and have much crosslinks in its structural fold. Some of these plastics are; polyurethanes, phenol-formaldehyde, etc (Sidi & Yahaya, 2022). Thermoplastics are types of plastics that culturally do not alter their chemical compositions after being subjected to heat; therefore, they can be molded for a number of times; for examples, polyvinyl chloride, polyethylene, polystyrene, etc (Gazal & Gheewala, 2020; Sarkingobir et al., 2020; Sarkingobir et al., 2021; Sarkingobir et al., 2022). Microplastics are tiny plastics that are below 5 mm in size. Some of them termed primary microplastics are initially produced at microscopic size, such as in the case of fibers, pellet, foam, film, abrasives and are found in cosmetics and other personal care products. Secondary microplastics are derived as a results of fragmentation, degradation of larger plastic materials into microscopic ones (Koushal et al., 2014; Gazal & Gheewala, 2020; Parejo et al., 2022).

3. COMMON PLASTIC USES ACCORDING TYPES

Sometimes plastics are mainly classified according to the substances applied in their production and are mostly utilized in different purposes albeit sometimes their applications superimposed. Some of the main types of plastics are as follows:

1. Polyethylene terephthalate- they are the found in soft drinks, salad dressing, containers, water bottles, trays,
2. high density polyethylene (HDPE) are examples of plastics applied in shopping bags, ice cream containers, crates, detergent bottles, milk bottle, freezer bags, buckets, (Alabi et al., 2019).
3. Polyvinyl chloride (PVC)- is present in many items such as pipes, cable sheaths, bottles, blood bags, tubes etc
4. Low density polyethylene (LDPE)- are plastics present in refuse bags, irrigation tubes, garbage bags, mulch
5. Polypropylene (PP)- examples are straws, lunch boxes, microwave dish, kettle, toys, cups, chip bag, tape
6. Polystyrene (PS)- is a common plastic in cases, cutlery, cups, building materials, food insulators, toy
7. Other- comprises other types of plastics used to make computers, cooler bottles, packaging, appliances, automotive components

(Mathur et al., 2014; Alabi et al., 2019).



Figure 1: Some clothes laced with plastics, Source: Regional Activity Centre for Sustainable Consumption and Production, 2020



Figure 2: Some toys and relations used by children at schools, Source: Regional Activity Centre for Sustainable Consumption and Production,

2020.



Figure 3: some wrappers made from plastic, Source: Regional Activity Centre for Sustainable Consumption and Production, 2020

4. COMMON USES OF PLASTICS IN SCHOOL ENVIRONMENT

Plastics are ubiquitous in our environment and everywhere you go. There are many uses of plastics in the school environment that are in direct contact with the students or are indirectly affecting the health of students. Some of the uses and contacts of students with plastics ranges from clothing, writing materials (such as pen, cleaners, mathematical sets), food containers (such as takeaways, coolers, beverage bottles, bags, packaging etc), electronics, building materials, toys, food wrappings, physical activity learning materials

etc. These can make learning easier in the classroom and at schools and on the other fold these can potentially pose effects to the health of the children (Proshad et al., 2018; Amran et al., 2022; Bhuyan, 2022; Mahmoud et al., 2023).

5. SOME POTENTIALLY HARMFUL CHEMICALS IN PLASTICS

Plastics contain several chemicals embedded together either due its production or due to sorption (Nor et al., 2021). Ideally, plastics contains monomers, additives, and attached chemicals. Some of the toxic additives in plastics that affects the health of humans especially children are as follows (Avio et al., 2016; Campanale et al., 2020; Hamza et al., 2023):

Bisphenol A is a common substance added in hard and clear plastics in food containers, beverage bottles, etc. The chemical is disgorging from the parent plastics into foods and relations especially during high temperature, acidity change; and acts as /like an endocrine hormone estrogen and disrupt the hormone. People at early life stages are more sensitive to this chemical and it is linked with cardiovascular diseases, type 2 diabetes, insulin resistance, obesity, cancer of prostate, cancer of breast, and miscarriage (Avio et al., 2016; Campanale et al., 2020).

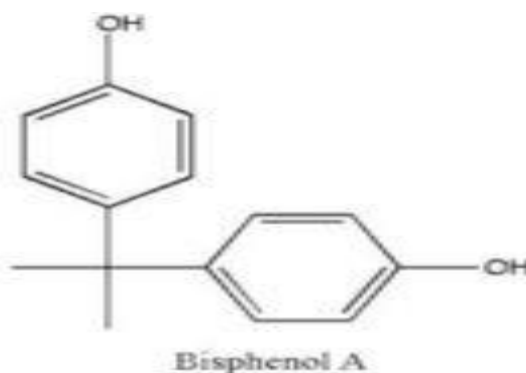


Figure 4; bisphenol A, Source: Proshad et al., 2018

Phthalates are a congregation of substances added to plastics as plasticizers to aid flexibility and resistance. These chemicals are present in food packages, raincoats, toys, coats, floors etc. These phthalates act as endocrine disruptors in humans and exert negative effects on reproductive system, and are related to obesity and allergies. Other concerns of the phthalates are effect on the cognitive development of children, and cause cancer, (Tachev & Christova-Bagdassarian, 2015; Campanale et al., 2020).

Brominated flame retardants such as polybrominated diphenyl esters, and tetrabromobisphenol A are endocrine disruptors due to their ability to leach into foods or contacts (Avio et al., 2016; Campanale et al., 2020). Flame retardants are types of chemicals

added to plastics and other consumer products for the purpose of prevention of fire spread. Some major flame retardants include phosphorus flame retardants (such as tris[2-chloroisopropyl] phosphate), brominated flame retardants (parable, polybrominated diphenyl ethers, tetrabromobisphenol A), paraffin types. These chemicals easily leach into foods or any contact and affect children more especially (Regional Activity Centre for Sustainable Consumption and Production, 2020; Sidi & Yahaya, 2022).

Metals such as cadmium, arsenic, lead, chromium, etc are also present in plastics as additives or sorption substances and leaches into the food materials and exert many effects on humans (Avio et al., 2016; Campanale et al., 2020; Sidi & Yahaya, 2022).

Table 1: Showing some metals added to plastics and their uses

Heavy metal	Use as additives	Plastic nature	Effects on health
Antimony	Flame retardant, biocide	PVC, PET, PBT	Metal-estrogen, breast cancer
Aluminum	Stabilizers, inorganic pigments, flame retardants	PVC, PET, PBT	Metal-estrogen, breast cancer
Zinc	Heat stabilizer, inorganic	PE, PVC, PP	-

	pigment, flame retardant		
Cadmium	UV stabilizer, heat stabilizer	PVC	Changes in calcium, bone, phosphorus, lipid and, metabolisms, cancer, apoptosis,
Cobalt	Inorganic pigment	PET bottle	Reactive oxygen species, neurological effect, endocrine defect, cardiovascular effect
Lead	Heat stabilizers, UV stabilizers, inorganic pigment	PVC, other types of plastics	Cytotoxic on colon cells, hypertension, anemia, miscarriage, infertility, cell damage, oxidative stress
Arsenic	Biocide	LDPE, PVC, polyester	Cancer of lung, skin, kidney, liver, bladder, apoptosis, death
Chromium	Pigment, UV stabilizers	PVC, PP, PE	Allergy, death, ulcer, hepatic effect, kidney effect, hematological effect, neurological effect
Mercury	Biocide	PU	Cancer, mutation, brain defect
Manganese	Pigments		Neurological

			disorder
Copper	Biocide	PU	Reactive oxygen species, oxidation of DNA, DNA break

Source: Bhuyan et al., (2022); Campanale et al., (2022)

Perflourinated substances are substances that bind proteins and gather in the brain, liver, kidney, spleen and relations. They cause cancer, mortality, physical development delay, endocrine disruption, reduced semen quality (RACSCP, 2020; Sidi & Yahaya, 2022).

Nonyphenols are formed as intermediate products after catabolism of antioxidants and related substances and are found to affect juvenile children in terms of fertility, and disruption of endocrine system (RACSCP, 2020; Sidi & Yahaya, 2022).

Table 2: Showing some biologically harmful chemicals emitted after plastic burning at school.

Chemical	Health effect
Acetaldehyde	Damages nervous system, lesion
Acetone	Eye irritation, GIT irritation
Benzaldehyde	Skin, and eye irritation, affect brain function, affect respiratory system
Formaldehyde	Eye damage, cancer, edema
Phosgene	Corrosive to eye, skin, and respiratory tract
Vinyl chloride	Cancer, irritation of skin and respiratory system, effect of CNS, spleen, liver, and bone marrow

Propylene	Central nervous system, low consciousness
Xylene	Eye irritation, nervous system defect, low learning, low consciousness
Toluene	Depression, irritation of respiratory tract and eyes
Styrene	Affect central nervous system, headache, weakness, fatigue, depression, eyes and mucous damage
Carbon monoxide	Reduces oxygen supply to the body
HCL	Skin burn, dermatitis, cough, nausea, vomiting, rhinitis, death, permanent loss of vision, dehydration, shock, bronchitis, stomachache, choking, tracheitis, lethargy, chills, circulation collapse
Volatile organic compounds	Sick building syndrome, asthma, headache, nausea, cancer, liver damage, kidney damage, CNS damage
Particulate	Low vision, excavate respiratory problems, asthma, bronchitis, heart attack, respiratory problem, emphysema
Dioxin and furans	Cancer, hormone disruption, immunity suppression, growth defects, , DNA damage, reproductive effect, endometriosis
Hexachlorobenzene	Kidney and liver damage, cancer, skin irritation
Polycyclic aromatic hydrocarbons	Cancer
Benzo(a)pyrene	Cancer
Sulfur oxides, dioxides	Damage lung tissues, skin, eyes, and nose irritations,

Source: Alabi et al., (2019); Bhuyan, (2022)

6. VULNERABLE NATURE OF CHILDREN PERTAINING PLASTICS

Children are more affected by plastics because they drink more water, eat more food, and breathe more than anyone. Therefore, more prone to exposure through air, water, and food. Children's metabolic pathways are not fully matured, therefore their ability to properly subject harmful chemicals to metabolism, detoxification and excretion is less and therefore more affected. Growth and development in children are rapid and the body system cannot easily repair when damage due to chemicals occurred. Likewise, children's life expectancy is longer than that of others, and impliedly have more time to develop diseases and effects due to toxicants (GESAMP, 2015; Amran et al., 2022; Bhuyan, 2022; Umar et al., 2022). Plastics have been part and parcel of our daily lives. Plastics are contacted by children through various means and in turn affecting human body. Children can swallow plastics (microplastics) through food, drinks, touching, tasting, and quasi exposures. Some plastics penetrate the body through sweat gland, wounds, hair follicle, and relations (Nor et al., 2021). Parable, a plastic bottle shaken with warm water makes about 16 million microplastics per liter. Plastics have the capacity to enter the respiratory system to stay in the alveolar surface, or transfer to other parts of the body. Children tendency to crawl, put

their hands in the mouth uncontrollably, and curiosity are more prone to plastic exposure compared to adults. It was estimated that about 553 tiny plastics are taken up by children every day, albeit some studies indicated a range of 14,600 to 4, 550, 000 particles daily. In the digestive system plastic accumulate and some are absorbed and results in inflammation and excitation of intestine due to passage. The microplastics can produce effect on esophagus, stomach and other regions of the intestine. Other effects due to plastics therein are: change in energy and fat metabolism, decreased lipid metabolism, oxidative stress, decrease amino acid, reduced mucous secretion, reduced feeding, intestinal dysbacteriosis etc (GESAMP, 2015; Amran et al., 2022). Henceforth, after absorption of plastics by the intestine they can be translocated and spread via the blood stream/ circulatory system and can enter the lungs where they cause pulmonary diseases. Other effects of microplastics in the circulatory system range from artery obstruction, incorporation into red cells, oxidative stress, high blood pressure, hematotoxicity, cardiac fibrosis, decrease white bold cells, etc (Amran et al., 2022; Bhuyan, 2022).

Similarly, microplastics are able to impede the normal reproductive

system of the body in many ways. Owing to their ability to traverse the system, they cause hormonal imbalance by inhibiting the gonads at hypothalamic level and leading to delay in puberty. Gonadotropin releasing hormone and gonadotropins are prevented. Likewise, plastics are able to instigate effect on placenta, and leading to other reproductive disorders such as pre-eclampsia, premature delivery, stillbirth, and abortion. Poor sperm production, nipple retention, damaging testes, low reproductive organ weight, hypoxia, undescended testes are some reported effects of plastics in males (Amran et al., 2022; Bhuyan, 2022).

On the nervous system, exposure to microplastics is implicated in effects such as memory loss, poor learning, anxiety, poor hormones production, oxidative stress, and poor performance. In the immune system, microplastics can impede metabolic balance, altered lymphocytes, aggravated localized toxicity, alteration of inflammation mediators' compositions, increased cytokines production (Singh et al., 2018ab; Amran et al., 2022; Bhuyan, 2022).

7. POSSIBLE PREVENTION TO PLASTIC POLLUTION

Indeed, the issues pertaining plastics are very delicate, few researches are done, few attention was paid on this area; but there is

critically important call for addressing the plastic concern as regards to the health of living organisms, let alone the vulnerable school children. Studies are indeed needed in the area to divulge appropriate unbiased information to the public. Public awareness on the pros and cons pertaining plastics is a key norm to safeguard public health, because nowadays most of the people regard plastic as a harmless entity contrary to the knowledge at the midst of specialists and scholars in the area (Amran et al., 2022). Similarly, making environmental education pertaining plastics is a priority. According to health belief mode humans that are knowledgeable about the harmful effects of plastics tend to act on preventive measures positively compared to those who are unaware. Therefore, plastics should be taught in schools to guide children on more appropriate ways to handle plastics in a way to reduces effects on the vulnerable children (Shamaki & Shehu, 2017; Dikko et al., 2022; Kraftl et al., 2022).

Recycling plastics is a norm that significantly reduce it further deterioration and further release of additives into the environment and the midst of the children/ consumers. And it is a norm that reduces the incorporation of plastics into the various parts of the

environment. However, very little portion of the plastics made globally is been recycled; therefore, companies should be forced by laws to abide by this strategy (GESAMP, 2015; Alabi et al., 2019; Shehu et al., 2020).

Effective production of plastics that are biodegradable is a predicted norm that reduces the plastics pollution and its consequent effect. Plastics such as bioplastics are suggested efforts to reduce pollution effect, and phasing-out harmful chemicals in plastics is another ploy of reducing the harmful effects of plastics of children and adult as well (Koushal et al., 2014; Hemavathi et al., 2019; Campanale et al., 2020).

8. CONCLUSION

Plastics have been part and parcel of our daily lives. Plastics are contained in many materials and items we dealt with nowadays. However, plastics contains harmful chemicals more especially as additives and these chemicals are able to leach into foods, water, air, and any contact. Children in contact with plastics containers, plastic teaching materials, plastic building materials and the likes are at the verge of taking harmful additives (and monomers such as styrene, vinyl chloride) into their body through food, water, air, skin etc.

Consequently, the additives could elicit negative effects such as oxidation, oxidative stress, inflammation, and cancer. Likewise, the important organs of the body such as kidney liver and quasi are prone to plastic effects especially because the body system of children is biochemically more vulnerable. There is need to divulge information to the public to take the issue of plastics very serious especially with regards to children vulnerability and make appropriate ways and motives to reduce the effects on children to the barest minimum.

9. REFERENCES

1. Alabi, O.A., Ologbunjaye, K.I., Awosolu, O., & Alalade, O.E. (2019). Public and Environmental health effects of plastic wastes disposal: A review. *Journal of Toxicology and Risk Assessment*,5(2),1-13.
2. Amran, N.H., Zaid, S.S.M., Mokhtar, M.H., Manaf, L.A., & Othman, WS. (2022). Exposure to microplastics during early developmental stage: Review of current evidence. *Toxics*, 10(597), 1-17.
3. Avio, C.G., Gorbi, S., & Regoli, F. (2016). Plastics and microplastics in the oceans: From emerging pollutants to

- emerged threat. *Marine Environmental Research*, xxx, 1-10.
4. Campanale, C., Massarelli, C., Savino, I., Locaputo, V., & V. F. Uricchio, (2020). A detailed review study on potential effects of microplastics and concern on human health. *International Journal of Environmental Research and Public Health*,17, (1212), 1-26.
 5. Dikko, M., Sarkingobir, Y., Abdullahi M.A., Salihu, I., & Tukur, U. (2022). Assessing immunization status and factors influencing vaccination coverage among children in rural suburbs of Sokoto state, Nigeria. *Al-athfal: Jurnal Pendidikan Anak*, 8(2),129-140.
 6. Gazal, A.A. & Gheewala, S.H. (2020). Plastics, microplastics and other polymer materials. *Journal of Sustainable Energy and Environment*, 11, 113-122.
 7. GESAMP (2015). Sources, fate, effects of the microplastics in the marine environment: a global assessment (Kershaw, P.J., ed.) (IMO/FAO/UNESCO IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP joint group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96p.
 8. Hamza, A., Gumi, A.M., Aliero, A.A., Umar, A, Sarkingobir, Y., Tambari, U. (2023). Potential of Neem Leaves on Preservation

- of Selected Elemental Compositions in Two Tomato Cultivars from Sokoto, Nigeria. *Journal of Bioresources and Environmental Sciences*, 2(1),15-20.
9. Hemavathi, B., Shobha Rani, A., Bharathi, D. (2019). Impacts of plastics on human health and environment. *International Journal of Development Research*, 9(1), 25267-25267.
 10. Koushal, V., Sharma, R., Sharma, M., Sharma, R., Sharma, V. (2014). Plastics: issues challenges and remediation. *International Journal of Waste Resources*, 4, 134-141.
 11. Kraftl, P., Hadfield-Hill, S., Jarman, p., Lynch, I., Menzel, A., Till, R., & Walker, A. (2022). articulating encounters between children and plastics. *Childhood*, 29(4), 478-494.
 12. Mahmoud, N.S., Kabbash, E.A., & Ek-kest, H.R. (2023). Effect of health educational program about plastic use hazards on knowledge, attitude and practice of preparatory school teachers. *Tanta Scientific Nursing Journal*, 28(1), 185-200.
 13. Mathur, N. Mathur, N. & Singh, A. (2014). Toxigenic effects of plastics on human health. *International Journal of Chemical Science*, 12(3),1045-1052.

14. Nor, N. H.M., Kooi, M., Diepens, N.J., & Koelmans, A.A. (2021). Lifetime accumulation of microplastic in children and adults. *Environmental Science and Technology*, 55, 5084-5096.
15. Parejo, J.L., Corton-Heras, M.O., Nieto-Blanco, A. & Segovia-Barberan, C. (2022). Plastics as an educational resource for sustainable development: A case study in Ghana. *Sustainability*, 13(6727), 1-22.
16. Proshad, R., Kormoker, T., Islam, M.S., Haque, M.A., Rahman, M.M., & Mithu, M.M.R. (2018). Toxic effects of plastic on human health and environment: A consequences of health risk assessment in Bangladesh. *International Journal of Health*, 6(1), 1-5.
17. Regional Activity Centre for Sustainable Consumption and Production (2020). Plastics toxic additives and the circular economy.
18. Sarkingobir, Y. Umar, A. I., Miya, Y.Y., Hamza, A., Tambari, U., Sule, I.F., & Magori, D.Z. (2022). Determination of Selected Essential (Copper, Zinc) And Non-Essential (Lead, Chromium, Cadmium) Heavy Metals in some single-use plastics from Sokoto Metropolis, Nigeria. *Journal of Materials and*

Metallurgical Engineering, 12(3), 29-37.

19. Sarkingobir, Y., Bello, A.A., & Yabo, H.M. (2021). Harmful effects of plastics on air quality. *Academia Letters*, 2967.
20. Sarkingobir, Y., Umar, A.I., & Shagari, K.A. (2020). Nanoplastics: Small science with bigger consequence. Proceedings of Virtual International Conference on Advancements in Nanotechnology (VICAN) & Association of Indian Biologists (AIB).
21. Shamaki, S.B. & Shehu, A.A. (2017). Assessment of solid waste management in Sokoto metropolis. *Journal of Agriculture and Environment*, 13(2), 159-167.
22. Shehu, A.A., Maiyaki, F.U., Yahaya, M.H., & Aliyu, S. (2020). Stakeholders views on ways to reduce the use of plastic bags and its environmental and public health impacts in Sokoto metropolis, Sokoto state, Nigeria. *International Journal of Research and Scientific Innovation*, vii(iv),196-200.
23. Sidi, A.S., & Yahaya, U.F. (2022). Chemical additives of concern in electronic plastics: Theoretical view. *ISSRA Journal of Applied Medical Sciences*, 1(3), 12-19.
24. Singh, A., & Raj, P. (2018a). Segregation of waste at source

- reduces environmental hazards of municipal solid waste in Patna, India. *Archives of Environmental Protection*, 44 (4), 96-110.
25. Singh, J., Saxena, R., Bharti, V., & Singh, A. (2018b). The importance of waste management to environmental sanitation: A review. *Advances in BioResearch*, 9(2), 202-207.
26. Soumiya, M., Balakrishnan, & Shanthi, K. (2018). Composition of municipal solid waste accumulated in Vellalore dump yard from Coimbatore City. *Research Journal of life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences*, 4(4),156-164.
27. Sripada, K., Wierzbicka, A., Abass, K., Grimalt, J.O., Erbe, A., Rollin, H.B., Weihe, P. etal (2022). A children's health perspective on nano-and microplastics. *Environmental Health Perspectives*, 130(1),1-15.
28. Tachev, A.K. & Christova-Bagdassarian, V. (2015). Phthalate plasticizers and safety of toys –problems and perspectives. *Emerging Life Sciences Research*, 1(1), 4-7.
29. Tait, P.W., Brew, J., Che, A., Costanzo, A., Danyluk, A., Davis, M., Khalaf, A., McMahon, K., Watson, A., Rowcliff, K., & Bowles, D.

(2020). The health impacts of waste incineration: A systematic review. *Australian and New Zealand Journal of Public Health*, 44 (1), 40-48.

30. Umar, A.I., Sarkingobir, Y., & Dikko, M., (2022). Spectro-analytical research of selected heavy metals (Cu, Cd, Cr, and Pb) in four different single-use plastics commonly in contact with food from Sokoto, Nigeria. *Jurnal Teknokes*, 15(1):76-80. <https://doi.org/10.35882/tekenokes.v15i2.199>.

Chapter - II

02

A STUDY ON THE POWER OF COMPOUNDING IN INVESTMENTS

Anthony Savio Herminio da Piedade Fernandes

Founder Owner of Trading Equations

Goa, India.

Email: anthonyfernandes9@gmail.com

ABSTRACT

We invest to beat inflation and maximize our return on investment. As an investor, we can use various proven strategies to get the best returns. However, if we want to make money the old-fashioned and effective way, we can consider a compound interest strategy. Compound interest gives us the best return on our investment, and interest earned continues to earn interest. This article explains how the power of compound interest can help us in our investment.

KEYWORDS: Power of compounding, simple interest, compound interest, study, investment

INTRODUCTION

Compound interest is the process of earning interest earned on an investment and reinvesting that interest back into the investment. Money can grow faster by putting the interest earned back into the investments. Basically, we are not only making a profit on our initial investment, but we are also making a profit on our previous earnings. Over time, compound interest can dramatically affect our overall wealth. In the short term, we can focus on compoundinm g

interest, but in the long term, you can earn more. For example, most people's retirement savings are the result of decades of accrued interest. The power of compound interest is one reason why it's important to start saving for retirement as soon as possible. Even if we cannot afford to give a large amount each month, investing consistently over a period of time can save us far more than starting investing until later in life. Before we can talk about the power of compound interest, we need to understand its foundation. Compound interest is the calculation of interest by adding principal and interest. Investments such as mutual funds and the stock market generate profits based on compound interest, hence the expression "the power of compounding".

COMPOUND INTEREST VS SIMPLE INTEREST

It is important to understand the difference between compound interest and simple interest. The simple interest rate is different from compound interest in that it offers interest only on the principal amount. For example, let us say that you invest Rs. 50,000 for a period of 20 years at an expected return rate of 7.5%. Let us now consider the below table to understand the different between compound interest and simple interest.

Investment Amount 50000			% Rate of Interest (p.a) 7.5		
Simple Interest Scenario			Compound Interest Scenario		
Year	Interest Accrued	Total Value	Year	Interest Accrued	Total Value
1	3750	53750	1	3750	53750
2	3750	57500	2	4031.25	57781.25
3	3750	61250	3	4333.59375	62114.8438
4	3750	65000	4	4658.613281	66773.457
5	3750	68750	5	5008.009277	71781.4663
6	3750	72500	6	5383.609973	77165.0763
7	3750	76250	7	5787.380721	82952.457
8	3750	80000	8	6221.434275	89173.8913
9	3750	83750	9	6688.041846	95861.9331
10	3750	87500	10	7189.644984	103051.578
11	3750	91250	11	7728.868358	110780.446
12	3750	95000	12	8308.533485	119088.98
13	3750	98750	13	8931.673496	128020.653
14	3750	102500	14	9601.549009	137622.202
15	3750	106250	15	10321.66518	147943.868
16	3750	110000	16	11095.79007	159039.658
17	3750	113750	17	11927.97433	170967.632
18	3750	117500	18	12822.5724	183790.204
19	3750	121250	19	13784.26533	197574.47
20	3750	125000	20	14818.08523	212392.555

At the end of 20 years through simple interest Rs. 50,000 got converted into Rs. 1,25,000 which is 2.5 times the investment amount. But through compound interest Rs. 50,000 invested has got

converted into Rs. 2,12,392 which is 4.24 times the investment amount, and almost double than what the simple interest could earn. The total interest earned under simple interest scenario is Rs. 75,000 whereas under the compound interest scenario it is Rs. 1,62,392, which is more than double as compared to the simple interest scenario.

CONCLUSION

The power of compounding refers to the reinvestment of accumulated returns. Returns earned on the principal is reinvested, increasing the principal. Compound interest helps maximize the return on investment. One should continue to invest in mutual fund programs with growth options and enjoy the benefits of compounding interest. Compound interest is based on the basic idea that interest is on interest. The power of compounding returns in stocks and mutual funds primarily helps maximize returns significantly more than other investments.

REFERENCES

1. Ślepaczuk, Robert and Zakrzewski, Grzegorz and Sakowski, Paweł, Investment Strategies Beating the Market: What Can We Squeeze from the Market? (January 11, 2012).

2. Farago, Adam and Hjalmarsson, Erik, Compound Returns (June 3, 2019). Proceedings of Paris December 2019 Finance Meeting EUROFIDAI – ESSEC.
3. Borgaon, Harshal, The Comparative Study on Systematic Investment Plan and One Time Investment Plan in Mutual Fund (June 30, 2020). GBS Impact
4. Power of Compounding, 07 Feb 2022,
5. Riley Adams, 13 Best Compound Interest Investments + Accounts, April 26, 2023,

Chapter- III

03

REVITALIZATION OF INDIAN TRADITIONAL (HERBAL) MEDICINE

T. Shri Vijaya Kirubha

Professor & Head, Dept. of Pharmacognosy

Periyar College of Pharmaceutical Sciences, Tiruchirappalli,

Tamil Nadu

ABSTRACT

In spite of incredible advances in modern science, technology and allopathic medicine at large, we are unable to provide quality healthcare to all. Traditional medicine particularly, herbal medicine is considered as a major healthcare provider around the globe particularly in rural and remote areas. A large section of people depends on such medicine for their primary healthcare mainly in underdeveloped or developing countries. Indian traditional medicinal system like Ayurveda, Siddha and Unani has a very rich history of their effectiveness; modern research also acknowledged the importance of such medicine. Indian traditional medicine or medicinal plants are also considered as a vital source of new drug. Mainstreaming of such medicine is important for the people. Several steps have been taken in India to promote such medicine and to integrate them into clinical practice. Evidence based incorporation of Indian Traditional Medicine in clinical practice will help to provide quality healthcare to all.

INTRODUCTION

Plants are always the key source of drug or treatment strategy indifferent traditional medicinal systems. In recent years, many

people are choosing plant based medicines or products to improve their health conditions or as curative substance either alone or in combination with others. According to the World Health Organization (WHO), herbs or herbal products are used by the large number of populations for basic healthcare needs. Herbal medicine includes herbs, herbal materials (like plant parts) or preparations, processed and finished herbal products, active ingredients. In recent years, there is a huge resurgence of the use of herbal product due to the side effects of modern drugs, failure of modern therapies for against chronic diseases, and microbial resistance. It is estimated that nearly 75% of the plant based therapeutic entities used worldwide were included from traditional/folk medicine. In India, approximately 70% of modern drug are discovered from natural resources and number of other synthetic analogues have been prepared from prototype compounds isolated from plants. It was reported that more than 60% of cancer drug available in market or in testing are based on natural products. Currently, about 80% of antimicrobial, immunosuppressive, cardiovascular, and anticancer drugs are derived from plant sources. More than 70% entities among 177 anticancer drugs approved are based on natural products or

mimetic. About 25% prescription drug found globally are derived from plant sources, and nearly 121 such drugs entity are in use. Thirteen drugs of natural origin are approved in United States between 2005 and 2007, and clinical trials are going on more than 100 natural product-based drugs. It was also estimated that 11% of the total 252 drugs found in essential medicine list of WHO are exclusively of plant origin. In Indian traditional medicine a large number of plants are used. It was estimated that Ayurveda uses 1,200 - 1,800 plants, Siddha medicine includes 500 - 900 plants, Unani utilize 400 - 700 medicinal plants and Amchi medicine uses nearly 300 plants while folk healers of India use more than 7,500 medicinal plants in different medicine. Three classical Ayurvedic literature Charaka Samhita, Sushruta Samhita and Astanga Hridaya mentioned about 526,573 and 902 number of plants.

Globalization of Indian Traditional Medicine

In recent years there is a huge upsurge in the use of traditional and complementary medicine around the globe. In Africa nearly 80% of population uses such medicine for their primary healthcare. In China, it was estimated that traditional herbal medicine account for 30 - 50% of the total medicinal consumption. Majority of the people

(around 60%) uses traditional herbal drugs as a first line medicine for treatment high fever resulting from malaria in countries like Ghana, Mali, Nigeria and Zambia. In Australia about 48%, in Canada 70%, in Germany 80%, in USA 42%, in Belgium 39% and in France 76% of population uses traditional/complementary medicine at least once. Around 75% of the HIV positive/AIDS patients living in San Francisco, London and South Africa use traditional and complementary medicine. In Malaysia, people spent more on traditional medicine than allopathic drugs. Importance of herbal medicines in terms of healthcare provider and economy are growing steadily. Therefore, India has a great opportunity to promote its Traditional Medicine globally.

Medicinal Plants of India and Economy

Approximately 25,000 effective plant-based formulations are available in Traditional Medicine which is commonly used by rural and ethnic people in India and the popularity of such medicine is also increasing among the common people. It was also estimated that >2000 tons of medicinal plant raw material is required annually. More than 1,500 herbals are also sold as dietary supplements or ethnic traditional medicines. It was also estimated that nearly 960

species of medicinal plants are in trade, among them 178 species have annual consumption levels more than 100 metric tons. Domestic trade of AYUSH industry is approximately INR. 80 - 90 billion, and export value of medicinal plants and related products from India is approximately 110 billion. In 2012 -2013, the export of AYUSH products was INR. 24,741.2 crores, though in next financial year (2013 - 2014) it was reduced slightly. The percentage share of AYUSH products in the total trade of India in 2013 - 2014 was 0.36%. The global market for herbal drugs is increasing in steady manner and the global herbal trade will reach USD 7 trillion by 2050.

Preventive and curative approaches of Herbal Medicine

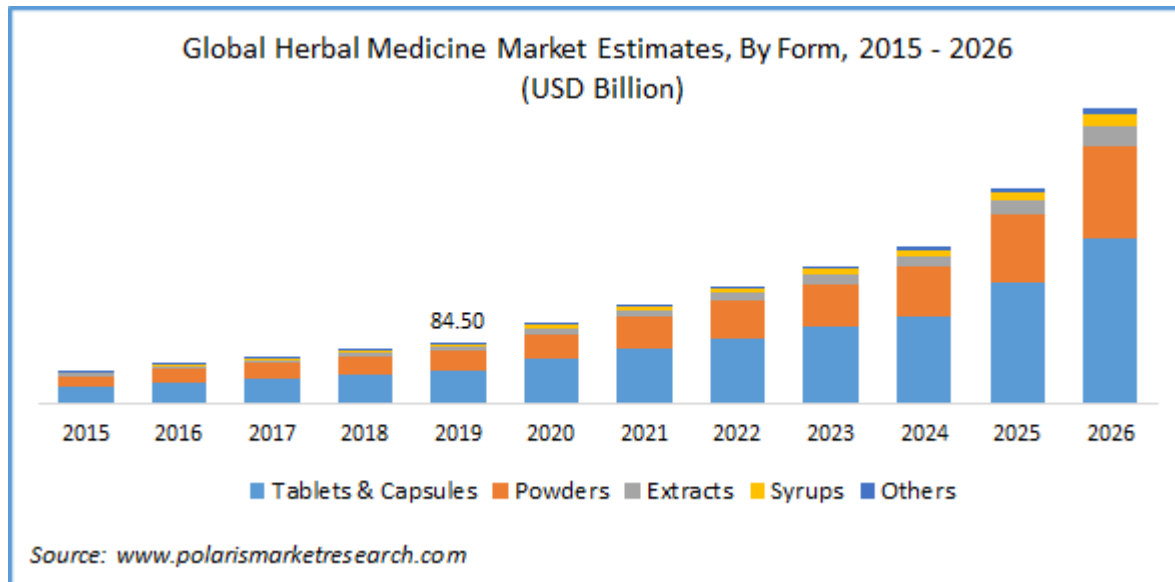
Ayurveda and other herbal medicine are involved in the curative and preventive measures to promote the health. Rasayana (rejuvenation therapy), branch of Ayurveda involve in the preservation and promotion of health by promoting longevity and also prevents or delays the ageing process, which another speciality of Ayurveda namely 'Panchakarma' (purification therapy) removes the toxins and waste materials from the body and thus purify the biological system to disease completely. 10 Ayurvedic formulations are highly effective against various common diseases like common cold, fever,

hyperacidity, ulcer, cough, gastro-intestinal problems, diarrhoea, amoebic dysentery, liver diseases, uterine bleeding, urinary tract infection, arthritic condition, gout, bronchial asthma, eye diseases etc. at the primary healthcare level. Formulation of Ayurveda also had shown prominent effect in the treatment of several chronic diseases like cardiovascular disease (hypertension, angina, cardiomyopathies, myocardial infarction, congenital heart disease), cancer, dengue, anti-inflammatory disease, kidney diseases etc.

Some studies have suggested that Ayurvedic medicine is also useful to manage some emergency conditions like severe diarrhoea and vomiting, patient suffering from typhoid suffered from semi consciousness and also muttering delirium, burns and seals, poison, threatened abortion, abortion & miscarriage etc. Medicine from Siddha system is used to cure diverse diseases like skin problems (psoriasis), sexual transmitted diseases, urinary tract infections, liver and gastro-intestinal diseases, diabetes, general debility, postpartum anaemia, diarrhoea, rheumatic diseases, prostate enlargement, bleeding piles, peptic ulcer, venereal diseases, fever, allergic disorders and general fevers other than emergency cases. Unani drugs are used to treat hepatitis, gastroenteritis & uteritis, fever,

cardiovascular problems, palpitation, nausea, vomiting, diarrhoea, gastro intestinal trouble, fever, insomnia, schizophrenia, epilepsy, gonorrhoea, urinary tract infection, kidney stone, headache, dizziness, common cold, migraine, colic pain, arthritis, syphilis, paralysis, diabetes insipidus, bad wetting, anxiety, typhoid fever, measles, small pox, premature ejaculation etc. ISMs are also found useful for care of HIV/AIDS patients.⁶⁸ Medicinal plants found in India and utilized by the different folk and codified medicine are utilized to cure diverse diseases.

The global Herbal Medicine Market size was valued at USD 84.5 billion in 2019 and is anticipated to grow at a CAGR of 20.5% during the forecast period. This revenue generation can be accredited to its increasing usage by people across the globe for maintaining and improving their health conditions. Rising demand for natural medicines along with increasing amount of funding for the development of traditional drugs will induce growth opportunities for the industry over coming few years. Additionally, herbal medications are considered as a type of dietary supplements which are available in market in different forms including powder, extracts, fresh leaves, dried plants, teas, capsules as well as tablets.



Rising number of various types of diseases is anticipated to support the industry growth rate during the projection period. Comparatively low cost of these products and building high value for the customers is primarily supporting the development of the market size. Moreover, awareness of these products among the customers across the globe will further boost the product growth rate over the study period.

Dated back to the ancient times, herbal medicines have been the common source of treatment for various diseases as well as enhancing health conditions. As per the National Center for Biotechnology Information 2015, the World Health Organization (WHO), stated that approximately 70% to 80% of the global population are dependent upon herbal sources for their treatment.

In 2016, according to the American Botanical Council the sales of herbal supplements ascended by more than 7% in the U.S. Thus, this increasing demand for traditional drugs will fuel the industry growth over the projected period.

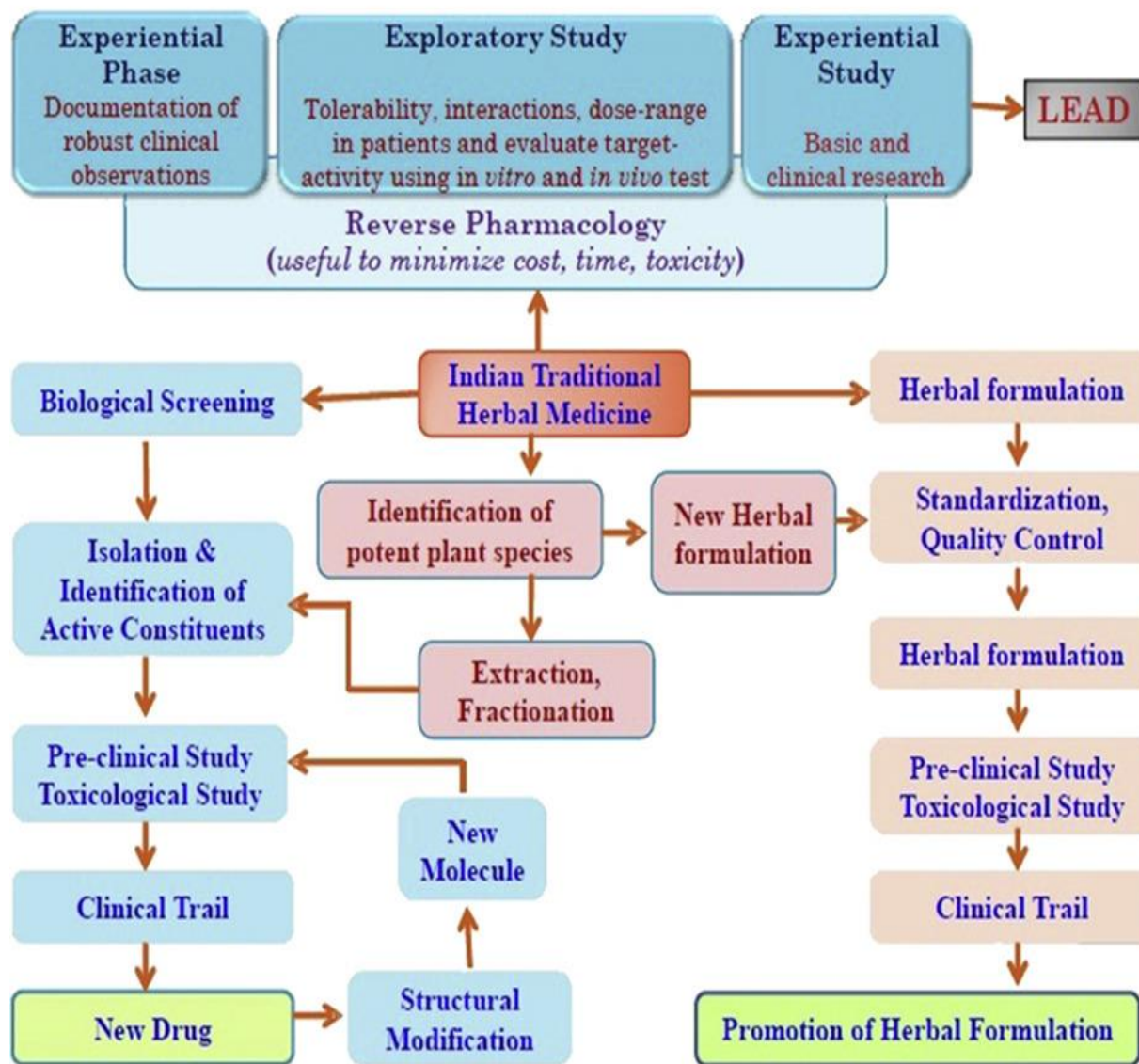


Fig. 2. Opportunity of drug discovery from Indian Traditional Herbal Medicine.

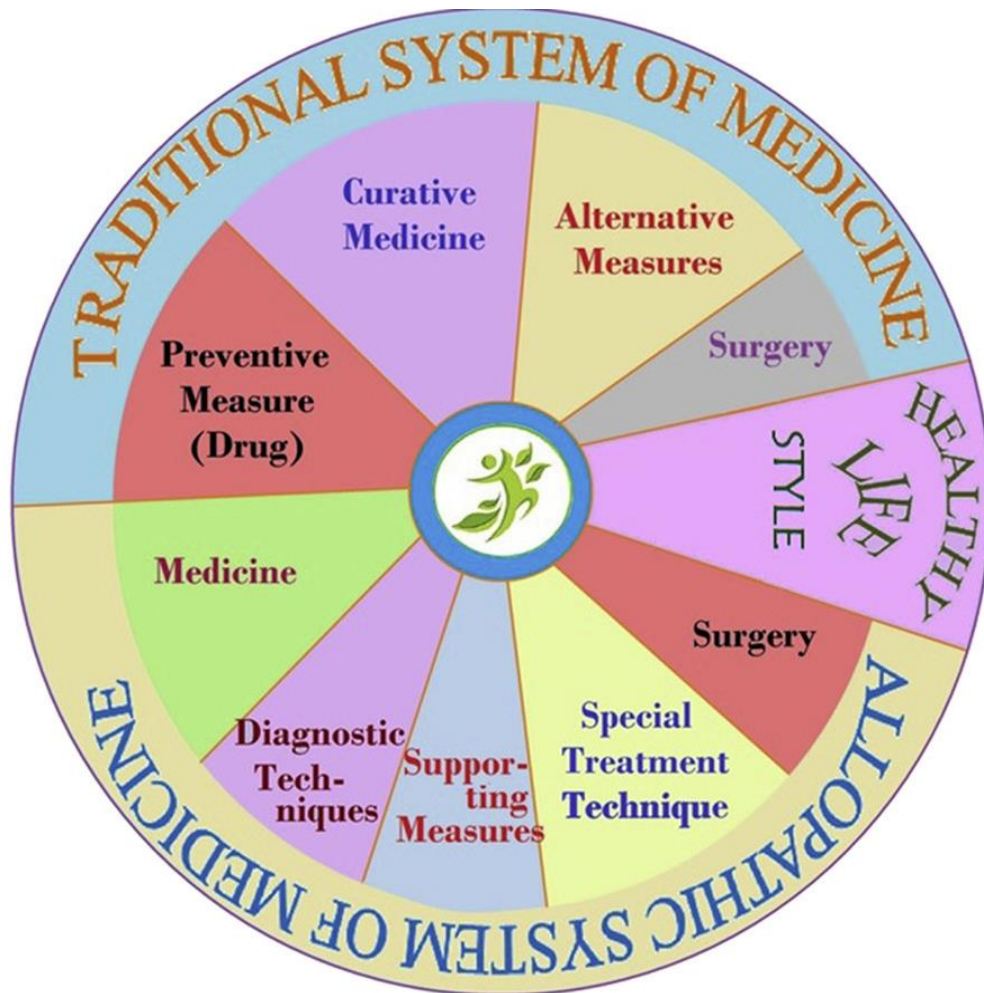


Fig. 3 Circle of life for achieving universal and quality life.

Indian Medicinal plants and Drug discovery

Drug discovery from medicinal plants used in different Indian medicinal systems is a hot spot of research. A number of drugs were obtained from the plant sources and several others have discovered by using natural substance as lead. Investigations in India and abroad became played a key role in such research. In 1931, Sen and

Bose reported two alkaloids from *Rauwolfia serpentina*, Siddiqui and Siddiqui in same year isolated five alkaloids which named as Ajmaline, Ajmalinine, Ajmalicine, Scrpentine, and Serpentinine. Chopra and his colleagues in 1933 isolated an alkaloid from the plant and observed the hypotensive and CNS depressant activity. Several others investigations had also been made by the Indian researchers in subsequent years. In 1949, a historical paper by Dr Vakil in British Heart Journal reported the antihypertensive activity of Rauwolfia in patients. During that time nearly 90% of doctors in India used it as a routine hypotensive drug and about 50 million tablets had been sold by a manufacturing agency alone. Peruvoside, a cardiac glycoside was isolated from *Thevetia peruviana* at the Indian laboratory and developed in Germany. Taxol, potent anticancer drug discovered from *Taxus brevifolia*, the plant has been utilized by western Indian cultures as a medicine since long time. national/ international research discovered a number of drugs from plant which has been used

Indian traditional medicine since ancient time, like, vasicine and vasicinone from *Adhatoda vasica*, bacosoids from *Bacopa monnieri*, tylophorine from *Tylophora indica*, homoharringtonine from

Cephalotaxus, camptothecin from *Camptotheca acuminata*, conessine from *Holarrhena antidysentrica*, morphine and codeine from *Papaver somniferum*, sarsasapogenin, asparanin A and asparanin B from *Asparagus adscendens*, shatavarin from *Asparagus racemosus*, atropine from *Atropa belladonna*, glycyrrhizin from *Glycyrrhiza glabra*, aloin from *Aloe vera*, protodioscin from *Tribulus terrestris*, sophoradin from *Sophora subprostrata*, quinine from *Cinchona* spp., trigonelline from *Trigonella foenum-graecum*, catechin from *Acacia catechu*, withanolides from *Withania somnifera*, tinosporic acid from *Tinospora cordifolia*, cocaine from *Erythroxylum coca*, aegelin and marmelosin from *Aegle marmelos*, pris-timerin from *Celastrus paniculata*, asiaticoside from *Centella asiatica*, emetine from *Cephaelis ipecacuanha*, psoralen from *Psoralea corylifolia*, glycyrrhizin from *G. glabra*, boeravinones from *Boerhavia diffusa*, berberine from *Berberis aristata*, plumbagin from *Plumbago indica*, curcumin from *Curcuma longa*, podophyllin from *Podophyllum emodi*, jatamansone from *Nardostachys jatamansi*, quassinoids from *Ailanthus* spp., arjunolic acid from *Terminalia arjuna*, gingerols from *Zingiber officinale*, digoxin and digitoxin from *Digitalis lanata*, paclitaxel from *Taxus baccata* and *Taxus brevifolia*, allicin from

Allium sativum, nimbidin from *Azadirachta indica*, forskolin from *Coleus forskohlii*, pilocarpine from *Pilocarpus jaborandi*, Dysobinin from *Dysoxylum binectariferum*, Diosgenin from *T. foenum-graecum* and plants of *Dioscorea* spp., vinblastine and vincristine from *Catharanthus roseus* and many more.

Novel semisynthetic derivatives of rohitukine (from the plant *Amoora rohituka* & *D. binectariferum*) named as flavopiridol and P-276-00 are in the advance clinical trial as anticancer drug.¹⁷ Guggulu, an oleo-gum resin obtained from the bark of *Commiphora wightii* has been used in Ayurveda for the treatment of inflammation, gout, rheumatism, obesity, and disorders of lipids metabolism.

Several compounds namely Z-guggulsterone, E-guggulsterone, guggulsterol-I, guggulsterol-II etc. have been isolated from guggulu. CSIR and its constituent laboratories are involved in the development of new herbal drug or formulation. Some of the key developments in Central Drug Research Institute (CDRI) in this area are, (i) standardized fraction of guggulipid was developed by CDRI and marketed (Guglip®, Cipla Ltd) as a drug for hyperlipidaemia and atherosclerosis, (ii) arteether (a semisynthetic derivative of artemisinin, the active constituent of *Artemisia annua*) as

antimalarial drug which is marketed by Themis Chemicals Ltd., Mumbai under the trade name E-Mal, (iii) Consap (a local spermicidal cream) contain saponins from *Sapindus mukorossi*, (iv) picroliv, an iridoid glycoside mixture containing 60% picroside I and kutoside obtained from *Picrorhiza kurroa* developed as hepatoprotective agent, (v) a standardize herbal preparation derived from the plant *B. monnieri* as memory enhancer.⁷⁸ RRL Jammu has commercialized *Boswellia serrata* gum resin as NSAID (non-steroidal anti-inflammatory drug) (Sallaki® Gufic).⁷⁹ A number of herbal pain reliever, antifungal cream, anti-dandruff shampoo has been developed by different CSIR labs across the country. Very recently, an antidiabetic drug (BGR-34) has developed jointly developed by scientist of CSIR-NBRI & CSIR-CIMAP. Under the 'Golden Triangle Partnership' project between AYUSH, Indian Council of Medical Research (ICMR), CSIR there is an attempt to find few formulations and developing new drugs.

In recent years research on these areas is increasing and lot more drug/formulations investigated by public or private sector in India are in queue or in under clinical trial. India has great pool of diverse medicinal plant sources, a long and well characterized traditional

medicinal system which makes India a unique place of new drug discovery.

Current Science & Technology in modernization of Herbal Medicine

Global pharmaceutical companies and researchers equipped with modern scientific knowledge, technology, idea and started to rediscover medicinal plants as a source of new drug candidates based on traditional knowledge. Modern technology and techniques have revolutionized the progression of drug discovery from medicinal plants. New approaches/concepts/technologies became a key tool in the development of traditional medicine further.

Research utilizing modern equipment or methods helped us to isolate and develop phytoconstituents as new drug present in traditional herbal formulation or medicinal plants. Modern technology and techniques became an essential tool to monitor and maintain the quality of traditional formulation, use phytochemical as lead to discover new drugs, to find pharmacokinetic profile and toxicity, to find out mechanism, to find the new use of existing drug or formulation, acceleration of drug discovery process, synthetic and semisynthetic process to manufacture a natural constituent etc.

Ayurveda is one of the oldest and well documented health traditions in the world. Drug discovery based on traditional information is a key path towards the discovery of new drug. Reverse pharmacology is an approach where discovery of leads/formulations is based on the documented clinical experiences and scientific observations through series of studies. Reverse pharmacology based on traditional knowledge concentrate on the reversing routine 'laboratory-to-clinic' development to 'clinics-to-laboratories'. Safety is considered as most significant point remains and the effectiveness becomes a matter of validation. This process is highly useful to find better and safer leads.

CONCLUSION

Medicinal herbs as a potential source of therapeutics aids have attained a significant role in health care system all over the world for human beings not only in the diseased condition but also as a potential material for maintaining proper health. It is clear that the herbal industry can make great strides in the world. With the increased use of herbal products, the future worldwide labeling practice should adequately address quality aspects. Standardization of methods and quality control data on safety and efficacy are

required for an understanding of the use of herbal drugs. A major factor impeding the development of the medicinal plant based industries in developing countries has been the lack of information on the social and economic benefits that could be derived from the industrial utilization of medicinal plants. Further research is required to exploit the compounds responsible for the observed biological activity.

REFERENCES

1. Ministry of Health and Family Welfare, Govt. of India. Regulation of Manufacture and Sale of ASU Drugs; 2006. Accessed from:
2. Mandal SC, Mandal M. Quality, safety, and efficacy of herbal products through regulatory harmonization. Drug Info J. 2011;45:45e53.
3. Pharmacopoeial Laboratory for Indian Medicine. Publications; 2015. Accessed from:
4. Central Council for Research in Unani Medicine. Unani Pharmacopoeial Committee; 2015. Accessed from: <http://www.ccrum.net/research/upc/>. Anonymous. Section 1: Summary of All-India AYUSH Infrastructure Facilities; 0913923524-Summary.pdf.

5. Ministry of AYUSH. AYUSH for Holistic Healthcare & Healthy Living; 2015.
6. <http://www.indianmedicine.nic.in>.
7. <http://www.pharmabiz.com/NewsDetails.aspx>
8. Health Division Planning Commission Government of India. Report of the Steering Committee on AYUSH for 12th Five Year Plan (2012 - 17); 2015.
9. http://planningcommission.gov.in/aboutus/committee/strgrp12/st_ayush0903.pdf.
10. Jain AK, Sharma BK. Developments in the field of Ayurveda e past to present. Ayushdhara. 2014;1:51 - 64.
11. Kasagana VN, Karumuri SS. Conservation of medicinal plants (past, present & future trends). J Pharm Sci Res. 2011;3:1378e1386.
12. National Medicinal Plants Board. Standard for Good Field Collection Practices of Medicinal Plants [DOC: NMPB-GFCP-01(FD)]; 2015.
13. World Health Organization. WHO Traditional Medicine Strategy 2002 - 2005.
14. Patel P. Globalisation of Ayurveda e A global vision for next

decade. Accessed from: <http://iaf-ngo.org/pdf/Globalisation>

15. Anonymous. Section: AYUSH Related Foreign Trade; 2014.

Chapter – IV

04

CARBON DOTS NANOMATERIAL AND THEIR MULTIMODAL APPLICATIONS

C. Dhanush, N. Bhuvaneshwari & K. Kousalya

Department of Physics, Rathinam College of Arts & Science,
Coimbatore, Tamil Nadu.

Email: dhanushchittan5261@gmail.com

Abstract

Over the past two decades, there has been an intense effort to widen the technological advantages of carbon-based nanomaterials such as graphene, carbon nanotubes (CNTs), fullerene, graphene quantum dots (GQDs), and carbon dots (CDs). Especially, CDs are recognized as excellent, zero-dimensional, bio-compatible carbon nanomaterials with size less than 10 nm. CDs have been extensively studied and applied in many aspects in the past years. CDs are bio-compatible and non-toxic nanomaterials which are mainly derived from carbon rich sources in comparison to other nanoparticles such as semi-conductor quantum dots. In contrast to quantum dots, the synthesis of CDs is usually simple and inexpensive. Recent literature explains the basics and technical features of CDs in detail. Earlier, organic fluorescent dyes were utilised as diagnostic agents but they experienced high photo-bleaching. Whereas, this drawback was absent in CDs and hence they were used in bio-imaging application. CDs were also used in bio-imaging studies due to their excellent photo stability, high fluorescence quantum yield and low cytotoxicity. In addition, due to their high catalytic activity they are used as catalysts in both chemo catalytic and photocatalytic applications.

In addition, CDs were also used in the fields of sensing, theranostics, optoelectronics and energy storage devices manufacturing.

1. Introduction:

Nanoscience has made huge strides in recent years, and its applications have started having profound influence on our daily lives. Nanoscience is the study of the characteristics of particles with sizes ranging from 1 to 100 nm in size [1,2]. Carbon nanomaterials (CNMs) have been ruling the field of nanotechnology for more than two decades now. Carbon is the most significant element in the periodic table and it is also the most important component of all living beings and organic molecules [3]. Carbon is the second most prevalent non-metal in the earth's crust after oxygen. CNMs excite researchers all around the world because of their intrinsic optical, electrical, and magnetic characteristics [4]. They are the most suitable materials used in semiconductor devices, energy conversion and storage devices, sensors. The different environmental and bio-medical applications are due to their simple synthetic techniques, chemically versatile nature and compatibility with biological systems [5].

Hybridization and catenation are the primary causes of the extreme optical and electrical characteristics of CNMs. The small energy gap between the 2s and 2p orbitals tends to occupy the electrons of the lower energy 1s orbital, resulting in an empty ground state that allows for sp , sp^2 , or sp^3 hybridization of carbon atoms with neighbouring ones, and this diversity in hybridization contributes to the formation of a wide range of organic compounds. CNMs have a wide range of structures (allotropes) due to their propensity to create strong covalent bonds with other atoms. C_{60} fullerenes, graphene, CNTs, graphene/carbon quantum dots (GQDs/CQDs) and CDs are the most common carbon allotropes [6].

2. Classification of carbon nanomaterials:

Carbon allotropes are categorized into three groups based on their dimensionality; they are [7]

- I. Zero dimensional (0D) (eg: C_{60} fullerene, nano-diamonds and CDs)
- II. One dimensional (1D) (eg: carbon nanotubes, carbon nanofibers)
- III. Two dimensional (2D) (eg: graphene)
- IV. Three dimensional (3D) (eg: multi-layered graphitic sheets,

diamonds)

- V. In the above-mentioned allotropes of carbon, CDs possess unique properties and application potentials. Thus, the significance of CDs are explained in detail in this chapter.

3. Discovery of CDs:

CDs were initially discovered by Xu et al., in 2004 during the refining process of single-walled carbon nanotubes (SWCNTs) through gel electrophoresis from carbon soot produced by arc discharge method. Xu and colleagues discovered several microscopic carbon particles during the purification process, and these particles glowed blue when excited at 365 nm and finally they named these particles as “Carbon Dots” [8]. In 2006, Sun et al., followed laser ablation approach to synthesize fluorescent CDs. Carbon dots can attach to a variety of organic and inorganic molecules due to their diverse surface functionalization. In reality, numerous procedures including doping, surface functionalization and composite formation with other materials can improve the capabilities of CDs making them attractive candidates for catalytic reactions, bio-imaging, sensing, and drug delivery [9].

CDs are the new emerging 0D star material with the size less than 10 nm in the carbon family. CDs have received lot of attention due to their excellent and tunable fluorescence, high quantum yield (QY), high thermal and optical photo-stability, low toxicity, small size, appreciable biocompatibility and abundant low-cost synthesis from renewable sources, which made them effective in a variety of fields like biomedicine, catalysis, sensors, optoelectronic devices, energy conversion/storage and anti-counterfeiting [10].

CDs have gained considerable attention in the last decade as a new class of nanomaterials [11]. Fluorescence is one of the most exciting ways of characterization of CDs from a fundamental aspect of application. The optical behaviour of CDs may be due to the distribution of distinct emissive sites on CDs and as well as by various particle sizes in the sample. CDs exhibit excitation-dependent emission behaviour where their PL mechanism still remains to be unclear. The PL emission spectra of the CDs is also influenced by the excitation wavelength and also by other parameters such as particle size, shape, composition, and internal structure. Mostly CDs are easily soluble in water and polar solvents

because of the presence of hydrophilic carboxyl groups on the surface [12].

4. Synthesis of CDs:

Various synthetic approaches for the production of CDs have been developed by researchers all around the world. They are divided into the two approaches listed below [13].

1) Top-down approach

2) Bottom- up approach

4.1. Top-down approach:

Since 2004, top-down strategies have been established. These techniques entail breaking up of bulk or 100 nm carbon-based starting materials into small sized CDs. Larger sources such as graphite, nano diamonds, graphene oxide, carbon nanotubes and carbon soot were employed in the production of CDs in this method. The solid large material was oxidized and thinned using a high-energy laser or an ionic beam. The particle size may be adjusted to 1-3 nm with this technological approach. Following are the top-down approaches,

(i) Laser ablation method

(ii) Arc discharge and

(iii) Electrochemical method

4.2. Bottom-up approach:

Small organic compounds are used to synthesize nanoscale carbon dots in a bottom-up approach. In this approach, glucose, citric acid, protein and resins were utilized as a carbon precursor for the synthesis of CDs. This approach includes the following methods,

- (i) Hydrothermal carbonization method
- (ii) Microwave assisted synthesis
- (iii) Solvothermal synthesis
- (iv) Thermal oxidation/combustion method

5. Doping on CDs:

Doping is a versatile and robust strategy for improving the chemical composition, fluorescence, defects, electrical, optical and structural properties of CDs. Pure CDs have a poor fluorescence quantum yield and low fluorescent behavior, which limits their use in sensing and biological applications. Doping of hetero atoms and metal atoms are effective ways to fine-tune the fluorescent properties of CDs [14]. Doping not only modifies the fluorescent behavior but also influences the reactivity or sensitivity of CDs towards the environment [15]. Due to their unique fluorescence characteristics,

good biocompatibility and excellent water stability, the doped CDs could be a suitable material for future biomedical and sensing applications [11].

5.1. Hetero atom doping:

To enhance the optical and electrical characteristics of CDs, doping with various heteroatoms have been attempted and reported. Heteroatom-doped CDs possess improved and enhanced fluorescence for widespread and diverse applications. Heteroatom doping has significantly improved physicochemical features such as fluorescence quantum yield, catalytic activity, and simulative responsibility. Hence, these highly fluorescent hetero atoms doped CDs are mostly used in the field of bio-imaging and other fluorescent biological applications due to their low-toxicity and good biocompatibility [16].

As per the literature, single hetero atoms like N, S, B and P doped CDs and multiple hetero atoms like NB, NS, NP and NSP doped CDs were reported mostly.

6. Applications of CDs:

Various kinds of distinctive, excellent and unique properties of CDs had enlightened its usage in the fields of catalysis, sensing,

theranostics, optoelectronics, energy storage devices and bio-imaging [17].

6.1. Catalysis:

CDs act as catalysts in the case of normal and photochemical reactions. CDs were proposed to be active materials in the field of photocatalysis. Absorption of light, electron transfer properties and the ease of coupling with semi-conductor material are the beneficial strategies of this application. At present, CDs are extensively used in the degradation of harmful dyes, industrial effluents and organic pollutants for environmental remediation purposes [18].

6.1.1. Photocatalysis:

Studies which involve light energy to create electron holes on the CDs surface and transports the electrons to the species for degradation is called as photocatalytic degradation. Compared to other degradation studies, photocatalytic degradation seems to be an attractive technique for the treatment of environmental pollutants [19]. CDs are good electron acceptors and donors which separate the electrons and holes effectively. Semiconductor materials- based CDs perform better photocatalytic activity than pure CDs. The biogenic CDs have gained remarkable attention due to their role in

photocatalytic activity in recent years. The interfacial interactions and band structures are playing major role in the photocatalytic behaviour of CDs and these activities can be enhanced by doping of hetero atoms, tuning of size and introducing new functional groups [20].

P. Adhimoorthy *et al.*, prepared fluorescent CDs from the waste orange peels through simple hydrothermal carbonization method. These CDs were amorphous in nature with large number of oxygen containing functional groups on their surface. CDs-ZnO photocatalyst was used for the degradation of naphthol blue-black azo dye under UV irradiation and its superior photocatalytic behaviour was also explored [21].

6.1.2. Electrocatalysis:

Electrocatalysis is a type of catalysis that results in the modification of the rate of an electrochemical reaction occurring on an electrode surface. The large surface area, fast charge transfer, high stability and excellent electrical conductivity of CDs endow them with great potential for application in electrocatalysis. CDs have been widely used as electrocatalysts for fuel cell energy conversion reactions such as oxygen reduction reactions (ORR), hydrogen evolution

reaction (HER), oxygen evolution reaction (OER) and electrocatalytic oxidation. Electrocatalytic performance of CDs were also improved by doping of hetero atoms onto the surface of CDs [22].

Y. Dong *et al.*, prepared nitrogen doped CDs (N-CDs) by dehydrating ethylenediamine tetra acetic acid (EDTA) with hot and concentrated sulphuric acid for oxygen reduction reaction (ORR). The prepared N-CDs were in 7 nm size. These N-CDs possess abundant oxygen-containing groups and emit blue fluorescence under 365 nm UV light irradiation. N-CDs supported by graphene exhibit outstanding electrocatalytic activity for ORR, and have a great application potential in direct methanol and alkaline fuel cells [23].

6.2. Sensing:

The optical and electrical features of CDs have excellent detection capability, sensitivity and selectivity in extending their applicability in sensor domains [24]. Owing to its functional groups on their surface, CDs have been employed as a fluorescence sensing probes in chemical and biological sensing applications [25].

6.2.1. Chemical sensing:

A.K. Singh *et al.*, hydrothermally synthesized nitrogen and phosphorous co-doped CDs from a microalgae *Dunaliella salina*.

These CDs acted as a fluorescent turn-off sensor for toxic metal ion such as Hg (II) and Cr (VI) with good selectivity and sensitivity. The limit of detection for Cr (VI) was found to be $0.018 \mu\text{M}$ ($0.9 \mu\text{gL}^{-1}$) which was below the permissible level in drinking water ($50 \mu\text{gL}^{-1}$) while in case of Hg, limit of detection was calculated to be $0.018 \mu\text{M}$ better than already reported biologically-derived sensor for Hg. Such sensing resulted because of combination of inner filter effect and dynamic quenching mechanism [26].

6.2.2. Biological sensing:

C. Wang *et al.*, successfully synthesized CDs from liquid fuels by chemical oxidation for cerebral Cu^{2+} sensing in rat brain microdialysate. The fluorescence of the synthesized CDs was quenched by the addition of Cu^{2+} . This phenomenon was due to the trapping of Cu^{2+} ions by the oxygen and nitrogen functional groups surrounding the emissive CDs. CDs displayed high sensitivity, selectivity and strong anti-interference ability for Cu^{2+} with a low detection limit of $0.039 \mu\text{M}$. Thus, a fluorescence assay was successfully employed for the analysis of cerebral Cu^{2+} in rat brain [27].

6.3. Theranostic applications:

Theranostics is a word which comprises the integrity of therapy and diagnosis. The therapeutic role of a theranostic system focuses on effective transport and controllable release of drugs/reagents to the lesion sites, while the diagnostic function offers information about the position, type and size of tumours in organisms [28]. Recently, CDs are used as theranostic agents in chemotherapy, gene therapy, photo thermaltherapy (PTT) and photodynamic therapy (PDT). Functional CDs could target tumors either through the enhanced permeability and retention (EPR) effect of the tumor microvasculature or by the specific binding with tumor-associated biomarkers, such as tumor cell receptors, tumor extracellular matrixes, and enzymes [29].

Lai *et al.*, worked on drug delivery using CDs and obtained excellent optical properties of CDs by conjugating mSiO₂-PEG to the surface of the CDs. The mSiO₂ PEG-CDs were used as a drug carrier for the anticancer drug DOX in HeLa cells [30].

6.4. Optoelectronics:

Optoelectronics is a branch of electronics that deals with electronic devices for emitting, modulating, transmitting, and sensing light. The use of CDs in the field of optoelectronics is of great interest currently

and has a high development potential [31]. The outstanding characteristics such as good biocompatibility, low cytotoxicity, high photo stability, versatility, unique tunable fluorescence and other exceptional physicochemical properties show that the emerging fluorescent CDs have enormous potentials for optoelectronic applications in recent years. CDs have previously been employed in solar cells and LEDs [32].

F. Yan *et al.*, synthesized multiple colour CDs by one step solvothermal method using some phenol derivatives. Blue to red emissive CDs were prepared by altering the reaction temperature. In this work, CDs mixed in a certain proportion yielded white-light emission diodes (0.32, 0.31; CIE coordinate). This research established a new platform for fluorescence detection of multi-color emission CDs and as well as the possibility for new optoelectronic devices [33].

6.5. Energy storage devices:

CDs have recently received substantial attention in the formulation of high-performance energy storage materials due to their ultrafine particle sizes and outstanding physicochemical features. The conductivity and electrochemical kinetics of other active materials

were found to be dramatically improved by CDs. CDs can boost electrical conductivity and speed ion-transport through their interfacial edges and ion diffusion routes, owing to their conductive graphitized cores. CDs with a variety of functional groups and various structural defects can provide a lot of absorption sites, which can effectively prevent electrode materials from dissolving and buffer volumetric expansions. Excellent solubility of CDs facilitates homogenous distribution of CDs within composite materials ensuring electrode consistency and stability. CDs are smaller in size with abundant surface functional groups and this could improve the electrode materials surface wettability property facilitating the electrochemical interactions between electrodes and electrolytes [34].

S. Daniel *et al.*, proposed a greener microwave-assisted pyrolysis route to synthesize highly blue fluorescent first-row transition elements (Mn^{2+} , Fe^{2+} , Co^{2+} , Ni^{2+} , Cu^{2+} , and Zn^{2+}) co-doped with nitrogen and nitrogen-sulphur carbon dots. Introduction of transition metal atoms to these CDs causes a significant increase in fluorescence and enables to fine-tune the emission characteristics of the CDs. These extremely fluorescent transition metal CDs

demonstrated considerable super capacitance capabilities and was a sustainable energy storage material. The capacitance results were consistent with the capacitance values published in the literature for carbon-based materials such as graphene and other kinds of CDs [35].

6.6. Bio imaging:

CDs have shown excellent potential to be used as probes for analysing biological systems, particularly for imaging-guided biomedical applications due to their unique properties such as the ability to tune surface functions, low toxicity, low cost, superior photo stability, high brightness, photo bleaching resistance, prominent biocompatibility, and spontaneous penetration capabilities [36]. Thus, for creating significant approaches in imaging applications, distinct functional CDs have been synthesized based on unique membrane lipids, proteins, targeting ligands, and biomarkers of various cells [37]. CDs were used for the development, diagnosis and treatment of cancers and neurological diseases. CDs were highly useful for discriminating normal cells from cancer cells which is of high importance in the current scenario [38].

R. Atchudan *et al.*, successfully synthesized nitrogen doped CDs (N-CDs) from *Magnolia liliiflora* hydrothermally for the multicolour fluorescent imaging of Clone 9 hepatocytes cells. CDs were highly mono dispersible, bio- compatible and blue fluorescent with a quantum yield of 11%. These N-CDs were quickly absorbed into the cytoplasm of the Clone 9 hepatocytes cells and possessed a strong cyto-compatibility on cellular morphology [39].

7. Conclusions:

CDs are a kind of carbon-based nanomaterial with size less than 10 nm size. These CDs are highly fluorescent in nature and possess excitation dependent emission behaviour and these CDs are amorphous in nature. CDs derived from carbon rich sources play a vital role in various fields like catalysis, sensing, optoelectronic devices, theranostics, energy storage devices and bio-imaging. These CDs material derived from natural green sources like plants, fruits and vegetables etc. exhibits highest impact in application and environment remediation measures. These kinds of carbon related nanomaterials are feasible to prepare and functionalise according to their application potentials.

References:

1. Khan, W.S. Hamadneh, N.N. Khan, W.A. (2016). Polymer nanocomposites – synthesis, techniques, classification and properties. *Science and Applications of Tailored Nanostructures*, 67, 50.
2. Lines, M. G. (2008). Nanomaterials for practical functional uses. *Journal of Alloys and Compounds*, 449, 242-245,
3. Cui, X. Xu, S. Wang, X. Chen, C. (2018). The nano-bio interaction and biomedical applications of carbon nanomaterials. *Carbon*, 138, 436-450.
4. Thirunavukkarasu, A. Nithya, R. Sivashankar, R. (2020). A review on the role of nanomaterials in the removal of organic pollutants from wastewater. *Reviews in Environmental Science and Bio-Technology*, 4, 751-778.
5. Kurra, N. Jiang, Q. Nayak, P. Alshareef, H. N. (2019). Laser-derived graphene: A three-dimensional printed graphene electrode and its emerging applications. *Nano Today*, 24, 81-102,
6. Garrido, M. Gualandi, L. Di Noja, S. Filippini, G. Bosi, S. Prato, M. (2020) Synthesis and applications of amino-functionalized carbon nanomaterials, *Chemical Communications*, 84, 12698-716,
7. Gaur, M. Misra, C. Yadav, A.B. Swaroop, S. Maolmhuaidh, F.O.

- Bechelany, M. Barhoum, A. (2021). Biomedical applications of carbon nanomaterials: fullerenes, quantum dots, nanotubes, nanofibers, and graphene. *Materials*, 14, 5978,
8. Xu, X. Ray, R. Gu, Y. Ploehn, H. J. Gearheart, L. Raker, K. Scrivens, W. A. (2004). Electrophoretic analysis and purification of fluorescent single-walled carbon nanotube fragments. *Journal of the American Chemical Society*, 126, 12736-12737.
9. Nair, A. Haponiuk, J. T. Thomas, S. Gopi, S. (2020). Natural carbon-based quantum dots and their applications in drug delivery: A review. *Biomedicine & Pharmacotherapy*, 132, 110834,
10. Das, S. Ngashangva, L. Goswami, P. (2021). Carbon dots: an emerging smart material for analytical applications. *Micromachines*, 12, 84.
11. Atabaev, T. S. (2018). Doped carbon dots for sensing and bioimaging applications: a minireview. *Nanomaterials*, 8, 342.
12. Xu, X. Li, Y. Hu, G. Mo, L. Zheng, M. Lei, B. Zhang, X. Hu, C. Zhuang, J. Liu, Y. (2020). Surface functional carbon dots: chemical engineering applications beyond optical properties. *Journal of Materials Chemistry C*, 8, 16282-16294.

13. Sharma, A. Das, J. (2019). Small molecules derived carbon dots: synthesis and applications in sensing, catalysis, imaging, and biomedicine. *Journal of Nano Biotechnology*, 17, 1-24,
14. Zhou, J. Zhou, H. Tang, J. Deng, S. Yan, F. Li, W. Qu, M. (2017). Carbon dots doped with heteroatoms for fluorescent bioimaging: a review. *Microchimica Acta*, 184, 343-368,
15. Reckmeier, C.J. Wang, Y. Zboril, R. Rogach, A.L. (2016). Influence of doping and temperature on solvato chromic shifts in optical spectra of carbon dots. *The Journal of Physical Chemistry C*, 120, 10591-10604.
16. Li, F. Yang, D. Xu, H. (2019). Non-metal-heteroatom-doped carbon dots: synthesis and properties. *Chemistry–A European Journal*, 25, 1165-1176.
17. Cui, L. Ren, X. Sun, M. Liu, H. Xia, L. (2021). Carbon dots: Synthesis, properties and applications. *Nanomaterials*, 11, 3419.
18. Anandan, S. Ikuma, Y. Niwa, K. (2010). An overview of semiconductor photocatalysis: modification of TiO₂ nanomaterials. *Solid State Phenomena*, 162, 239-260,
19. Koe, W.S. Lee, J.W. Chong, W.C. Pang, Y.L. Sim, L.C. (2020). An overview of photocatalytic degradation: photocatalysts,

- mechanisms, and development of photocatalytic membrane. *Environmental Science and Pollution Research*, 27, 2522-2565,
20. Dordevic, L. Arcudi, F. Cacioppo, M. Prato, M.A. (2022). A multifunctional chemical toolbox to engineer carbon dots for biomedical and energy applications *Nature. Nanotechnology*, 17, 112-130.
21. Prasannan, A. Imae, T. (2013). One-pot synthesis of fluorescent carbon dots from orange waste peels. *Industrial & Engineering Chemistry Research*, 52, 15673-15678,
22. Xu, F. Zhao, J. Wang, J. Guan, T. Li. K. (2022). Strong coordination ability of sulfur with cobalt for facilitating scale-up synthesis of Co₉S₈ encapsulated S, N co-doped carbon as a trifunctional electrocatalyst for oxygen reduction reaction, oxygen and hydrogen evolution reaction. *Journal of Colloid and Interface Science*, 608, 2623-2632.
23. Dong, Y. Pang, H. Yang, H. Jiang, J. Chi, Y. Yu, T. (2014). Nitrogen-doped carbon-based dots prepared by dehydrating EDTA with hot sulfuric acid and their electrocatalysis for oxygen reduction reaction. *RSC Advances*, 4, 32791-32795,

24. Ding, C. Zhu, A. Tian, Y. (2014). Functional surface engineering of C-dots for fluorescent biosensing and in vivo bioimaging. *Accounts of Chemical Research*, 47, 20-30,
25. Yi, Z. Li, X. Zhang, H. Ji, X. Sun, W. Yu, Y. Liu, Y. Huang, J. Sarshar, Z. Sain, M. (2021). High quantum yield photoluminescent N-doped carbon dots for switch sensing and imaging. *Talanta*, 222,121663.
26. Singh, A.K. Singh, V.K. Singh, M. Singh, P. Khadim, S.R. Singh, U. Koch, B. Hasan, S.H. Asthana, R.K. (2019). One pot hydrothermal synthesis of fluorescent NP-carbon dots derived from *Dunaliella salina* biomass and its application in on-off sensing of Hg (II), Cr (VI) and live cell imaging. *Journal of Photochemistry and Photobiology A: Chemistry*, 376, 63-72.
27. Wang, C. Pan, C. Wei, X. Yang, F. Wu, W. Mao, L. (2020). Emissive carbon dots derived from natural liquid fuels and its biological sensing for copper ions, *Talanta*, 208, 120375.
28. Dehviri, K. Chiu, S.H. Lin, J.S. Girma, W.M. Ling, Y.C. Chang, J.Y. (2020). Heteroatom doped carbon dots with nano enzyme like properties as theranostic platforms for free radical scavenging, imaging, and chemotherapy. *Acta Biomaterialia*, 114, 343-357.

29. Du, J. Xu, N. Fan, J. Sun, W. Peng, X. (2019). Carbon dots for in vivo bioimaging and theranostics. *Small*, 15, 1805087,
30. Lai, C.W. Hsiao, Y.H. Peng, Y.K. Chou, P.T. (2012). Facile synthesis of highly emissive carbon dots from pyrolysis of glycerol; gram scale production of carbon dots/mSiO₂ for cell imaging and drug release. *Journal of Materials Chemistry*, 22, 14403-14409.
31. Zada, A. Muhammad, P. Ahmad, W. Hussain, Z. Ali, S. Khan, M. Khan, Q. Maqbool, M. (2020). Surface plasmonic-assisted photocatalysis and optoelectronic devices with noble metal nanocrystals: design, synthesis, and applications. *Advanced Functional Materials*, 30, 1906744,
32. Li, X. Rui, M. Song, J. Shen, Z. Zeng, H. (2015). Carbon and graphene quantum dots for optoelectronic and energy devices: a review. *Advanced Functional Materials*, 25, 4929-4947,
33. Yan, F. Zhang, H. Yu, N. Sun, Z. Chen, L. (2021). Conjugate area-controlled synthesis of multiple-colour carbon dots and application in sensors and optoelectronic devices. *Sensors and Actuators B: Chemical*, 329, 129263,
34. Chao, D. Zhu, C. Xia, X. Liu, J. Zhang, X. Wang, J. Liang, P. Lin, J. Zhang, H. Shen, Z.X. Fan, H. J. (2015). Graphene Quantum Dots

- Coated VO₂ Arrays for Highly Durable Electrodes for Li and Na Ion Batteries. *Nano Letters*, 15, 565-573,
35. Daniel, S. Praveena, M.G. Mohammed, E.M. (2021). Exploration of highly photoluminescent first-row transition metals (manganese, iron, cobalt, nickel, copper and zinc) co-doped nano carbon dots as energy storage materials. *Materials Science and Engineering: B*, 269, 115145,
36. Chen, Y. Rosenzweig, Z. (2002). Luminescent CdS quantum dots as selective ion probes. *Analytical Chemistry*, 74, 5132-5138,
37. Li, H. Yan, X. Kong, D. Jin, R. Sun, C. Du, D. Lin, Y. Lu, G. (2020). Recent advances in carbon dots for bioimaging applications. *Nanoscale Horizons*, 5, 218-234,
38. Nocito, G. Calabrese, G. Forte, S. Petralia, S. Puglisi, C. Campolo, M. Esposito, E. Conoci, S. (2021). Carbon dots as promising tools for cancer diagnosis and therapy. *Cancers*, 13, 1991,
39. Atchudan, R. Edison, T.N.J.I. Aseer, K.R. Perumal, S. Lee, Y.R. (2018). Hydrothermal conversion of *Magnolia liliiflora* into nitrogen-doped carbon dots as an effective turn-off fluorescence sensing, multi-colour cell imaging and fluorescent ink. *Colloids and Surfaces B: Biointerfaces*, 169, 321-328,

Chapter – V

05

STUDIES ON THE ANTIMICROBIAL PROPERTIES OF OPSIN AND ENOLASE PROTEINS FROM THE *FIDDLER* CRAB SPECIES

Harshini. S

M.Sc.Biochemistry, P.G Research Department of Biochemistry,
D.K.M College for Women (Autonomous), Vellore – 632001.

Haritha. S

M.Sc.Biochemistry, P.G Research Department of Biochemistry,
D.K.M College for Women (Autonomous), Vellore – 632001.

Shoba. K*

***Corresponding Author**

Assistant Professor, P.G Research Department of
Biochemistry, D.K.M College for Women (Autonomous),
Vellore – 632001. Email: danishoba@gmail.com.

INTRODUCTION

The fiddler crabs are semiterrestrial marine crabs belonging to the family Ocypodidae, which contains over a hundred species. In Western Africa, the Western Atlantic, the Eastern Pacific, and the Indo-Pacific, there are little crabs that are no larger than 5 cm in diameter. The term "Fiddler Crab" (the giant claw) refers to the males' eating activity, which involved a tiny claw that travelled from the ground to its mouth in a way like to how a bow would be dragged across a fiddle. Their "sister genus" Ocypode's ghost crabs are their closest relatives. Lagoons, swamps, brackish intertidal mud flats, seashores, and other salt- or brackish-water wetlands are all places where fiddler crabs can be found.

Fiddler crabs are easily identified by their distinctly asymmetric claws and are found in mangroves, salt marshes, and on sandy or muddy beaches in West Africa, the Western Atlantic, the Eastern Pacific, the Indo-Pacific, and the Algarve region of Portugal. Over 100 species of fiddler crab can be found in 1 of the 13 genera that make up the Ocypodidae family of crabs.

Leptuca pugilator:

The sand fiddler crab (*Leptuca pugilator*), also known as the Atlantic sand fiddler crab or the Calico fiddler, is a type of fiddler crab that can be found from Massachusetts to the Gulf of Mexico. It can be found in great abundance and dwells in burrows in estuary and coastal mudflats.

*Leptuca pugilator**Austruca annulipes*

Fiddler crabs of the *Austruca annulipes* species can be found from South Africa through Somalia, Madagascar, India, China, Indonesia, Malaysia, and the Philippines.

Austruca annulipes was once a member of the genus *Uca* but changed to the genus *Leptuca* in 2016, which was formerly a subgenus of *Uca*.

There are nearly 100 species of fiddler crabs recorded around the

globe. The most common species in the Indian coast is the 'ring-legged fiddler crab' *Uca annulipes* (Fiddler crabs are closely related to Ghost crabs (eyes on stalk) under the family Ocypodidae (includes small crabs). *Uca annulipes* have been recorded in colours of red, orange, yellow and white.

This small crab with an enlarged pincer that is smooth is sometimes seen on some of our shores. Sandy, silty shores near the low water mark, often near mangroves. It was previously known as *Uca annulipes*.



Austruca annulipes

Antimicrobial Proteins:

Antimicrobial peptides (AMPs) are oligopeptides with a range of amino acid compositions (from five to over one hundred). From viruses to parasites, AMPs have a wide range of target organisms.

Anionic antimicrobial peptides/proteins, cationic amphipathic peptides, cationic AMPs , host defence peptides, and α -helical antimicrobial peptides are other names for AMPs that have been used historically.

Antimicrobial proteins or peptides (AMPs) are essential components of the innate immune response and are present in all kingdoms, including fungi, plants, mammals, and even yeast. According to several studies (Bulet et al., 2004; Yount et al., 2006; Guan-Guerra et al., 2010), AMPs are widely regarded as "natural antibiotics" because of their quick and potent antibacterial activities against a variety of microorganisms, including yeast, filamentous fungus, and, to a lesser extent, protozoans and enveloped viruses. Recent research has shown that AMPs are multifunctional molecules that not only have an antibacterial action but may also have a variety of other biological roles. A sizable quantity of data on AMPs has been saved in AMP databases, and research on AMPs is constantly expanding.

There have been more than 5,000 AMPs found or created as of now . Prokaryotes, such as bacteria, and eukaryotes, such as protozoa, fungi, plants, insects, and animals, are both known to have natural AMPs . Animals' tissues and organs that are exposed to airborne

pathogens are where AMPs are most commonly found, and they are thought to constitute the first line of defence for the innate immune system against viruses, bacteria, and fungi . As a result, AMPs are crucial in preventing most infections before any symptoms appear.

A number of antimicrobial peptides, including crustins, anti-lipoplysaccharide factors, penaeidins, arasin, and hyastatin, have been found from several crab species. AMPs are an essential part of the innate immune system in crustaceans. To the best of our knowledge, there aren't many reports concerning AMPs high in glycine.

Scientists have paid close attention to AMPs in marine creatures since 1988 because of their functions and potential as sources of potent antibacterial compounds. *Tachypleus tridentatus*, a Japanese horseshoe crab, produces tachypleusin, an 18-amino acid peptide that was isolated from its hemocytes and described as the earliest AMP in crab by Nakamura et al.. The AMPs are composed of diverse structure, length, and sequence, and are often rather tiny (less than 10 kDA). Another important factor to remember is that fish and marine invertebrates are heavily exposed to different bacterial strains in aquatic systems . As a result, AMPs participate in host

innate immunity as a defence against infections and diseases while living in that particular type of habitat. The ability of AMPs to demonstrate broad activity against fungi, protozoa, yeasts, and viruses is also stated. Numerous antimicrobial peptide counts have been discovered and reported in crabs over the past few years. Similarly, Schnapp et al. extracted a 6.5 kDa proline peptide known as another AMP from the hemocytes of the shore crab *Carcinus maenas*.

Opsin in Leptuca pugilator:

Opsins are a group of proteins that have been given the ability to detect light by a chromophore, typically the retina. G-protein-coupled receptors are opsins. When they are attached to retina, opsins transform into retinylidene proteins, but they are still frequently referred to as opsins. They are mostly located in the retina's photoreceptor cells. Five traditional groups of opsins mediate the conversion of a photon of light into an electrochemical signal, the first stage in the visual transduction cascade. A separate opsin called melanopsin, found in the retinas of mammals, is involved in the pupillary reflex and circadian cycles but not in vision. Humans contain a total of nine opsins. Along with the ability to

perceive vision and light, opsins can also detect chemicals, sound, and temperature.

Opsins are membrane proteins that serve largely as light sensors in living things. They are connected to the protein portion of the photoreceptive molecule rhodopsin and have molecular weights of 30 to 50 kDa.

For circadian rhythms, phototaxis, and other light-mediated reactions in living things, opsins are proteins that bind to molecules that respond to light. Type I opsins, which are typical of bacteria, originated independently of type II opsins, which are typical of vertebrates. This protein is necessary for healthy colour vision. Photoreceptor cells, which are grouped together in ommatidia in arthropod compound eyes, are in charge of transmitting visual signals. *Leptuca pugilator* one of the fiddler crab species where opsin protein is found.

Opsins, which are family-A GPCRs, fall into three major categories: ciliaryopsins, rhabdomericopsins, and photoisomerases. Ciliaryopsins have the cyclic nucleotide signalling cascade and are expressed in ciliary photoreceptor cells. The rhabdomericopsins, which have a phosphoinositol signalling cascade, are expressed by

rhabdomeric photoreceptor cells in contrast. Additionally, the term "photoisomerases" refers to both established and hypothetical stereospecific photoisomerases.

Leptuca pugilator's Opsin protein has 380 amino acids and a molecular weight of 42.13926 KDA (42139.26 g/mol).

FORMULA : $C_{1950}H_{2962}N_{480}O_{517}S_{23}$

Opsin protein deficiencies:

Retinitis Pigmentosa:

Retinitis pigmentosa (RP) is a set of uncommon eye conditions that affect the retina, the layer of tissue at the back of the eye that is sensitive to light. RP causes the retinal cells to gradually deteriorate over time, resulting in visual loss. RP is a hereditary condition that affects people from birth. Most people eventually lose the majority of their vision, and symptoms typically begin in childhood. Rods and cones are the two different classes of light-gathering cells in the retina. In low light, the rods that surround the retina's outer ring become active. The rods often experience the initial effects of retinitis pigmentosa. Your peripheral vision, which includes your ability to see at night, is lost. The majority of cones are located in the retina's middle. They aid with sharp detail and colour perception.

You gradually lose your capacity to see colour and your centre vision as RP affects you.

The loss of night vision, which usually manifests in childhood, is the earliest indication of retinitis pigmentosa. It may be challenging to move in low light if you have night vision issues. Later, the condition results in the development of blind spots in the peripheral (side) vision. These blind areas eventually converge to create tunnel vision. The condition worsens over years or decades, affecting central vision, which is essential for intricate tasks like reading, driving, and identifying people. Many adults with retinitis pigmentosa get legally blind at some point in their lives.

Most frequently, vision loss is the only retinitis pigmentosa symptom. Nonsyndromic refers to a condition that develops on its own. Nonsyndromic retinitis pigmentosa has been divided into three different subtypes, which are often defined by their mode of inheritance: autosomal dominant, autosomal recessive, or X-linked.

Retinitis pigmentosa develops less frequently as a result of disorders that affect different body organs and tissues. These illness manifestations are referred to as syndromic. Usher syndrome, the most prevalent kind of syndromic retinitis pigmentosa, is

characterised by the onset of visual and hearing loss simultaneously at a young age. Other hereditary syndromes with retinitis pigmentosa include Bardet-Biedl syndrome, Refsum disease, neuropathy, ataxia, and retinitis. The other names includes Pigmentary retinopathy, Rod-cone dystrophy, RP, Tapetoretinal degeneration.

When it comes to treatment there's no cure for this retinitis pigmentosa. There are few medications which may helps to feel better for the individuals with this disorder.

1. Acetazolamide: The little region in the middle of your retina may swell in the later stages. This condition is known as macular edoema and it too can impair the vision. This medicine might enhance your vision while reducing edoema.
2. Vitamin A Palmitate: High dosages of vitamin A palmitate may decrease the progression of retinitis pigmentosa by a little amount each year. However, the individual need to exercise caution because too much can be harmful.
3. Sunglasses: These shield the eyes from harmful ultraviolet rays that could hasten vision loss and lessen the eyes' sensitivity to light.

Lung Adenocarcinoma:

The most common cancer-related death in the world is lung cancer. According to estimates, there will be 142,670 lung and bronchial cancer fatalities and 228,150 new cases in the United States in 2019 . The majority of lung cancers, up to 85%, are non-small cell lung cancers (NSCLC), which is thought to be a sneaky illness with a bad prognosis. The aggressiveness of NSCLC and its resistance to standard treatments remain unsolved problems. Therefore, it is urgently necessary and clinically crucial to elucidate the pathophysiologic mechanisms in order to identify biomolecules as drug targets and develop novel therapeutic agents.

The G protein-coupled receptor (GPCR) known as opsin 4/melanopsin (OPN4), which is typically found in a small subset of intrinsically photosensitive retinal ganglion cells, controls circadian rhythms, pupil functions, melatonin expression, cognition, and sleep. There are about 900 members of the GPCR family, which activates heterotrimeric G proteins to transmit extracellular signals to intracellular effector pathways. The majority of GPCRs are overexpressed in head and neck, NSCLC, breast, prostate, gastric tumour, and melanoma primary and metastatic tumour cells. Many of the cell membrane receptors in this family are involved in

aberrant intracellular signal transmission that is frequently linked to the development and metastasis of tumours. In order to create new anticancer therapeutics for NSCLC, it may be logical to target the GPCRs involved in oncogenic signaling

GPCRs interact with different signalling proteins such as G proteins (G, families Gi, Gs, Gq/11, and G12/13) or arrestin to convey signals from the extracellular into the intracellular space. These G proteins are involved in a number of signalling pathways, including the activation of the PLC family by Gq/11, the stimulation of the adenylyl cyclase pathway by Gs, the suppression of the adenylyl cyclase pathway by Gi/o, and the activation of the small GTPase pathway by G12/13. Similar in structure are the protein complexes Gq, G11, G14, and G15/16, each of which has an active component that can cause PLC activation. Additionally, these subunits control overlapping and distinct signalling pathways, activating inositol lipid [for instance, calcium/protein kinase C (PKC)] signalling PLC isoforms as a result..

The increased expression of OPN4 contributes to the growth of lung cancer.

The symptoms includes shortness of breath, persistant cough, chest pain, Fatigue, raspy voice, Difficulty breathing, wheezing, etc.,

In order to help the individuals with this Retinitis pigmentosa and Lung Adenocarcinoma the medications such as drugs can be designed by using this *Leptuca pugilator* which contains an opsin protein. So by means of using bioinformatics tools the characterization that needs before designing a drug can be identified systematically within a little time.

Enolase in Austruca annulipes:

Enolase, a major glycolytic enzyme, belongs to a novel class of surface proteins that lack traditional surface transport machinery but are carried on the cell surface via an unknown method. Enolase is a multifunctional protein, and its capacity to act as a plasminogen receptor on the surface of a wide range of hematopoietic, epithelial, and endothelial cells implies that it may play a role in the intravascular and pericellular fibrinolytic system. Its function in systemic and invasive autoimmune diseases was just recently discovered. In addition to this capability, enolase's ability to function as a heat-shock protein and to bind cytoskeletal and chromatin structures suggests that it may be important in transcription and a range of pathological processes.

Enolase is a metalloenzyme that facilitates the interconversion of 2-

phosphoglycerate to phosphoenolpyruvate during glycolysis. This reversible enzymatic reaction is affected by the concentration of substrates available in the environment.

Enolase belongs to the large enolase superfamily. Depending on the isoform, it has a molecular weight of 82,000-100,000 Daltons. The two subunits of human alpha enolase are antiparallel in orientation, thus Glu20 of one subunit forms an ionic connection with Arg414 of the other. Each subunit is divided into two domains. The N-terminal domain is made up of three α -helices and four β -sheets. The larger C-terminal domain begins with two β -sheets, then two α -helices, and ends with a barrel composed of alternating β -sheets and α -helices arranged so that the α -helices surround the β -beta sheets. The compact, globular structure of the enzyme is the result of significant hydrophobic interactions between these two domains.

- In humans, there are three subunits of enolase α , β , and γ , and, each encoded by a separate gene and capable of combining to generate five different isoenzymes $\alpha\alpha$, $\alpha\beta$, $\alpha\gamma$, $\beta\beta$, and $\gamma\gamma$.
- $\alpha\alpha$ or non-neuronal enolase (NNE). Enolase 1 is another name for this enzyme. It can be found in a range of tissues, including the liver, brain, kidney, spleen, and adipose tissue. It is

found in all normal human cells at some level.

- $\beta\beta$ or enolase specific to muscles (MSE). Enolase 3 is another name for it. This enzyme is mostly limited to muscle, where it is found in extremely high concentrations.
- $\gamma\gamma$ or neuron-specific enolase (NSE). Also known as enolase 2. It is expressed at very high levels in neurons and neural tissues, where it can account for up to 3% of total soluble protein. Most mammalian cells express it at much lower levels.

Enolase Protein Deficiencies:

α -Enolase in Myogenesis and Muscle Regeneration

Proteolysis associated with the cell surface is a common mechanism in several physiological processes involving tissue remodelling. Myogenesis is an example of tissue remodelling in which massive extracellular matrix degradation takes place. Components of the PA system play important yet distinct roles in muscle regeneration after injury. Using genetically modified mice for uPA and plasminogen, we and others have shown that loss of uPA-mediated plasmin activity blunts muscle repair *in vivo*. In contrast, a negative role for PAI-1 in muscle regeneration was suggested. The PA system has also been shown to have an increasingly important role in muscular

dystrophies. For example, greater expression of uPA has been found in *mdx* muscle, the mouse model for Duchenne muscular dystrophy (DMD). Conversely, genetic loss of uPA exacerbated dystrophy and reduced muscle function in *MDX* mice. Satellite cells derived from human DMD patients produce more uPAR and PAI-1 and less uPA than normal satellite cells. uPA and plasmin appear to be required for the infiltration of macrophages into the damaged or dystrophic muscle in *mdx* mice. However, an interesting observation underpinning these results was that genetic loss of the uPAR in *mdx* mice failed to exacerbate muscular dystrophy, suggesting that uPA exerts its proteolytic effects independently of its cell surface receptor, the uPAR.

The particular muscle enolase isoform, known as β -enolase, is expressed in both differentiated myotubes and adult myoblasts that are actively growing. It is regarded as an early marker of myogenesis since it is increased in muscle during embryogenic development. The β -isoform is completely missing in adult muscle, whereas the expression of the α -isoform is maintained in adult muscle and in muscular cells. The increase of the α -isoform is followed by a decrease of the β -isoform. Additionally, we have shown that α -enolase is

upregulated in murine myoblasts C2C12 differentiation in vitro and in muscle regeneration in vivo. This raises the possibility that plasminogen receptors may also play a role in myogenesis and skeletal regeneration as a mechanism for controlling plasmin activity.

α -Enolase in Cancer

Enolase serves as a crucial protein, improving cellular metabolism in anaerobic environments, and encouraging tumour invasion through plasminogen activation and ECM degradation in cancer cells, where its activity as a plasminogen receptor has been widely studied.

Desmin, interleukin 8, and enolase were recently discovered as key players in the tumorigenesis of colon cancer in an investigation of disease-specific gene networks. The invasiveness of the follicular thyroid cancer cell lines was reduced by the knockdown of enolase-tubulin interactions, suggesting a function for the enolase gene product. Expression of enolase encouraged cell division, migration, invasion, and tumorigenesis.

Tumour cells must speed up their glucose metabolism as they grow and create tumours. Solid tumours frequently exhibit hypoxia. Glycolytic gene overexpression has been discovered in numerous

human malignancies, which is consistent with this. Enolase is produced on the cell surface of tumour cells, where it encourages cancer invasion and upregulates anaerobic proliferation (Warburg effect). Thus, it appears that α -enolase is having a pleiotropic effect on the development of cancer cells. A variety of posttranslational changes, including acetylation, methylation, and phosphorylation, have been shown to affect α -enolase in pancreatic ductal adenocarcinoma, where it has also been shown to be increased. Both the expression of α -enolase and posttranslational changes may have diagnostic and prognostic significance in cancer.

α -Enolase in Rheumatoid Arthritis

Chronic autoimmune conditions like rheumatoid arthritis, systemic sclerosis, and primary nephropathies have all been linked to overexpression of α -enolase. Autoantibodies to α -enolase are seen in the sera of people with extremely early-stage rheumatoid arthritis and may be useful for prognostic and diagnostic purposes. The primary autoantigen of rheumatoid arthritis has recently been identified as citrullinated proteins. Peptidylargininedeaminase catalyses citrullination, also known as deimination, which modifies the side chains of arginines. Protein structure, antigenicity, and

function could all be changed by this posttranscriptional alteration. The sinovial membrane has high levels of α -enolase, and rheumatoid arthritis-specific antibodies were detected against citrullinated α -enolase. Citrullination modifies the conformation of α -enolase, disrupts the noncovalent contact that leads to the development of the enolase dimer, and alters the glycolytic activity and plasminogen binding. It's probable that citrullination of cell-surface α -enolase abolishes its plasminogen binding and activating action and is a factor in the reduced fibrinolysis seen in rheumatoid arthritis. Oddly, additional glycolytic enzymes that operate as autoantigens for rheumatoid arthritis, such as glucose phosphate isomerase and aldolase, also encourage autoimmunity to the disease.

α -Enolase in Alzheimer's Disease

Although the specific neuronal enolase isoform is α -enolase, neurological tissues also contain the β -isoform. It has been suggested that enolase-enhanced plasmin production enhances neuritogenesis. The survival and neurogenesis of neural cells were also hampered by cathepsin X's cleavage of the C-terminal lysine of α -enolase. Enolase has been identified as a powerful plasminogen receptor in the brain and as a potential therapeutic target for Alzheimer's disease. It is

also known to be increased in this organ. Alzheimer's disease is characterised primarily by glucose hypometabolism and upregulation of glycolytic enzymes, but growing evidence suggests that -enolase may serve other purposes besides glucose metabolism. For example, plasminogen bound to -enolase stimulates plasmin activation of the prosurvival factor mitogen-activated protein kinase (MAPK)/extracellular-signal regulated kinase 1/2 (ERK1/2) as well as can drive In light of its many capabilities, α -enolase may operate as a neuroprotective agent.

Alzheimer's disease has recently been linked to a number of posttranslational changes of the enzyme α -enolase. Glycosylated-enolase, oxidised, or glutathionylated levels have been linked to Alzheimer's disease. Due to the metabolic deficiency linked to Alzheimer's disease, these alterations would make enolase catalytically inactive. A-enolase alterations may affect not just glucose metabolism but also its function as a plasminogen receptor, which regulates neuronal survival and $A\beta$ degradation. However, the impact of these modifications on the enzyme's other many activities is still a matter of active research.

REFERENCES

1. A. Castegna, M. Aksenov, V. Thongboonkerd et al., "Proteomic identification of oxidatively modified proteins in Alzheimer's disease brain. Part II: dihydropyrimidinase-related protein 2, α -enolase and heat shock cognate 71," *Journal of Neurochemistry*, vol. 82, no. 6, pp. 1524–1532, 2002.
2. A. Keller, J. Peltzer, G. Carpentier et al., "Interactions of enolase isoforms with tubulin and microtubules during myogenesis," *Biochimica et Biophysica Acta*, vol. 1770, no. 6, pp. 919–926, 2007.
3. A. Kinloch, V. Tatzer, R. Wait et al., "Identification of citrullinated alpha-enolase as a candidate autoantigen in rheumatoid arthritis," *Arthritis Research & Therapy*, vol. 7, no. 6, pp. R1421–1429, 2005.
4. B.Kavipriya, T.Nalini, K.Shoba, & B.Deevika, Protein Designing studies and Biophysical Characterization of Gaucher Disease, *International Journal of Pharmacy and Biological Sciences*, Volume 9 , Issue 2, 303-313, April 2019, ISSN: 2230-7605
5. Brunna da Silva Vianna , Caio Akira Miyai , Alessandra Augusto , Tânia Marcia Costa. Effects of temperature increase on the

physiology and behavior of fiddler crabs. *PhysiolBehav.* 2020 Mar 1;215:112765.

6. Christian Hamel . Retinitis pigmentosa. *Orphanet J Rare Dis.* 2006 Oct 11;1:40.

7. Dr. K. Shoba, S. Haritha and S. Harshini , Antimicrobial Peptides and its functional studies on *Austrucaannulipes*, Recent Advancements in commerce and management, Innovation and Entrepreneurship, Science and Technology, Pharmacy and health, Humanities and social science, education, language and literature, & Environment and Sustainability, International Publications, Volume 1, 186-194, August 2022,

8. F. Pratesi, S. Moscato, A. Sabbatini, D. Chimenti, S. Bombardieri, and P. Migliorini, "Autoantibodies specific for α -enolase in systemic autoimmune disorders," *Journal of Rheumatology*, vol. 27, no. 1, pp. 109–115, 2000.

9. G. C. Chang, K. J. Liu, C. L. Hsieh et al., "Identification of α -enolase as an autoantigen in lung cancer: its overexpression is associated with clinical outcomes," *Clinical Cancer Research*, vol. 12, no. 19, pp. 5746–5754, 2006.

10. Guinot, Danièle (2019-11-14). "New hypotheses concerning the

earliest brachyurans (Crustacea, Decapoda, Brachyura)".
Geodiversitas. 41 (1): 747.

11. Hsi-Te Shih, Joseph Poupin. A New Fiddler Crab of Austrorotuma, 1973, Closely Related to *A. perplexa* (H. Milne Edwards, 1852) (Crustacea: Brachyura: Ocypodidae), from the South Pacific Islands, *Affiliationsexpand*, PMID: 33262849, PMCID: PMC7688405

12. Hsi-Te Shih, Benny K K Chan. Systematics and Biogeography of Fiddler Crabs -A Special Issue in Zoological Studies. *Zool Stud*. 2022 Nov 16;61:e64.

13. J. B. Owen, F. D. Domenico, R. Suitana et al., "Proteomics-determined differences in the concanavalin-A-fractionated proteome of hippocampus and inferior parietal lobule in subjects with Alzheimer's disease and mild cognitive impairment: implications for progression of AD," *Journal of Proteome Research*, vol. 8, no. 2, pp. 471–482, 2009.

14. J. M. Taylor, J. D. Davies, and C. A. Peterson, "Regulation of the myoblast-specific expression of the human β -enolase gene," *Journal of Biological Chemistry*, vol. 270, no. 6, pp. 2535–2540, 1995.

15. Jeffrey S Levinton, Nils Volkenborn, Samuel Gurr, Kelly Correal, Sebastian Villacres, Rui Seabra, Fernando P Lima.

Temperature-related heart rate in water and air and a comparison to other temperature-related measures of performance in the fiddler crab *Leptuca pugilator* (Bosc 1802). *Therm Biol.* 2020 Feb;88:102502.

16. M. Suelves, B. Vidal, V. Ruiz et al., "The plasminogen activation system in skeletal muscle regeneration: antagonistic roles of Urokinase-type Plasminogen Activator (UPA) and its inhibitor (PAI-1)," *Frontiers in Bioscience*, vol. 10, no. 3, pp. 2978–2985, 2005.

17. M. Suelves, R. López-Alemany, F. Lluís et al., "Plasmin activity is required for myogenesis in vitro and skeletal muscle regeneration in vivo," *Blood*, vol. 99, no. 8, pp. 2835–2844, 2002.

18. Maeda T, Maeda A, Maruyama I, Ogawa KI, Kuroki Y, Sahara H, Sato N, Ohguro H. Mechanisms of photoreceptor cell death in cancer-associated retinopathy. *Ophthalmol Vis Sci.* 2001 Mar;42(3):705-12.

19. N. Obermajer, B. Doljak, P. Jamnik, U. P. Fonović, and J. Kos, "Cathepsin X cleaves the C-terminal dipeptide of alpha- and gamma-enolase and impairs survival and neuritogenesis of neuronal cells," *International Journal of Biochemistry and Cell Biology*, vol. 41, no. 8-9, pp. 1685–1696, 2009.

20.N. Wegner, K. Lundberg, A. Kinloch et al., "Autoimmunity to specific citrullinated proteins gives the first clues to the etiology of rheumatoid arthritis," *Immunological Reviews*, vol. 233, no. 1, pp. 34–54, 2010.

21.R. López-Aleman, M. Suelves, and P. Muñoz-Cánoves, "Plasmin generation dependent on α -enolase-type plasminogen receptor is required for myogenesis," *Thrombosis and Haemostasis*, vol. 90, no. 4, pp. 724–733, 2003.

22.Rosenberg, Michael S. (2019). "A fresh look at the biodiversity lexicon for fiddler crabs (Decapoda: Brachyura: Ocypodidae). Part 1: Taxonomy". *Journal of Crustacean Biology*. 39 (6).

23.S. F. Newman, R. Sultana, M. Perluigi et al., "An increase in S-glutathionylated proteins in the Alzheimer's disease inferior parietal lobule, a proteomics approach," *Journal of Neuroscience Research*, vol. 85, no. 7, pp. 1506–1514, 2007.

24.Shoba K. , Sowmiya S and Dr. Mazher sultana, *World Journal of Pharmaceutical and Life Sciences*, ISSN 2454-2229, Vol. 3, Issue 1, 427-436. 10.

25.Shoba K., Kalpana K., *Protein Modeling and Drug Docking Studies on Potential Protein Target (E. coli-dosP) and Compound Aldehyde*

(Sumatriptan) using Bioinformatics Tools. Research & Reviews: A Journal of Bioinformatics. 2018; 5(3): 9–18p.

26.T. Merkulova, M. Dehaupas, M. C. Nevers, C. Créminon, H. Alameddine, and A. Keller, “Differential modulation of α , β and γ enolase isoforms in regenerating mouse skeletal muscle,” European Journal of Biochemistry, vol. 267, no. 12, pp. 3735–3743, 2000.

27.V. Saulot, O. Vittecoq, R. Charlionet et al., “Presence of autoantibodies to the glycolytic enzyme α -enolase in sera from patients with early rheumatoid arthritis,” Arthritis and Rheumatism, vol. 46, no. 5, pp. 1196–1201, 2002.

28.Valerie J Smith , Elisabeth A Dyrynda . Antimicrobial proteins: From old proteins, new tricks. MolImmunol. 2015 Dec;68(2 Pt B):383-98. doi: 10.1016/j.molimm.2015.08.009. Epub 2015 Aug 29. PMID: 26320628

29.View at: Publisher Site E. Georges, A. M. Bonneau, and P. Prinos, “RNAi-mediated knockdown of alpha-enolase increases the sensitivity of tumor cells to antitubulin chemotherapeutics,” International Journal of Biochemistry and Molecular Biology, vol. 2, pp. 303–308, 2011.

30.W Sylvester Fredrick and S Ravichandran. Hemolymph proteins in marine crustaceans Asian Pac J Trop Biomed. 2012 Jun; 2(6): 496–502.

31. W. Jiang, X. Li, S. Rao et al., “Constructing disease-specific gene networks using pair-wise relevance metric: application to colon cancer identifies interleukin 8, desmin and enolase 1 as the central elements,” BMC Systems Biology, vol. 2, article 72, 2008.

32.W. Zhou, M. Capello, C. Fredolini et al., “Mass spectrometry analysis of the post-translational modifications of r-enolase from pancreatic ductal adenocarcinoma cells,” Journal of Proteome Research, vol. 9, no. 6, pp. 2929–2936, 2010.

33.Wan Roslina Wan Yusof, Fasihuddin Badruddin Ahmad, and Mummedy Swamy. A Brief Review on the Antioxidants and Antimicrobial Peptides Revealed in Mud Crabs from the Genus of Scylla.

34.Wang Q, Zhang T, Chang X, Wang K, Lee MH, Ma WY, Liu K, Dong Z. Targeting Opsin4/Melanopsin with a Novel Small Molecule Suppresses PKC/RAF/MEK/ERK Signaling and Inhibits Lung Adenocarcinoma Progression. Mol Cancer Res. 2020 Jul;18(7):1028-1038. WoRMS taxon details, Austrucaannulipes”.

World Register of Marine Species. Retrieved 2020-11-15.

35.X. Chang and C. Wei, "Glycolysis and rheumatoid arthritis," *International Journal of Rheumatic Diseases*, vol. 14, no. 3, pp. 217–222, 2011.

36.X.u C, Wang R, Yang Y, Xu T, Li Y, Xu J, Jiang Z. Expression of OPN3 in lung adenocarcinoma promotes epithelial-mesenchymal transition and tumor metastasis. *Thorac cancer*. 2020 Feb;11(2):286-294.

37. Y. Abiko, M. Nishimura, K. Kusano et al., "Expression of MIP-3 α /CCL20, a macrophage inflammatory protein in oral squamous cell carcinoma," *Archives of Oral Biology*, vol. 48, no. 2, pp. 171–175, 2003.

06

ENHANCING COGNITIVE LEARNING APPROACH WITH PSYCHOLOGICAL PERSPECTIVE AND ITS IMPLICATIONS

Dr. A.Kabilath Begum

Assistant Professor in English,
Rathinam College of Arts and Science
Coimbatore, Tamil Nadu

Abstract

In emerging education scenarios, the cognitive learning approach plays a vital role. Inculcating this process of learning emphasizes the role of the internal mental process such as memory, perception, and analysis in shaping our actions and reactions. However, recent research suggests that there is much scope for enhancing the cognitive approach to further our understanding of the complex workings of the human mind. In this paper, we explore the various ways in which the cognitive approach can be enhanced, and how this can contribute to a more nuanced understanding of the psychology of the students. The psychological approach has significant implications in designing instructional strategies to promote sustained attention, operational memory, retrieval and retention, critical thinking, and problem-solving skills among the students by designing instructional strategies to explore various domains to overcome the crucial load. Ultimately, incorporating cognitive psychology research into teaching practices increases their full potential to prepare them for success in their academic and professional lives.

Key words: Cognitive, Psychological, Memory, Attention, Perception.

Introduction

The cognitive approach emerged in the mid-20th century as a response to behaviourism, which emphasized the study of observable behaviors rather than internal mental processes. It posits that our mental processes play a crucial role in our behaviour and that by understanding these processes, we can better understand human behaviour. The cognitive approach has been applied to various domains such as perception, memory, language, and problem-solving, and has led to significant advances in our understanding of these domains. However, there is still much to be explored and understood about the human mind, and the cognitive approach can be enhanced to further our understanding.

Enhancing the Cognitive Approach

Incorporating Neuroscience: While the cognitive approach has traditionally focused on internal mental processes, recent advances in neuroscience have provided new insights into how these processes are implemented in the brain. By incorporating findings from neuroscience, we can gain a deeper understanding of how the brain supports cognitive processes and how these processes are affected by neurological disorders.

For example, studies using functional magnetic resonance imaging (fMRI) have revealed how different areas of the brain are activated during various cognitive tasks, such as working memory and attention. This information can be used to refine our understanding of how these processes work and how they are interrelated.

Similarly, research on neurological disorders such as Alzheimer's disease and Parkinson's disease has provided insights into the cognitive deficits associated with these disorders. By understanding the underlying neural mechanisms involved in these disorders, we can gain a better understanding of how cognition works and how it can be affected by various factors.

While the cognitive approach has traditionally focused on internal mental processes, recent advances in neuroscience have provided new insights into how these processes are implemented in the brain. By incorporating findings from neuroscience, we can receive a deeper understanding of how the brain supports cognitive processes and how these processes are affected by neurological disorders.

Emphasizing Individual Differences

The cognitive approach has often been criticized for ignoring individual differences in cognition. By taking into account differences

in factors such as age, gender, and culture, we can gain a more nuanced understanding of how cognition works and how it varies across individuals. For example, research has shown that cognitive abilities tend to decline with age, but the rate and pattern of decline can vary across individuals. Similarly, studies have shown that there are gender differences in cognitive abilities, with men performing better on tasks involving spatial reasoning and women performing better on tasks involving verbal ability.

By taking into account individual differences, we can gain a better understanding of the range of cognitive abilities and how they are influenced by various factors. This can be useful in developing interventions to enhance cognitive functioning in individuals with cognitive deficits.

Using Multidisciplinary Approaches

The cognitive approach has traditionally been an interdisciplinary field, drawing on insights from philosophy, linguistics, and computer science. However, by incorporating findings from other fields such as anthropology, sociology, and economics, we can gain a more holistic understanding of cognition and its role in human behavior. For example, research in anthropology has shown that cultural factors

can influence cognitive processes such as perception and memory. Similarly, studies in sociology have shown how social factors such as race and ethnicity can affect cognitive performance. By incorporating insights from these fields, we can gain a better understanding of how cognition is shaped by various factors, both internal and external. This can be useful in developing interventions that take into account the broader social and cultural contexts

Exploring Nonconscious Processes

While the cognitive approach has traditionally focused on conscious mental processes, recent research has shown that nonconscious processes play a significant role in shaping our behavior. By exploring these processes, we can gain a more complete understanding of how cognition works and how it influences behavior. Brain imaging techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) have also been used to investigate nonconscious processes. These methods allow researchers to observe neural activity in response to subliminal or implicitly presented stimuli. The other popular method is implicit association testing, which assesses the strength of associations between concepts that people may not be consciously

aware of. Participants are asked to categorize stimuli that are presented on a computer screen, and the speed and accuracy of their responses are measured to determine the strength of their implicit associations. Researchers can gain a deeper understanding of the mechanisms that underlie human behavior and decision-making. This knowledge can have important implications for fields such as psychology, marketing, and education, as it can help identify ways to influence behavior and attitudes at an unconscious level.

Cognitive psychological research in Teaching follows these steps.

Attention

Attention is an important part of learning, and research in cognitive psychology can help teachers design activities that encourage sustained attention. For example, teachers can use techniques such as chunking, where information is divided into smaller units to reduce cognitive load and improve attention. Teachers can also use multimodal teaching methods that include visual, auditory and kinesthetic methods to increase attention and retention.

Recall

Memory is another important component of learning cognitive

psychology has made significant contributions to our understanding of how it works. Memory refers to the process by which information is encoded, stored, and retrieved in the brain, and cognitive psychologists have developed a range of theoretical models to explain these processes. One of the most influential models of memory is the Atkinson-Shiffrin model, which proposes that memory consists of three stages, sensory, short-term memory, and long-term memory. Sensory memory holds incoming sensory information for a brief period, allowing us to perceive the world as a continuous stream of information. Short-term memory, or working memory, holds information for a limited time (typically less than 30 seconds) and is crucial for tasks such as problem-solving and decision-making. Long-term memory is the final stage, where information can be stored indefinitely and retrieved when needed. Research in cognitive psychology has also identified various factors that can affect memory performance, such as attention, rehearsal, and elaboration. Attention is critical for encoding information into memory, and studies have shown that divided attention (i.e., trying to focus on multiple things at once) can impair memory performance. Rehearsal involves repeating information to help

maintain it in short-term memory, and elaboration involves linking new Cognitive psychologists have also identified different types of memory, such as episodic memory, semantic memory, and procedural memory. Episodic memory refers to memories of specific events, while semantic memory refers to general knowledge about the world. Procedural memory involves the memory of how to perform specific tasks or skills, such as riding a bike or playing an instrument.

Cognitive psychology has made significant contributions to our understanding of how it works. Memory refers to the process by which information is encoded, stored, and retrieved in the brain, and cognitive psychologists have developed a range of theoretical models to explain these processes. Research in cognitive psychology has also identified various factors that can affect memory performance, such as attention, rehearsal, and elaboration. Attention is critical for encoding information into memory, and studies have shown that divided attention (i.e., trying to focus on multiple things at once) can impair memory performance. Rehearsal involves repeating information to help maintain it in short-term memory, and elaboration involves linking new information to existing knowledge

structures to facilitate encoding.

Cognitive psychologists have also identified different types of memory, such as episodic memory, semantic memory, and procedural memory. Episodic memory refers to memories of specific events, while semantic memory refers to general knowledge about the world. Procedural memory involves the memory of how to perform specific tasks or skills, such as riding a bike or playing an instrument.

Finally, research in cognitive psychology has also investigated memory distortions and errors, such as the misinformation effect, where exposure to misleading information can alter memory of an event. Studies have also shown that memory can be influenced by factors such as emotions, motivation, and the use of memory-enhancing strategies.

Cognitive psychology has and research in cognitive psychology helps teachers develop strategies that promote effective memory retrieval and retention. For example, teachers can use the principle of elaboration to combine new information with existing knowledge to improve memory recall and retention. Teachers can also use mnemonics such as acronyms and rhymes to help students

remember information.

Problem-Solving:

Problem-solving is a critical component of learning. A cognitive psychological approach have developed various measures to study how people approach and solve problems. These measures aim to understand the cognitive processes involved in problem-solving, such as planning, reasoning, decision-making, and creativity. One commonly used measure is the Tower of Hanoi task, which involves moving a series of disks from one peg to another, following specific rules. This task requires planning and strategy, and researchers can use it to measure problem-solving abilities and explore the cognitive processes involved in solving problems. Studies have shown that individual differences in problem-solving abilities can affect performance on the Tower of Hanoi task, and that training can improve problem-solving skills.

Another popular measure is the Remote Associates Test (RAT), which assesses creativity and divergent thinking by asking participants to identify a word that is associated with three seemingly unrelated words. For example, participants may be given

the words "banana," "heart," and "suit" and asked to identify the word that is associated with all three (in this case, "card"). The RAT can measure the ability to make remote associations between concepts and is used to study the cognitive processes involved in creative problem-solving. It can help teachers to develop effective problem-solving strategies. For example, teachers can use the principle of metacognition, which involves teaching students to reflect on their own thinking, to help them identify strengths and weaknesses in problem-solving. Teachers can also use cooperative learning activities that encourage students to work together to solve problems, promoting critical thinking and problem-solving skills.

4. Feedback:

Feedback is an integral part of learning, and research in cognitive psychology can help teachers provide effective feedback to students. For example, teachers can use formative assessment where feedback is provided during the learning process to help students identify their strengths and weaknesses. Teachers can also use peer feedback, where students give feedback to each other, to promote self-regulated learning and increase student motivation.

5. Cognitive load

Cognitive load refers to how much mental effort is required to process information and cognitive psychology research can help teachers reduce cognitive load in their teaching practice... For example, teachers can use techniques such as distributed learning, where learning is spread over time, to reduce cognitive load and improve retention. Teachers can also use scaffolding to break learning into manageable steps to reduce cognitive load and improve understanding.

6. Attitude

Mindset refers to the underlying beliefs and attitudes that influence behaviour and research in cognitive psychology can help teachers foster the growth of their students. For example, teachers can promote a growth mindset by emphasizing effort and persistence over innate ability. This can help students develop confidence in their ability to improve and succeed.

Conclusion:

In this paper, we have explored various in which the cognitive approach can be enhanced to further our understanding of psychology. Incorporating findings from neuroscience, emphasizing individual differences, using multidisciplinary approaches, and

exploring nonconscious processes, can gain a more nuanced and holistic understanding of noesis and its role in human behaviour, cognitive psychology research into teaching practices can have a significant impact on student learning outcomes. By designing instructional strategies that promote sustained attention, effective memory retrieval and retention, critical thinking and problem-solving skills, and effective feedback, teachers can enhance their students' learning experiences. Additionally, by reducing cognitive load and promoting a growth mindset, teachers can help students to develop the skills and attitudes they need to succeed in their future endeavors. Ultimately, by incorporating cognitive psychology research into teaching practices, we can help students reach their full potential and prepare them for success in academia and the workplace.

Reference

1. Brown.C. Peter, Henry L. Roediger III and Mark A. McDaniel. (2014) Make it Stick: The Science of Successful Learning.
2. Coyle Daniel (2009) The Talent Code
3. Kahneman, Daneil (2011) :Thinking Fast and Slow.
4. Duhigg, Charles., (2012): The Power of Habit

Chapter – VII

07

**INTERLACING AUTHOR AND
TEXT: LITERARY RUMINATIONS
ON MEANING-MAKING**

Rima Namhata; P. Prayer Elmo Raj

Introduction

The publication of Roland Gérard Barthes' seminal essay, "The Death of an Author" in 1967 and followed by Michel Foucault's radical essay, "What is an Author?" in 1979 earned raging reviews that stormed the academia as to the understanding of the notion of 'absolute' author in literary criticism. Albeit the history of literary criticism has had its share of debates on the understanding of author and authorship, firmly substantiated by Séan Burke, the theorist of authorship as in: "There is no theory of literature or the text which does not imply a certain stance towards the author" (1995).

The two radical essays instigated pertinent questions mainly that of the interpretation of a text, meaning-making and that of authorship. Barthes' and Foucault's essay have tried to separate the identity of author or divorce the text from the author, and argues that writing and author are unrelated, paradoxically, even though the word author is written in capital 'A' in both the essays. So, whether the essays are reflective of the subversion of authority of the author or making an attempt to not assign a signified (final meaning) to the text or want the text to speak for itself and make it predominant with the birth of the reader to let the final meaning rest with the complete

reading of the text by the reader. This meaning-making of a text is likely limited to criticisms as well. But here, instead of talking about criticisms, we will look into what and how i.e. which literary period became a precursor to fervently talk about text and meaning.

Mapping Authorship

The origin of the word 'author' as mentioned in *Oxford English Dictionary* (OED) is found from the Middle English period where it means a person who invents or causes something. The Old French has the word as *autor*. The Latin origin puts it as *auctor*, from *augere* which means an increase, to originate or to promote. However, shift of *auctor* (in Latin), to the spelling, 'th' took place in 15th century which happened under the influence of *authentic* (OED). Initially the traditional role of the author was bound to supremacy, authority within and even meaning-making of a literary text. Simply put, a common-sense concept ascribed the status of author to a creative, individual source, where the authorial intentions "warrant a particular reading for texts, the meanings of which are taken to be a form of private property belonging to the author" (Hartley, 2004, p.13) and this meaning-making, the creation of the creator/genius/author/composer/poet, with whatever we make it

coterminous with, but is primarily of the author, who had a linear bearing both in terms of meaning-making for the reader and interpretation of the text. In the lineage of English Literary criticism, the concept of author is relatively a recent debatable invention and no school of English literary thought have probed into the possible consideration of author.

Interestingly, the notion of reading and interpretation was assumed to be a channel sent directly by the author to the reader. This could be firmly accounted for in the pre-modern or medieval religious reading or textual theories where the author of a sacred-text, let us say for example, the *Bible* was considered to be transcendental, supreme, sovereign, and divine and anything the readers could do was but to comply with the scriptures or demurely accept the authorial intention with slavish obedience. The idea that readers could make meaning out of texts would have sounded blasphemous. So, meaning had to be divine, fixed. It was two centuries ago, in the eighteenth-century Romantic tradition, that with the probing questions of creativity, where Coleridge and Wordsworth understood the meaning of creation as something original, not a representation, imitation, reflection or even adaptation but

something unique, which could completely be called original, the creation of the author/poet. So, during Romantic Age, if it was anything, then 'creativity' was the probing question. Conversely the concept of text just did not spring from Zeus' head. Instead, English literary theory when consolidated into the school of New Criticism in the first decades of twentieth century became the founding head for the challenging notion of author. The controversy on authorial intention, meaning- making, and supremacy as Author-God is a modern concept in secular literary textual criticism. And it is this concept that underpins the ideological theory of meaning of a text that first found its roots and prominence in the School of Anglo-American New Criticism or Practical Criticism or Leavisism. In modern times, "textual theory located meaning in the text" (Hartley, 2004, p.140). In other words, Hartley (2004) quips,

Textual analysis is particularist...(and) involves examining the formal internal features and contextual location of a text to ascertain what readings or meanings can be obtained from it. It is not a tool to find the correct interpretation of a text, rather it is used to understand what interpretations are possible (p.227).

So, the Text under consideration is a thing and without any consideration of extraneous factors like biography, history, sociology, psychology etc. The growing dissatisfaction of the younger generation of critics with “bio-historical and subjective literary criticism” (Krishnaswamy, Varghese and Mishra, 2004, p. 113) brought the sprouts of the school of new criticism, initially an American movement that paralleled germination in England as *Practical Criticism*. The spearhead of this movement in America was John Crowe Ransom, Allen Tate, Cleanth Brooks and Robert Penn Warren who came to be identified with New Criticism. John Crowe Ransom wrote a founding book on Richards, Eliot, and others by the title of *The New Criticism* (1941), from which the movement got its name. However, the pioneers who mobilized the same movement in England were I.A. Richards and T.S. Eliot. Though the crusaders of each school differed but there were common grounds on which they shared the critical aspects of the text and meaning-making. However, the single influential person who had mobilized and shaped the present discourse of complex and overlapping trends of critical literary movements (British or American) spanning from 1930s to 1970s was none but the critic, poet, and dramatist T.S. Eliot.

The “technologico-Benthamite” (cited in Selden, 2005, p.15) civilization as was stated by F.R. Leavis, progressed rapidly with scientific discoveries, and fast-moving industrial societies; but there was an increasing unease growing for the most reverential literary works that were suffering from stagnancy. Writers were looking for a change in the literary sphere as the political, social, and cultural environment increasingly felt the untoward consequences of postwar pessimism and Victorian prudery. This desire brought in revolt in almost all critical camps who increasingly found escape in new criticism.

The reverential regard for the literary work that suffered from formulaic thoughts and sluggish ideas, found an excessive concern in the text itself. Citing John Crowe Ransom, who came up with the first law of criticism about the literary work that shall recognize: “The autonomy of the work itself as existing for its own sake” (1941, p.8). In simpler words, the basic aim of New Critics was to urge the readers while reading and evaluating a literary work not to take recourse to the biography of the author, the history of his/her times or an academic emphasis on the social and economic order at the time of production of the text and to eschew the psychological

bearing and moral effects on the reader. Apart from this, some of the tenets that governed the ideas of New Criticism were the intrinsic approach to check the extreme bio-historical approaches or the lop-sided humanistic approach. The distinct approach of the New Critics was *close-reading* or *explication* [derived from I.A. Richards' *Practical Criticism* (1929)] and William Empson's *Seven Types of Ambiguity* (1930). They put forth a fresh way of looking at texts as a self-contained verbal organization (Krishnaswamy et al., 2008, p.114). So, the meaning was intently to be found in the language, that is words, figures of speech, images, and symbols rather than character, thought and plot. A huge emphasis was laid on structure and meaning (organic unity) the two taken together and not divorced from one another. This could be further explicated to any form of literary work which primarily has the linguistic elements (a house of lexical analytical tools developed by Cleanth Brooks on T.S. Eliot and I.A. Richards' writings) that help in the interpretation of complex interrelations. The tools are: 'ambiguities' (multiple meanings), 'irony', 'paradox' and 'tension' within the work of literature. This is rightly put by M.H. Abrams (1978) as a form of a work which has a 'structure of meanings' and develops mainly through evoking

‘thematic imagery’ and ‘symbolic action.’ Thereby reading a literary text of any form: poetry, novella, narrative, ‘close reading’ enabled the readers’ understanding and interpretation of the text to get hold of the contextual connotations rather than the denotative lexical meanings. So, rigorous textual reading emphasizing form and content shorn of biographical and socio-historical perspectives, strengthened the school of New Criticism which emerged at its peak in the 1940s and 1950s. Going back to the lexical tone and style or analytical tool of a literary work, ‘tension’ has a major bearing, as Allan Tate used the word ‘tension’ to imply in a poem, “‘extension’ which means referentiality--and ‘intension’ which denotes implication.” To simplify, the theoretical frame for this study was provided by William K. Wimsatt along with Monroe. C. Beardsley, the two together came up with two path-breaking essays, *The Intentional Fallacy* (1946) and its corollary essay *Affective Fallacy* (1949) where the basic understanding for the literary text is the “printed material and not the author’s intention (realized/unrealized, conscious/unconscious) nor the historical context that created it” (Krishnaswamy et al., p.117). The term *intentional fallacy* implies reading or interpreting a literary piece of work or trying to

understand by way of reference to something outside the text.

Wimsatt and Beardsley asserted,

an author's intended aims and meanings in writing a literary work—whether these are asserted by the author or merely inferred from our knowledge of the author's life and opinions—are irrelevant to the literary critic, because the meaning, structure, and value of a text are inherent within the finished, free-standing, and public work of literature itself. Reference to the author's supposed purposes, or else to the author's personal situation and state of mind in writing a text, is held to be a harmful mistake, because it diverts our attention to such "external" matters as the author's biography, or psychological condition, or creative process, which we substitute for the proper critical concern with the "internal" constitution and inherent value of the literary product. (cited in

Selden 2005, p. 20)

The reading of the text in other words should be objective. This had formed the central tenet of New Criticism. Similarly, the corollary essay, *Affective Fallacy*, talks about the mistake of reading a text and evaluating it on the 'effects' it has on the readers. By effects we understand the emotion it evokes in the readers; because of which,

instead of democratising or making the reading objective, the critics realised that the interpretation becomes 'impressionistic and relativistic'. The two essays also acted as reactionary responses to I.A. Richards' writing, *The Principles of Literary Criticism* (1923), which says that the quality of a poem is to evoke psychological responses in the readers. (Abrams 1978, p.4)

New Criticism with its premise on ahistorical, neutral nature--and the study of 'only the words on the page' is not concerned with historical, biographical, social, and other cultural contexts; not interested in the fallacy of 'intention' and 'affect', but only in the text itself with language and organization; do not look for the text's meaning, but how the text 'speaks itself' (Selden, 2005, p.19). Drawing to an end, the movement of New Criticism actually acted as a precursor in the complex and radical movements of critical theories as to the questions of text, author and meaning. However, with the 1960s and 1970s, the movement began to wane away as more probing questions came into the nature of author?

Re-configuring Text and Meaning

The consonance with postmodernism/poststructuralism brought in the most radical and revolutionary essay by the French

poststructuralist, Roland Barthes' *The Death of the Author* (1967). Author, as the traditional notion conceptualises, has been confined to any work of art, book, photograph, literature, music, or anything created and can be read by another person. An author is a person responsible for a particular piece of work. In the same way, a writer would probably claim that he/she wrote the book. This could be applied to a photographer, film, television, or literary work---- anything that is created by a conscious, intellectual, and imaginative mind, and can be judged or interpreted by another person. So, a commonsensical idea would be a piece of work which assigns meaning by ascribing it to a creative, individual source. So, an author's intentions warrant a particular meaning to the text. In other words, any source of writing entails its meaning in a figure who is the guiding principle; someone above or beyond and the meaning-giver to the work. This unquestioning notion of the author as an absolute source of meaning and traditionally ordained as the origin and the meaning of the text stands as the final 'signified'. In accordance with the above postulation, we find a mention in *A Reader's Guide to Contemporary Literary Theory* that some literature/literary works after examination and scrutiny stand out in

distinction or preferably to say acquires a superior status. These texts become a canon and exhibit hierarchy or become exclusive, and the status is enjoyed by the authors as well (Selden et al., 2005). This brought raging anger and insecurity to the class of writers. It was the movement of New Criticism that first consolidated and questioned the notion of author. Furthermore, in the 1960s, a number of structuralists and poststructuralist theorists critically questioned that the canonical status had to be dismantled and demystified as the authority of the author or the meaning of the text was tyrannically determinate to the author's life, intention, psychology, historiography, codes, customs and manners.

Barthes locates a linguistic theory that marked a radical departure from the traditional author-oriented views that links the author with a radically metaphorical word, 'death'. As put by Graham Allen, "'The Death of the Author', is, however, a usefully condensed expression of Barthes' developing a post-structuralist approach to the issues of reading, writing, and the relationship between texts and the signs which comprise them (2007, p.73). Barthes' essay supposes that the historicity of the author has its foundation in the early modern period of Western Europe, "a modern figure, a product of our society

in so far as emerging from the Middle Ages with English empiricism and French rationalism and the personal faith of the Reformation...more nobly put the 'human person'" (142-143). Barthes contends that the author, the 'human person', functional in the capitalist society, is like an 'anchor' of the literary work and is the origin, the centre, the signifier. To put it simply, the work in which is embedded an assimilation of cultures, finds meaning in the origin which is manifested into the authorial figure. The author is ascribed as the centre or to put it in other words, meaning or reading of the text unarguably directed towards the authorial figure. In this way, Barthes critiques the author in traditional literature as, "The image of literature to be found in ordinary culture is tyrannically centred on the author, his person, his life, his tastes, his passions" (143). The tradition has upheld author, remarks Barthes, as the "transcendental signified standing behind the work as God is thought to stand behind the material universe" (Allen, 2007, p.74). Divine status was conferred to that of the author, someone who gives stability or acts as an anchor to closed, linear meanings. Barthes refutes: "a text is not a line of words releasing a single 'theological' meaning (the 'message' of the Author-God) but a multi-dimensional

space in which a variety of writings, none of them original, blend and clash” (p.146). The idea that the Author with its traditional inherent meaning enshrines the text with the final signified has been ceaselessly derided not only by Barthes, especially in his introduction of this notion in the epitaph to the essay extracted from Honoré de Balzac’s novel *Sarrasine*, that leads to a series of questions relating to the uncertainty of the voice, that is the voice that speaks has been subjected to questions. It was in France, the precedence was set to subvert the authority of the author. Mallarmé proposed to substitute language for man because it is the language which speaks, not the author. Valéry consolidated Mallarmé’s theory though with an inclination towards rhetoric and the verbal conditions of literature.

Writing does not signify or depend on an ultimate signified--- Author/God/Logos: that is the origin, and the end of the meaning are perpetually deferral in post-structuralist terms. The argument put forth by Barthes is that, in a “multiple of writing, everything is to be distinguished, but nothing deciphered (p. 147). In other words, meaning has no determinacy, no specificity. Barthes asserts: “Literature (better to say *writing*), by refusing to assign to the text a

‘secret,’ i.e. an ultimate meaning, liberates an activity we may call counter theological, properly revolutionary, for to refuse to halt meaning is finally to refuse God and his hypostases, reason, science, the law” (p. 54). This revolutionary argument opened a new stage for literary discourse, especially for the triad--- author, text and meaning; specifically speaking of meaning that cannot be assigned to text and which subverts the hypostases of God/Author/Logos/Reason/Science. The arguments add to Barthes’ understanding in a way where the conventional thoughts weakened, waned, and dismantled with the political and social currents of May 1968: French history suffered from the cataclysmic events of student’s protest the Vietnam War and the atrocities of the then French Government and the revolt of the workers’ union against the government and the aftermath thereafter. The political events resulted in the birth of radical thoughts among the intellectual class, especially with the theorists and philosophers like Roland Barthes, Jacques Derrida, Julia Kristeva, Michel Foucault, Jean Baudrillard and Phillipe Sollers. The emergence of the ardent school of New Criticism acted as a precursor to the more radical ideas of Post-structuralism. These schools became catalytic in situating literature as a discourse,

not in that transcendental, patriarchal frame, but very much in the world order of symmetry, horizontal and non-hierarchical immanent foundations.

Barthes' argument, to fix meaning to the figure of the author, in a sense limits, contains and tames meaning (p. 53). To clarify, give a text an Author is to impose a limit on the text, to furnish it with a final signified, to close the writing (p.147). Creating one's own connotation with words also forms the basic cardinal critique of Barthes, which gives a post-structuralist turn to the essay. What the essay implies is that the author loses control as to what background the reader brings to the text, which largely depends on the reader's personal experiences, cultures, and history of the words inscribed in the text. But the dimension is more complex than that. Post-structuralist thinking says that a reader's today's reading of a text will vary from tomorrow's reading of the same text and vary the day and after and after. The changeable meaning cannot be ascribed to a linear thought as every day the reader encounters a new experience that changes the lens of the interpretation. So, the meaning is subjected to the subjectivities of the reader and does not attain a final signified. With each 're-reading' the 'origin' of meaning lies

exclusively in 'language itself.' Dispensing away with the notion of the author, this post-structuralist essay gives within the birth of intertextuality, theory of the text and the journal *Tel Quel* (published between 1960-1983). The journal's prime objective echoes the idea behind the essay, *Death of the Author*, where, Barthes contests that the "figure of the author to stabilize meaning is to join modern western society's attempt to" give *writing* "a singular, unified and indisputable meaning or truth" associated with the capitalist, consumerist culture where the readers wanted to assign a stable, consumable, finite meaning to all texts would lead literature to consumption and consumerism. *Tel Quel* theory resisted the idea of texts assigned with a linear, decipherable meaning and being mass-produced and consumed. (Allen, 2007, pp.74-76). Conjecturing the author as the origin of meaning limits the profusion of meaning or the plurality of meaning that language displays. It is instead perpetually deferring; in a way, language becomes, fluid, and complex and never ends in tangible meaning. Barthes quips in by way of remark, there is "No underlying ground; the space of the writing is to be traversed, not penetrated: writing ceaselessly posits meaning but always in order to evaporate it: it proceeds to a

systematic exemption of meaning” (p.147).

Barthes theorises, that the creation of a text has versatile manifestations of pre-existing ideas, cultures, beliefs, languages, ideologies, philosophies, and the like. So, when a writer asserts a piece of creation as his/her own, with the understanding that the ideas are one's own, however, is not true. What one fails to acknowledge is that the author has borrowed everything from the previously existing, ideas, languages, texts, and human expressions that h/she has read or has been aware of. To simplify, the author as the source of meaning is replaced with readings based on linguistic elements in the text making the text open to multiple meanings and multiple readings. This is put by Allen as,

The literary text is no longer viewed as a unique and autonomous entity but as the product of a host of pre-existent codes, discourses, and previous texts. Every word in a text in this sense is intertextual and so must be read not only in terms of a meaning presumed to exist within the text itself, but also in terms of meaningful relations stretching far outside the text into a host of cultural discourses...viewing meaning can never be contained and constrained within the text itself... (this major term) Intertextuality

is not, however, an intended reference by an author to another text: intertextuality is the very condition of signification, of meaning, in literary and indeed all language. (2007, p.82)

So, the intertextual elements in a literary text affirm that there cannot be any centre of meaning, be it in the 'sign' (with a presumed signified) or the 'Author-God', who rendered meaning to the text. It is suggestive of a 'literary text always comprised of pre-existing textual elements' (Allen, 81). So, every word, idea, and concept used to create the text has come from some pre-existing ideas, cultures and human expressions woven into something apparently new and unseen. This is well reflected in the article where Barthes opines, "A text consists... of a multidimensional space in which are married and contested several writings, none of which is original: the text is a fabric of quotations, resulting from a thousand sources of culture" (Allen, p. 76).

Barthes decentralizes the authorial figure and divorces his/her history, and biography, from the interpretation of the text as to bequeath meaning on the authorial intention will limit the multiple meaning the text incorporates. So, to understand a text's perception and interpretation lies squarely with the reader; one should look into

oneself for the ultimate author. Through the iconoclastic lens of Barthes, the author has to die as writing is “the black-and-white where all identity is lost”. (Barthes, 2006, p.1256). Further asserted by litterateurs, like Jakki Spicer, “No presence can anchor a text’s meaning, no holy grail can ensure the truth; there is nothing that stands behind the name of the author” (2005, p.391) and interpretation lies only in the hands of the reader. Inferring from Balzac’s quote, there are multiple meanings inherent in the passage *Sarrasine* (1970), and the imprecise Author’s intent.

The Author is “further transplanted in his duties of production by the “modern scriptor,” (a distinction made by Barthes about the creators of text) a personage enacting a performative, “pure gesture of inscription,” drawing on a vast inner dictionary and mixing different writings to come up with something new, ultimately without singular, deep meaning (p.255). That is the author is merely a *scriptor* who only produces a text and does not explain the text; is born simultaneously with the text; does not ‘precede or exceed the writing, [and] is not the subject with the book as predicate’. To put it simply, Barthes says that a text is a place of multiple meanings drawn from several cultures, quotations, artefacts, and customs

which has a possible range of infinite meanings because of the language chosen from diverse cultures/objects. To bequeath an author for interpretation of a text is to foreclose the text and sever it from possible meanings. So, an inscription has no 'origin than language itself and language which ceaselessly calls into question all origins." Barthes finally makes the radical observation that the death of the author will simultaneously give birth to the Reader whose readings, philosophy of life, and understanding of the world would open an infinite range of interpretations or give impressions to the meaning of the text. So, Barthes concludes with, it is the reader who gives meaning to the text or actively produces meaning; Meaning should be found not in the origin, but in the destination which lies with the Reader.

It has been observed that for a text to be interpreted, meaning could never be anchored to a fixed site, locus, origin, centre as meaning has been quite flippant. So, writing as an entity with all its multiplicity, as diverse cultures, ideas, and concepts get assimilated into writing and one place where this manifold thought gets united, cohesive, bound-- is for Barthes, not the Author but the Reader. To simplify there could

not be any ultimate/s not even the reader for that matter and Barthes' essay is suggestive of meaning that does not concentrate at a point. Putting it in other words, writing with its diversity has no origin, but finds meaning in its destination, in its readers, who coalesce the various dimensions of writing, gather the text and with the readers, the text finds its meaning. The inference that could be drawn is the Reader is just one of the ultimate/s of interpreting or giving writing meaning.

Conclusion

The idea that meaning is not fixed but negotiated refers to the belief that the meaning of a text is not determined solely by the author's intentions or background. Instead, meaning is created through a complex interaction between the text, the reader, and the context in which it is read. Barthes argues that the author's authority over the meaning of a text is not absolute, and that the reader is an active participant in the process of interpretation. The meaning of a text is not a fixed or objective reality that can be discovered or decoded by the reader. Instead, it is a dynamic and subjective process that depends on the reader's own experiences, beliefs, and cultural background. In other words, the meaning of a text is negotiated

between the reader and the text, and it can change over time and in different contexts.

In the context of meaning-making, Barthesian perspective suggests that meaning is not fixed or objective, but rather is the result of a complex and dynamic process of interpretation. Meaning is not inherent in language, author's prerogative, or the objects that language describes. Instead, meaning is constructed through a process of interpretation, in which individuals make sense of the world around them based on their own experiences, cultural backgrounds, and social contexts. The meaning-making process involves a complex interplay of language, culture, and power relations. This suggests that the same text or object can be interpreted in various ways, depending on the individual interpreting it and the context in which they are interpreting it. Instead of relying on the author as the sole source of meaning in a text, meaning is produced through a collaborative and dynamic process between the reader and the text. The reader's interpretation of a text is just as important as the author's original intentions, and the meaning of a text can change over time and in different contexts.

Barthes' critique on the traditional idea of the author as the sole

source of meaning in a text argues that the author's intentions and biographical details are not necessary for understanding a text and that the reader's interpretation is just as important as the author's intentions. He distinguishes between readerly texts and writerly texts. Readerly texts are easy to understand and do not require active participation from the reader. They are typically structured in a linear and predictable way, and they reinforce dominant cultural values and ideologies. In contrast, writerly texts are those that require active participation from the reader. They are typically more complex and fragmented, and they encourage the reader to participate in the meaning-making process. It is the importance of context, power relations, and individual experiences that shapes the meaning-making process. Barthes' approach to meaning-making also emphasizes the role of language in shaping our understanding of the world. Language is not simply a neutral tool for communication but is rather a complex and powerful system that shapes our perception and understanding of reality. In this sense, texts are not simply transparent vehicles for conveying meaning but rather are complex and multilayered structures that require active interpretation and analysis. Accordingly, Barthes challenges the idea of a single,

universal meaning, and instead emphasises the multiplicity of meanings that can be produced through the interpretation of a text. Texts are open to multiple interpretations, and the meanings produced are shaped by the individual experiences and cultural contexts of the readers.

REFERENCES

1. Abrams, M.H. (1978). *A Glossary of Literary Terms*, Earl McPeck, USA.
2. Allen, G. (2007). *Roland Barthes*. In *Routledge Critical Thinkers* series. Routledge.
3. Barthes, R. (1977). *The Death of the Author*. *Image, music, text*. Fontana.
4. Barthes, R. (2006). "The Death of the Author." *Critical Theory Since 1965*. (Eds). Hazard Adams and Leroy Searle. New York: Wadsworth, 1256-58.
5. Barthes, R. (2000). "The Death of the Author." *Falling Into Theory: Conflicting Views on Reading Literature*. Boston: Bedford/St. Martin's.
6. Hartley, J. (2004). *Key Concepts in Communication, Cultural and Media Studies: The Key Concepts*, Routledge.

7. Selden, R., Widdowson, P. & Brooker, P. (2005). *A Reader's Guide to Contemporary Literary Theory*. Pearson, Longman.
8. Spicer, J. (2005). The Author Is Dead, Long Live the Author: Autobiography and the Fantasy of the Individual. *Criticism* 47(3), 387-403.
9. Wilson, S. (2012). Situated Authorship: Feminist Critical Engagement with Roland Barthes's "The Death of the Author". *Verso: An Undergraduate Journal of Literary Criticism*. 1-9.
10. Burke, S. (1992). *The Death and Return of the Author: Criticism and Subjectivity in Barthes, Foucault and Derrida*. Edinburgh University Press.
11. Author in Oxford English Dictionary.
12. Krishnaswamy, N., Varghese, J. & Mishra, S., (2008). *Contemporary Literary Theory: A Student's Companion*. Trinity Publisher.
13. Ransom, J.C. (1941). *The New Criticism*. Norfolk, Connecticut. New Directions.
14. Burke, S. (Ed.). (1995). *Authorship: From Plato to the Postmodern*. Edinburgh University Press.

Chapter-VIII

08

MARINE ACTINOMYCETES AND THEIR APPLICATIONS

Bhagyashree. C. R.

Research Scholar, Department of Studies in Microbiology,
Davangere University, Davangere-577007, Karnataka, India.

E-mail: crshreebhagya@gmail.com

Ramalingappa. B

Professor, Department of Studies in Microbiology, Davangere
University, Davangere-577007, Karnataka,
India. E-mail: ramalingappa.88@gmail.com

Abstract:

Actinomycetes have a significant role owing to their variety and shown capacity to create novel bioactive chemicals. They are almost endless sources of new compounds with several uses. Out of the over 10,000 known antibiotics, the streptomycetes group is regarded as economically significant among actinomycetes. The goal of Actinobacteria inhabit is to find new strains of this important group of microorganisms that produce distinctive, innovative bioactive substances. Due to their potential uses in the food, nutrition, and health industries, they have enormous economic significance.

Introduction:

Actinomycetes are gram-positive, spore-producing microorganisms that have characteristics with both fungi and bacteria. The actinomycetes are primarily found in freshwater, marine, and soil settings. Actinomycetes were recovered from soil samples all around the world in astonishing numbers (Berdy, 2005). The soil is one of the primary habitats of actinomycetes, however *Streptomyces* sp. continues to be the population's most crucial element (Oskay *et al.*, 2005). According to reports, *Micromonospora* species predominate in river sediments, while *Streptomyces* species are primarily found in river water (Rifaat, 2003). *Micromonospora* sp., *Actinoplanes* sp., *Thermoactinomyces* sp., *Rhodococcus* sp., etc. are some examples of the fresh

water actinomycetes. These species are typical freshwater actinomycetes that break down lignin, cellulose, chitin, and other materials (Rajagopal *et al.*, 2018). Marine ecosystems are a type of extreme habitat. a significant source for the isolation of novel microorganisms is thought to be the combination of temperature, pressure, and salinity.



To withstand the environmental conditions and have the ability to transform and mineralize organic materials, the microorganisms that survive in that environment must have special physiological and structural properties (Das *et al.*, 2007, Usama *et al.*, 2014). Actinomycetes are also found in plants as endophytes and in other harsh environments, such as antarctic environments, volcanic caves, hydrothermal vents, and deserts (Karuppiyah & Mustaffa, 2013). Actinomycetes, which make up the largest taxonomic unit in the bacterial

kingdom, are members of the phylum *Actinomycetales*. According to (Dhakal *et al.*, 2017), they are gram positive organisms that are aerobic or facultatively anaerobic in nature and have DNA that contains more than 50% guanine and cytosine. They have a coccoid structure, resemble rods, or give forth branching mycelia. Aerial mycelium and substrate mycelium are the two types of mycelia. The aerial mycelia are carried on substrate mycelia and bear chains of spores or sporangia, whilst the substrate mycelia branch out widely and cling to the surface of the medium in quest of nutrition (Rajagopal *et al.*, 2018). Seas and oceans encircle around 70% of the earth's crust, and this area is thought to be an understudied habitat for microbial diversity. Due to their capacity for producing a large variety of bioactive compounds, marine actinomycetes are regarded as commercially priceless and a treasure trove of prokaryotic organisms. Even the manufacturing of over 70% of the antibiotics used to treat infectious diseases was proven to take place (Berdy, 2005). Promising secondary metabolites come in a wide variety, including antibiotics, antitumor agents, antiparasitic agents, antiviral agents, herbicides, insecticides, vitamins, enzymes, enzyme inhibitors, etc. (Rashad *et al.*, 2015). Numerous kinds of antibiotics, including ansamycins, anthracyclines, macrolides, aminoglycosides, β -lactams, terpenes, tetracyclines, peptides, fatty acids, polyketides, alkaloids, sugars, etc., are produced by marine actinomycetes (Dina *et al.*, 2020). Due to

the abuse and overuse of antibiotics in the medical, agricultural, and pharmaceutical industries today, pathogenic bacteria have developed a greater resistance to them.

These microbes pose a major threat to human life. According to reports, drug-resistant microbial diseases claim the lives of approximately 700,000 individuals' year across the globe (Miethke *et al.*, 2021). In order to identify powerful bioactive compounds, the successful isolation of marine actinomycetes from uncharted regions has been demonstrated. The current investigation focuses on the bio-prospecting and metabolite profiling of actinomycetes in samples of maritime water and sand.

Actinomycetes in the marine environment:

Only 7-8% of the total sea surface is made up of coasts, while the remaining 60% is deep sea, 60% of which is submerged by water deeper than 2000 m (Das *et al.*, 2006). According to Bull *et al.*, (2000), the deep sea is a distinct and severe habitat with high pressure, low temperature, little light, and changeable salinity and oxygen concentration. Despite the deep sea's large geographic expanse, little is known about its diverse microbial population (Das *et al.*, 2006). It has been demonstrated, nonetheless, that it is a valuable source of unusual bacteria for the search for fresh antibiotics (Bull *et al.*, 2000). However, actinobacteria isolated from deep marine sediments were poorly characterised

in prior research (Goodfellow and Williams 1983). In more recent times, research that were not influenced by culture have demonstrated that there are native marine actinomycetes in the seas (Ward and Bora 2006). These include individuals from the genera *Dietzia*, *Rhodococcus* (Nesterenko *et al.*, 1982; Helmke and Weyland, 1984; Rainey *et al.*, 1995; Heald *et al.*, 2001); *Streptomyces* (Moran *et al.*, 1995); the recently described genera *Salinispora* (Mincer *et al.*, 2005; Jensen *et al.*, 2005). *Salinibacterium*, a newly discovered genus, can withstand up to 10% NaCl without requiring salt for growth (Han *et al.*, 2003). It's possible that the recently discovered *Verrucosipora* strain AB-18-032 (Riedlinger *et al.*, 2004) meets the criteria for being a native marine actinobacterium. It was discovered that some of these species generate distinctive substances, such as *salinosporamides*, which are now being tested in clinical settings as effective anticancer treatments (Feling *et al.*, 2003). The actinomycetes generate stable, persistent populations in a variety of marine habitats (Das *et al.*, 2006) and are active members of marine microbial communities (Jensen *et al.*, 2005, Jensen *et al.*, 2005). The ability of indigenous marine actinomycetes to form stable populations in various habitats and produce novel compounds with a variety of biological activities (Fenical and Jensen, 2006), as well as the discovery of several new marine actinomycete taxa with unique metabolic activity in their natural environments (Magarvey *et*

al., 2004, Jensen *et al.*, 2005, Lam, 2006, Prudhomme *et al.*, 2008).

Role of Actinomycetes in marine environment:

In addition to producing antibiotics, actinomycetes have a significant role in the marine environment (Das *et al.*, 2006). Multiple microbes operate as intermediaries in the ongoing degradation and turnover of different compounds (Jensen *et al.*, 2005; Lam, 2006). According to a theory put up by Ramesh and Mathivanan (2009), the presence or absence of a certain enzyme-producing microbe may be a good indicator of the amount of natural substrate present and the environmental circumstances. Chandramohan *et al.*, (1972) identified the marine actinomycetes' cellulolytic activity; Pisano *et al.*, (1992) reported actinomycetes' chitinolytic activity; and Ramesh and Mathivanan (2009) reported many actinomycetes that produce key commercial enzymes. According to Goodfellow and Haynes (1984), actinomycetes also aid in the oxidation and recycling of organic molecules. They also significantly contribute to the mineralization of organic matter, the immobilisation of mineral nutrients, the fixation of nitrogen, the enhancement of physical characteristics, and the preservation of the environment (Goodfellow and Williams 1983). Secondary metabolites produced by microorganisms are a significant source of antibiotics used today to fight drug-resistant diseases. Actinobacteria are only one of the microbes that create these significant secondary metabolites.

Table1: List of bioactive compounds, producers, source of isolation and screening for their bioactivity isolated from aquatic and marine Actinobacteria.

Bioactive Compound	Producer	Chemical Group	Bioactivity	Source of Isolation
Lynamicins, spiroidimicins	<i>Streptomyces sp.</i>	Bisindole pyrrole	Anti-bacterial	Deep sea marine sediment
Anandins	<i>Streptomyces anandii</i>	Steroidal Alkaloids	cytotoxic	Marine sediments from mangrove zone
Paulomycin G	<i>Micromonospora matsumotoense</i>	Paulomycin derivatives	Anti-tumor properties	Deep sea marine sediment
Rifamycin B	<i>Salinispora sp.</i>	Polyketides	Anti-bacterial	Sediment
Violapyrone B	<i>Streptomyces somaliensis</i>	α -pyrone	Anti-bacterial	Deep sea marine sediment

Table2: List of important producers of antibiotics isolated from marine Actinobacteria.

Producer	Antibiotic
<i>Nocardia lactamdurans</i>	Cephamicin C
<i>S. aureofaciens</i>	Chlortetracycline
<i>S. rodeosporus</i>	Daptomycin

<i>Micromonospora olivasterospora</i>	Fortimicin
<i>Micromonospora spp</i>	Gentamycin
<i>S. kanamyceticus</i>	Kanamycin
<i>S. fradiae</i>	Neomycin
<i>Nocardia uniformis</i>	Nocardicin
<i>S. neveus</i>	Novobiocin

According to the World Health Organisation (WHO), antibiotic resistance is presently one of the major dangers to development, food security, and global health. Therefore, it is critically necessary for the globe to discover new antibiotics and modify how they are used in order to lessen this danger.

One of the most devastating illnesses, cancer has a major negative impact on people's health. For the treatment of cancer, a variety of therapeutic approaches are available, including immunotherapy, surgery, radiation, chemotherapy, etc. (Gillet *et al.*, 2007). Furthermore, the emergence of chemotherapeutic resistance has grown to be a significant medical issue.

Therefore, it is vital to identify potential actinomycete anticancer drugs that

might replace chemotherapy. Arenicolides from *Salinispora arenicola* against the human colon adenocarcinoma cell line and lajollamycin from *Streptomyces nodosus* against the murine melanoma cell line are only two examples of the anticancer drugs that have been identified from actinomycetes.

Conclusions:

The marine ecology is a fantastic resource for isolating important actinomycete species. An attempt should be made to investigate marine actinomycetes as a source of new secondary metabolites since they have developed with the highest genomic and metabolic diversity, especially actinomycetes. New antibiotics and chemotherapeutic drugs with high activity, low toxicity, and minimal environmental impact are in high demand worldwide. Actinobacteria have been isolated from a variety of habitats, including deep sea sediments, marine sponges, alkaline soil, and numerous medicinal plants from the terrestrial and rhizosphere environments.

References:

1. Chakraborty, B., Kumar, R. S., Almansour, A. I., Gunasekaran, P., & Nayaka, S. (2022). Bioprospection and secondary metabolites profiling of marine *Streptomyces levis* strain KS46. *Saudi Journal of Biological Sciences*, 29(2), 667-679.
2. Al-Shaibani, M. M., Radin Mohamed, R. M. S., Sidik, N. M., Enshasy, H. A. E.,

- Al-Gheethi, A., Noman, E., ... & Zin, N. M. (2021). Biodiversity of secondary metabolites compounds isolated from phylum actinobacteria and its therapeutic applications. *Molecules*, 26(15), 4504.
3. Berdy, J. (2005). Bioactive microbial metabolites. *The Journal of antibiotics*, 58(1), 1-26.
 4. Dhakal, D., Pokhrel, A. R., Shrestha, B., & Sohng, J. K. (2017). Marine rare actinobacteria: isolation, characterization, and strategies for harnessing bioactive compounds. *Frontiers in Microbiology*, 8, 1106.
 5. Amin, D. H., Abdallah, N. A., Abolmaaty, A., Tolba, S., & Wellington, E. M. (2020). Microbiological and molecular insights on rare Actinobacteria harboring bioactive prospective. *Bulletin of the National Research Centre*, 44(1), 1-12.
 6. Karuppiyah, P., & Mustaffa, M. (2013). Antibacterial and antioxidant activities of Musa sp. leaf extracts against multidrug resistant clinical pathogens causing nosocomial infection. *Asian Pacific journal of tropical biomedicine*, 3(9), 737-742.
 7. Miethke, M., Pieroni, M., Weber, T., Brönstrup, M., Hammann, P., Halby, L., ... & Müller, R. (2021). Towards the sustainable discovery and development of new antibiotics. *Nature Reviews Chemistry*, 5(10), 726-749.
 8. Balachandran, C., Duraipandiyan, V., Emi, N., & Ignacimuthu, S. (2015).

- Antimicrobial and cytotoxic properties of *Streptomyces* sp.(ERINLG-51) isolated from Southern Western Ghats. *South Indian J. Biol. Sci*, 1(714), 5.
9. Rashad, F. M., Fathy, H. M., El-Zayat, A. S., & Elghonaimy, A. M. (2015). Isolation and characterization of multifunctional *Streptomyces* species with antimicrobial, nematocidal and phytohormone activities from marine environments in Egypt. *Microbiological research*, 175, 34-47.
10. Bull, A. T., Stach, J. E., Ward, A. C., & Goodfellow, M. (2005). Marine actinobacteria: perspectives, challenges, future directions. *Antonie Van Leeuwenhoek*, 87, 65-79.
11. Feling, R. H., Buchanan, G. O., Mincer, T. J., Kauffman, C. A., Jensen, P. R., & Fenical, W. (2003). Salinosporamide A: a highly cytotoxic proteasome inhibitor from a novel microbial source, a marine bacterium of the new genus *Salinospira*. *Angewandte Chemie International Edition*, 42(3), 355-357.
12. Fenical, W., & Jensen, P. R. (2006). Developing a new resource for drug discovery: marine actinomycete bacteria. *Nature chemical biology*, 2(12), 666-673.
13. Goodfellow, M., & Haynes, J. A. (1984). Actinomycetes in marine sediments. *Biological, biochemical and biomedical aspects of actinomycetes*, 453-472.
14. Rifaat, H. M. (2003). The biodiversity of actinomycetes in the River Nile exhibiting antifungal activity. *Journal of Mediterranean Ecology*, 4, 5-8.

15. Abdelmohsen, U. R., Bayer, K., & Hentschel, U. (2014). Diversity, abundance and natural products of marine sponge-associated actinomycetes. *Natural product reports*, 31(3), 381-399.
16. Han, S. K., Nedashkovskaya, O. I., Mikhailov, V. V., Kim, S. B., & Bae, K. S. (2003). *Salinibacterium amurskyense* gen. nov., sp. nov., a novel genus of the family Microbacteriaceae from the marine environment. *International journal of systematic and evolutionary microbiology*, 53(6), 2061-2066.
17. Heald, S. C., Brandão, P. F., Hardicre, R., & Bull, A. T. (2001). Physiology, biochemistry and taxonomy of deep-sea nitrile metabolising *Rhodococcus* strains. *Antonie van Leeuwenhoek*, 80, 169-183.
18. Helmke, E., & Weyland, H. (1984). *Rhodococcus marinonascens* sp. nov., an actinomycete from the sea. *International Journal of Systematic and Evolutionary Microbiology*, 34(2), 127-138.
19. Farrelly, V., Rainey, F. A., & Stackebrandt, E. (1995). Effect of genome size and *rrn* gene copy number on PCR amplification of 16S rRNA genes from a mixture of bacterial species. *Applied and environmental microbiology*, 61(7), 2798-2801.
20. Jensen, P. R., Mincer, T. J., Williams, P. G., & Fenical, W. (2005). Marine actinomycete diversity and natural product discovery. *Antonie Van Leeuwenhoek*, 87, 43-48.

21. Rainey, F. A., Burghardt, J., Kroppenstedt, R. M., Klatt, S., & Stackebrandt, E. (1995). Phylogenetic analysis of the genera *Rhodococcus* and *Nocardia* and evidence for the evolutionary origin of the genus *Nocardia* from within the radiation of *Rhodococcus* species. *Microbiology*, 141(2), 523-528.
22. Nesterenko, O. A., Nogina, T. M., Kasumova, S. A., Kvasnikov, E. I., & Batrakov, S. G. (1982). *Rhodococcus luteus* nom. nov. and *Rhodococcus maris* nom. nov. *International Journal of Systematic and Evolutionary Microbiology*, 32(1), 1-14.
23. Lam, K. S. (2006). Discovery of novel metabolites from marine actinomycetes. *Current opinion in microbiology*, 9(3), 245-251.

09

THE GEM OF PARENTING IN HENRY LAWSON'S *DOVER'S WIFE*, J. M. COETZEE'S *DISGRACE*, BADAL SIRCAR'S THE *LIFE OF BAGALA*, LARA'S *LIKE WATER FOR CHOCOLATE* AND ADICHE'S *PURPLE HIBISCUS*

B. SHANMUGA PRIYA

Assistant Professor of English

Sairam Engineering College

Chennai, Tamil Nadu.

Email: shanmugapriya.eng@sairam.edu.in

“Creation is compared to both- mother and father and their love for a child are like pure air which is priceless in the world”.

Parenting is a lovable task and considers children are the boon of parents. The parent thinks their children will care for them when they become old. The very question is whether they are caring for them or not. Still, some of the children take care of their parents and only a few leave them abundantly. Like Hagar Shipley, the most abundant parents are in old-age homes.

The Drover's Wife is an Australian short story written by Henry Lawson. The story has no name and she is simply called as Drover. In the absence of Drover, her husband, she takes care of their children. When the snake enters the thatched hut, it hides nearby the firewood. Her elder son Jacky, the sharp-faced boy of eleven full of excitement, tells his mother that he will kill the snake but his mother advises him not to take the risk. She is the one, who wakes up all night to save guard her children. She herself brings the two boys and two girls to a large, table to sleep them. She gives a little amount of supper and makes a bed to sleep in. She serves as the best mother who concerns about her children in a terrible situation in a bush garden. Seeing his mother's uncanny situation, the youngest Tommy says that he will wake up all night to kill the snake by smashing its head. Learning about her two sons' braveness she feels proud.

Even though Tommy is more courageous, his mother warns him not to go

nearby the firewood. The reason is that Tommy's mother and her brother-in-law died because of a snake bite nearby the bush. The family's poverty is best shown when Jacky complains to his mother that there is no place to sleep freely. Drover's wife clears the kitchen table and makes the children sleep on it. At the time of midnight, the children all are asleep and she sits there next to her sleeping children, she does sewing and knitting work. She often overcomes her boredom life by reading old magazines. By seeing Drover's wife's reading habit, readers come to know that she is an educated woman. She glances from time to time around the floor, if she hears any noise from the woods; she takes her stick to beat the snake. Her dog Alligator lies at full length on the floor it sees a black brute, five feet long snake when it awakes all night sleeplessly. Alligator is more like another son of the family who helps Drover's wife to kill the snake at the end of the story. When Drover's wife sees the snake come out of the wood heap, she along with Alligator beats well the snake to safeguard her children when her husband is away.

The novel *Disgrace* aptly agrees with the saying that it is the children who suffer because of bad deeds done by their parents. Lucy, the daughter of David Lurie, Professor of Communication teaches at Cape Town University. Lucy is raped by the three black men when David is out. They raped Lucy, because of his father who has a sexual desire with many women. David is thrown out of

University because he is having a sexual relationship with his student Melaine Isaacs. Issacs's boyfriend complains against David who asks Issacs to give internal marks when she has a sexual relationship with him. Secondly, David is having an illegal affair with a prostitute named Soraya. On seeing David's behaviour his daughter Lucy asks her father do you ever feel and try to penance the crimes of the past as the reason for their present sufferings. Lucy does not want his father to change. She is damn sure that nobody asks David to change his vulgar behavior towards women. In Virginia Woolf's novel *To the Lighthouse*, it is Mrs. Ramsay's remarks to her husband Mr. Ramsay do you ever try to ask or make a letter about the goodness of your wife and children? She further asks angrily do you remember we were married a few years ago? She adds that if a child goes to the dreary sea waves what will happen? All the above-said questions are raised by Mrs. Ramsay and it shows her concern for her eight children. James, the son of Mr. and Mrs. Ramsay wants his heart to have a boating ride nearby the lighthouse sea. But his father would not like his son to have a ride due to bad weather, later his mother takes her children and friends to see the lighthouse.

Charles Dickens's greatest autobiographical novel *Oliver Twist*, in which Oliver, the orphan boy finds uncanny about life throughout the novel. Due to hungry Oliver cried and he begs his warden that he wants some more gruel. On using

Oliver's innocent nature, many people mislead him. After a few months, Oliver was the victim of gang robbery and treachery. He is caught up by the robbers and burglars gang and finally, Mr. Brownlow saves him and comes to know that he is Monk and earns half of the property. An Indian writer T. S. Pillai's translation work *The Scavenger's Son*, where a parent scavenger struggles a lot to educate his son well. He does not want his son to work in the toilets. He loves his son much and admires his son who goes to school to have an education.

Badal Sircar an Indian dramatist and his famous work is *The Life of Bagala*. As a parentless child, Bagala suffers from his aunt's ill-treatment. Though Bagala is a full bright scholar, he is afraid of an interview, which is made possible with the help of Nila, the supernatural character. When he gains the confidence to face the interview and gets a good job, he comes to see his aunt and uncle who tortures him at a young age. They do not allow him to read for his exams. They will give some household jobs like going to tailor shops and markets. His aunt sends him to buy fish from the market after the scales have been removed. He is not used to such kinds of household jobs he brings home to fish with scales. His aunt scolds him and asks why didn't tell the fishmonger to remove the scales of the fish. He answers that he said to him but the fishmonger has refused to cut the scales of the fish. His aunt does not agree with the answers of Bagala.

Bagala has to take care of his aunt's child in his leisure time. One day he visits his aunt and uncle's house with a huge amount and throws the huge rupees at their faces. Sircar's drama highlights the unemployment issues of an educated young man who attempts suicide. Bagala goes to the train track to kill himself and is finally saved by an old man who introduces Nila, the supernatural character to give motivation to Bagala.

In an interview, Sudha Murthy, a well-known speaker and also an author of many books, speaks about her son who is grown up under her great guidance. Her son develops the habit of small savings at a very young age. He helps the soldiers in an Indian army.

Bagala: Didn't I tell you to buy from the market after the scales have been taken off? Won't you ever remember?

Bagala: I did remember, aunt.

Aunt: Well. If you did, why didn't you tell the fishmonger?

Bagala: Told him, aunt. But he refused.

Aunt: Refused? He does it for everyone. Why not for you then? Why don't you say you forgot? Why tell stories?

Bagala: No aunt. It's true. He said.... taking off scales from fish weighing 250 grams...

Aunt (harsh tone): What did you say?

Bagala (weak voice): Not I. The fishmonger... (57)

In the Mexican novel *Like Water for Chocolate*, Tita, the youngest woman of the three girls in her family is to take care of her sick mother who is on a deathbed. It is the tradition of their family that the youngest woman has to sacrifice her life. Tita would not have to marry anybody, but Tita loves Pedro, a young man. Because of Tita's family tradition, her lover Pedro marries her own sister Elizabeth. Pedro and Elizabeth live happily but Pedro corners Tita and wants to have a sexual relationship with her. Tita never allows Pedro to be wrong to her. She is very loyal to her sister Elizabeth. When Elizabeth gives birth to a boy baby, it is Tita who nurtures the child well, after Elizabeth goes to her in-law's house, she does not feed the child properly and the baby dies pathetically. The child dies it is because of Elizabeth's loss of consciousness towards the newborn baby.

In Chimamanda Adichie's *Purple Hibiscus*, Kambili, the protagonist of the novel, and her brother Jaja suffers from her father Eugene's strict parenting. At the very beginning of the novel Jaja breaks figurines from the shelf. He never tells sorry to his father instead Kambili asks for his father's forgiveness for Jaja. He gives severe punishments to his children. For illustration, he pours hot water on the legs of her daughter Kambili when she gets the second rank in the school. Even Jaja dislikes his father for this reason and he disobeys his father

and he does not go to the church often to attend regular Mass. His father does not know the truth about why Jaja has behaved rudely towards him. He gives an example from the Holy Bible that Jesus Christ has been murdered to save the world. Christ saves man and he takes up every sin of the world.

Kambili calls her father affectionately as 'Papa' and Jaja does not. Jaja knows his father's ill-legal business and silently gives poison to his father to die. Someone calls over phone Jaja picks up the call and hears the news of the death of his father. He informs his mother about his father's death. She does not believe the fact that her husband died. She says that she never considers the possibility of her husband's death very early. At the death of Jaja's father the family lives peacefully from all kinds of violence. Papa acts like a good father when he learns that Kambili is infatuated with the young priest at his sister's house. He brings Kambili home and locked her in a room. Kambili becomes disappointed by her father's behavior towards her. She thinks that her father will approve of her love.

After seeing the strict father's domestic violence towards their children here is a good father relationship and son's relationship in Chinua Achebe's Things Fall Apart. The adopted son Ikemefuna has a close relationship and affection towards Okonkwo, the village headman. Okonkwo shows his real affection for Ikemefuna till his death. Here is a scene where Ikemefuna cries to save his life.

But getting approval from the village Umfia's people, Okonkwo raises his machete and cuts the head of Ikemefuna. The innocent son dies without the reason of his murder. He strongly believes his father will save him from his danger. Okonkwo's daughter finds Ikemefuna's absence and asks her father about him. His father replies that he went to meet his relatives in his village. In Chinua Achebe's *Things Fall Apart*, Ikemefuna likes to call his murderer a 'father' when he cuts the head of a boy with an axe.

As the man who cleared his throat drew up and raised his machete, Okonkwo looked away. He heard the blow. The pot fell and broke in the sand. He heard Ikemefuna cry, "My father, they have killed me!" as he ran towards him. Dazed with fear, Okonkwo drew his machete and cut him down. He was afraid of being weak. (43)

Okonkwo has three wives and eight children. Eugene's daughter likes Ikemefuna very much. She considers him as her own brother because he used to tell many stories to her. Okonkwo personally likes Ifemefuna too but decides to kill him because of the people. Even Eugene feels Ifemefuna's absence. Okonkwo would not be able to digest his own son who converts to Christianity. Toward the end, Okonkwo is never supported by his own people. He hangs himself pathetically because he does not want to die at the hands of the British people. Like Okonkwo, Bhoma in Sircar's play, never gets support from his own

people. Bhoma is a peasant protestor who fights for the welfare of farmers and land rights.

Beloved is one of the most powerful novels written by Toni Morrison. It is the story of a Black slave woman, Margaret Garner. It is believed the fact that Garner escaped from the plantation with her husband and children to save them in the year 1856. In her life-saving battle, she killed her young daughter to prevent her from slavery. In the novel *Seth*, the African woman, has two sons and two daughters. On being the fear of White dominance she murders her third child Beloved. Seth's two sons are Howard and Buglar and her daughter is Denver. Seth believes that her murdered daughter Beloved is alive and she often appears in the form of ghost. Denver likes her sister Beloved and believes that she does not die.

Riders to the Sea is a one-act play by J.M.Synge. Maurya is the mother of five sons and two daughters- Nora and Cathleen. Maurya, the poor mother does not want his sons to go to sea to catch a fish. She warns that the tidal waves are not good. In spite of her warning, her sons go to sea and died. Maurya was psychologically affected when her son Micheal died. She assumes that Micheal comes in by the horse, but her two daughters console Maurya that Micheal has a clean burial. *Parenthood* is a famous drama written by Jason Katims. The play tells about Braverman family. Their family struggled to raise their four children

and their family named Adam, Sarah, Crosby, and Julia in California.

Bhabani Bhattacharya's novel *So Many Hungers* discusses Rahuol, the son of Samerandra giving importance to a boy baby rather than a girl child. Samerandra thinks that if it is a girl baby, a dowry has to be given when she gets married. Rahuol follows Samerandra, his father, and demands to have a boy baby. Kunal, the brother of Rahuol, is a patriot who loves to serve the Nation. He eagerly shares the news of the birth of a girl child and asks Monju, for good health and care. Maya Angelo's *I Know Why the Caged Birds Sings* is an autobiographical work. In her work, she reveals the truth boldly that how children without their parent's care are molested by their neighbours and relatives. Maya Angelo is a victim of sexual abuse. To give awareness she writes Literature to give voice to the voiceless women. Maya's parents divorced when she is three years old. She and her brother live with their paternal grandmother Annie Henderson. As a young child, Maya and her older brother were abandoned by their parents. Like many children, she herself faced a lot of sexual harassment at a young age. The novel *Rabbit-Proof Fence* is another true story that tells how parents are hiding their children in order to prevent them from being taken by the enemies in order to sell them at the white man's house. The object "Fence" is an important landmark in the life of Molly, the central character.

The Metamorphosis, Franz Kafka's famous novella Gregor Samsa, the middle-class salesman of a company. Gregor Samsa wakes up in one morning gets transformed into a huge bug. Magical realism and absurdity is the theme of the novella. Gregor Samsa's parents are not worried about him, their ultimate goal is to earn money. His parents are quite satisfied with Samsa's salary amount. Samsa longs for parent's love and care. He is little bit happy because of his sister who takes care of him. With the little pay amount of Samsa, he sends his sister to learn violin music. When Samsa has no job, his family does not care him. He lacks love and emotion. His sister is very affectionate to him.

Because of the tedious work, and life's meaninglessness, he gets transformed into a huge bug. Here in this novella, parents' love becomes commercial. Samsa's parents throw out him into a dungeon when they learned that their son is transformed into a huge bug. His strict father beats him with an apple. He breaks his leg and gets some injuries over his body. With the body ache, he escapes to save his life. He thinks that his only relationship is with his sister. He finds some peace in his heart when he accompanies her sister. When the clock strikes three in the morning the bug Samsa breathes his last breath.

His father beats Samsa and breaks his leg, Samsa runs to hide himself to safeguard his life. His sister often comes to meet Samsa, she gives him some food scraps and pours milk on his plate. His boss comes to meet Samsa and

becomes faint on seeing the huge bug. On seeing Gregor Samsa, the house owner asks the family to move away from the flat. This creates more irritation for Samsa's parents. Samsa (huge bug) dies on the other day pathetically because of the wound made by his father. Nobody cares for Samsa's death except his sister and his parents are doing their work without giving a proper burial to Samsa.

Thus, to sum up, behavioural patterns can be shaped well at a young age. It is in the concerned parent's hands. Changing lifestyle, surroundings, and culture is the main reason for the change of behaviour of a child. Moral and Value Education can inculcate ethical values to young minds.

REFERENCES

1. Adiche, ChimmandaNagozi. *Purple Hibiscus*. Harper Perennial Publishers, London. 2012
2. Coetzee.J.M. *Disgrace*. Penguin Publishers, New York: 1999.
3. Esquirel, Lara. *Like Water for chocolate*. Trans. Carol and Thomas Christensen Knopf Double day Publishers, 1989.
4. Lawson, Hendry. "The Drover's Wife". Ed. Frans Moor house. Penguin Publishers, Australia. 2017
5. Murthy, Sudha. 29 August 2020. *A Gem of Parenting Tips from Sudha Murthy*.

Chapter-X

10

NEEM (*AZADIRACHTA INDICA* A. JUSS.) MICROBIOTA: ENDOPHYTIC BACTERIA AND RHIZOSPHERE MICROORGANISMS

Girish, K

Assistant Professor

Department of Microbiology

Government College for Women

Kolar – 563 101, India.

Email: girishk77@yahoo.com

Abstract

Azadirachta indica A. Juss., (neem), which is native to India, is globally well known for its medicinal properties. Neem products are known to have antibacterial, antifungal, insecticidal and other versatile biological activities. Since times immemorial, neem plant has been used for the treatment of several human ailments. Plants provide an important biological niche for the growth of a wide variety of microorganisms and neem plant is no exception to this. Many endophytes and rhizosphere microorganisms with numerous biological properties and functions have been reported associated with neem. Endophytic microbes are the storehouse of new bioactive metabolites, possessing a wide variety of biological activities as antibiotic, antiviral, anticancer, anti-inflammatory, antioxidant, etc. The rhizosphere, the narrow zone surrounding and influenced by plant roots, is a hot spot for numerous microorganisms with multifarious bioactivities.

Key words: Neem, *Azadirachta indica*, microbiota, endophytes, bioprospecting, rhizosphere microorganisms

Introduction

Azadirachta indica A. Juss., commonly known as neem, is a tree that grows in tropical regions such as India. Neem has been extensively used in Ayurveda, Unani and Homoeopathic medicine. All parts of the neem tree- leaves, flowers,

seeds, fruits, roots and bark have been used traditionally for the treatment of inflammation, infections, fever, skin diseases and dental disorders. Its role as health-promoting component is attributed to its rich source of phytochemicals (Girish and Shankara Bhat, 2008).

Endophytes constitute plant-colonizing microorganisms in a mutualistic symbiosis relationship. They live in apparently healthy internal plant tissues, without causing disease (Schulz and Boyle, 2006). Endophytes are found in plants of most ecosystems and are of importance since they help to improve yields, by stimulating plants growth and immune response, excluding plant pathogens by niche competition, as well as actively participating in antioxidant activities (Pandey *et al.*, 2018).

The root and its surrounding region or rhizosphere is a novel ecosystem which is the harbor of wide variety of microorganisms including bacteria, fungi, algae etc. (Prashar *et al.*, 2014). The rhizospheric microbial population has immense role in agriculture and crop improvement. Many studies have reported that these rhizosphere microorganisms can have profound effects on seed germination, seedling vigor, plant growth and development, nutrition, diseases, and productivity (Rodrigo Mendes *et al.*, 2013).

Endophytic bacteria from *Azadirachta indica*

Among plant microbiota, endophytic bacteria can be found in most plant species and be recovered from roots, leaves, stems, and a few from flowers, fruits, and seeds (Lodewyckx *et al.*, 2002). Many studies have emphasized endophytic bacteria from neem plant and their application in different areas Verma *et al.* (2009) isolated 55 different isolates of endophytic actinomycetes from neem plant. They reported *Streptomyces* to be the dominant species followed by *Streptosporangium*, *Microbispora*, *Streptoverticillium*, *Saccharomonospora* sp., and *Nocardia*. Actinomycetes were recovered more from roots (54.5%), followed by stems (23.6%), and leaves (21.8%). A *Streptomyces* strain was isolated from the neem. The isolate was closely related to the type strain of *Streptomyces plicatus* sharing a 16S rRNA gene sequence similarity of 96% and this new strain was named as *Streptomyces* sp. mrinalini7 (Singh and Padmavathy, 2014). Seven novel endophytic bacterial species *viz.*, *Bacillus amyloliquefaciens* (JNU-001), *Burkholderia denitrificans* (JNU-002), *Pseudomonas aeruginosa* (JNU-003), *Xanthomonas campestris* (JNU-004), *Azotobacter tropicalis* (JNU-005), *Acetobacter xylinum* (JNU-006) and *Azospirillum lipoferum* (JNU-007) were recovered from native neem varieties of Rajasthan state, India. Among these endophytic bacterial isolates obtained, *Bacillus amyloliquefaciens* (JNU-001) was dominant (Tiwari and Thakur, 2014). An actinomycetes strain was isolated from neem leaves and named as NEK5

(Vijayan *et al.*, 2014). Endophytic actinomycetes were isolated from healthy leaves, stem and root samples of *A. indica*, with highest species richness. *Streptomyces* species was the predominant actinomycetes isolated, while other actinomycetes isolated were *Kocuria*, *Microbispora*, *Micrococcus*, *Micromonospora*, and *Timonella* (Gohain *et al.*, 2015). The endophytic *Streptomyces coelicolor* strain AZRA 37 was isolated from the surface sterilized root of neem plant (Kumar *et al.*, 2016). An actinomycete closely related to *Micromonospora costi* and *Micromonospora avicenniae* (98.75% similarity in 16S rRNA gene sequences) was isolated from the roots of neem and was named *Micromonospora azadirachtae* sp. nov. (Kuncharoen *et al.*, 2019). Seven endophytic bacterial strains (6 Gram positive and 1 Gram-negative bacteria) were isolated from 12 neem samples collected in Phan Thiet and Lagi (Binh Thuan province), Vung Tau (Ba Ria - Vung Tau province), Vietnam (Linh *et al.*, 2020).

Bioprospecting of neem endophytic bacteria

Endophytes are a source of large number of bioactive secondary metabolites with unique structures including alkaloids, benzopyranones, flavonoids, phenolic acids, quinines, steroids, terpenoids, tetralones, xanthenes and others (Tan and Zou, 2001). Such bioactive metabolites find wide range of applications such as agrochemicals, antibiotics, immunosuppressants, antiparasitic,

antioxidant and anticancer agents (Gunatilika, 2006). The bioactive compounds found in the host plant tissues might be due to the associated endophytes. A few reports in the recent years show that the endophytic bacteria from *A. indica* produce bioactive compounds (Verma *et al.*, 2011b; Arun Kumar *et al.* 2015).

Antimicrobial activity:

Actinomycetes isolated from neem plant were screened for their antibacterial and antifungal activities. *Streptomyces* had acute activity against *Pseudomonas fluorescens* and *Escherichia coli*, while an isolate of *Nocardia* sp., from leaves showed antagonism against *Bacillus subtilis*. A few isolates of *Streptomyces*, *Nocardia* sp., and *Streptosporangium* sp., also showed significant antagonistic activity against root pathogens, including *Pythium* sp., and *Phytophthora* sp. (Verma *et al.*, 2009). Endophytic actinomycetes species isolated from neem effectively inhibited the growth of the *Alternaria alternata* causing early blight disease in tomato (Verma *et al.*, 2011).

Actinomycetes strain NEK5 isolated from neem leaves showed good antifungal activity. The ethyl acetate extract of culture filtrate of NEK5 isolate inhibited the growth of *Fusarium* sp., *Pythium* sp., *Curvularia* sp. and *Cercospora* sp. (Vijayan *et al.*, 2014). Methanol and ethanol extracts of endophytic bacterial (*Bacillus cereus* NRL2) cells isolated from neem were screened for antibacterial

activity by agar well diffusion assay. Methanol and ethanol extracts showed significant antibacterial activity against *S. aureus* with IZ of 33 mm and 29 mm, respectively. Four major compounds having antimicrobial activity were obtained from this bacteria such as Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-, Methyl-2-O-methyl- α -arabinopyranoside, Propionylfilicin acid and Benzene carboxylic acid (Arun Kumar *et al.* 2015).

The crude extract from *Streptomyces* species isolated from neem, grown in Casein-starch peptone-yeast (CSPY) broth, showed significant inhibition of bacteria *Pseudomonas syringae* (MTCC 673) and *S. aureus* (MTCC 96), and fungi *C. albicans* (MTCC 3017), and *Rhizoctonia solani* (MTCC 4634) (Gohain *et al.*, 2015). The *Streptomyces coelicolor* was treated with different concentrations of 5-azacytidine and evaluated for its antibacterial potential against five human pathogenic bacteria (*Aeromonas hydrophila* IMS/GN11, *Enterococcus faecalis* IMS/GN7, *Salmonella typhi* MTCC 3216, *Shigella flexneri* ATCC 12022 and *S. aureus* ATCC 25923). The crude extract obtained from cultures treated with 25 μ M concentration of 5-azacytidine, was found effective against all the five pathogenic bacteria tested (Kumar *et al.*, 2016).

A total of 25 endophytic bacterial isolates were obtained from neem fresh and healthy leaves. Maximum isolates were Gram-positive and rod shaped. In disk

diffusion assay using culture broth of endophytic bacteria, significant antibacterial activity was observed against *Bacillus cereus*, *E. coli*, *Klebsiella pneumoniae*, *S. aureus*, *Salmonella typhimurium*, and *Streptococcus pyogenes*. Out of 25 isolates 2 isolates were effective against *B. cereus*, 23 against *E. coli*, 22 against *K. pneumoniae*, 20 against *S. aureus*, 22 against *S. typhimurium*, and 21 against *S. pyogenes* (Singh *et al.*, 2017). A total of 80 bacterial endophytes were isolated from various parts of neem plant such as leaf, flower, seed, bark, cortex and root using novel neem-based media. Out of them, only three bacterial isolates showed antifungal potential by inhibiting the growth of *Magnaporthe oryzae* causing blast of rice (Agasimundin *et al.*, 2019).

Antifungal and antibacterial activities of endophytic bacteria from *A. indica* were studied by well diffusion agar method. KT2 strain inhibited *Salmonella typhi* and *Staphylococcus aureus*, KT3 strain showed inhibitory activity against three human pathogenic fungi such as *Candida albicans*, *Trichophyton mentagrophytes*, and *Trichophyton rubrum*, while KT1 and KT2 strains showed antifungal activity against *C. albicans* and *T. rubrum*. By biochemical tests, KT2 strain was identified as the *Bacillus subtilis* (Linh *et al.*, 2020).

Other activities:

Endophytic actinomycetes species isolated from *A. indica*, significantly improved the growth of tomato plant by producing the phytohormone indole

acetic acid (IAA) and siderophores. *Streptomyces* strain AzR-051 produced the highest amount of IAA at 13.73 $\mu\text{mol} / \text{ml}$, compared to strains AzR-049 and AzR-010 that produced 9.22 $\mu\text{mol} / \text{ml}$ and 10.43 $\mu\text{mol} / \text{ml}$ respectively. The *Streptomyces* strain also produced siderophores (Verma *et al.*, 2011). The *Streptomyces* sp. mrinalini7 isolate when inoculated into model tomato plants significantly enhanced the biomass production of the plant and seed germination (Singh and Padmavathy, 2014).

Rhizosphere Microorganisms of Neem

The rhizosphere is a narrow zone adjacent to and influenced by living plant roots (Kennedy, 1999). It is a site of high microbial activity in and around roots in soil (Sorenson, 1997). It harbors a great diversity of microorganisms affecting plant growth and health (Campbell and Greaves, 1990; Boehm *et al.*, 1993). The diversity and composition of microbial taxa in the rhizosphere can be affected by several factors including plant species (Miller *et al.*, 1989). The composition of microbial community in the rhizosphere is important for the performances of the plant, as microbial species can have beneficial, neutral or harmful relationships with the roots (Buchenauer, 1998; Atkinson and Watson, 2000; Sylvia and Chellemi, 2001). Microorganisms in the rhizosphere are found to be more in population and are having high metabolic rate than in non rhizosphere soil (Tamilarasi *et al.*, 2008). There are many reports of neem

rhizosphere microorganisms and their associated bioactivities.

Field investigation was carried out to determine the arbuscular mycorrhizal fungi (AM) population and their diversity in neem-based agroforestry fields. *Glomus*, *Gigaspora* and *Sclerocystis* were the genera of AM present in the neem-based agroforestry system. Among the three genera, *Glomus* occurred most frequently with 15 species, three species were of *Gigaspora* and two were of *Sclerocystis*. *Glomus fasciculatum* was the predominant AM fungus infecting neem (Pande and Tarafdar, 2004). Arbuscular mycorrhizal (AM) fungi are recognized as an essential component of sustainable agricultural ecosystems (Jefferies, 1987; Barea, 1991).

Rhizosphere microflora of medicinal plants including *A. indica* was estimated. The total number of heterotrophic bacteria in the neem rhizosphere was 41×10^4 cfu / g, actinomycetes population was 17×10^2 cfu / g and fungal population was 18×10^2 cfu / g. The predominant bacterial genus was *Bacillus* followed by *Pseudomonas*, *Enterobacter*, *Corynebacterium*, *Micrococcus* and *Serratia*. Among the fungus the most dominant genus was *Rhizopus* followed by *Aspergillus*, *Penicillium*, *Mucor* and *Fusarium*. Among the actinomycetes, isolates of *Streptomyces* was found to be maximum followed by *Frankia* sp. (Tamilarasi *et al.*, 2008).

Both Vesicular-arbuscular mycorrhizal fungi (VAM) and soil fungal diversity and frequency were studied in the neem rhizosphere from five ecogeographically different regions. Mycofloral diversity included *Aspergillus niger*, *A. flavus*, *A. nidulans*, *A. versicolor*, *A. fumigatus*, *Alternaria tenuis*, *A. alternata*, *Cladosporium* sp., *Cephalospora* sp., *C. albicans*, *Fusarium oxysporum*, *Pestalotia monorhinca*, *Paecilomyces*, *Monilia sitophila*, *Nigrospora oryzae* and *Rhizopus nigricans*. Saline-arid-parched soil exhibited three unique fungal species namely, *Monilia sitophila*, *Aspergillus versicolor* and *Paecilomyces fusisporus*, whereas, the delta-wet region exhibited *Rhizopus nigricans* as its unique species. Overall, in the five regions studied, three VAM genera with nine species were observed, with *Glomus* being the predominant genus viz., *Glomus mosseae*, *Glomus microcarpum*, *Glomus macrocarpum*, *Glomus constrictum*, *Glomus fasciculatum*, *Glomus multisubstance*, *Glomus deserticola*, *Gigaspora albida*, *Gigaspora margarita* and *Acaulospora* sp. (Chary, 2011).

Phosphate solubilizing bacteria (PSB) isolates namely N-B (col-1) and N-C (col-2), were isolated from neem rhizosphere (Shankarrao, 2012). Neem rhizosphere soil can be a rich source for the isolation of phosphate solubilizing microorganisms, due to high phosphate requirements of neem tree and other medicinal plants (Phavaphutanon *et al.*, 1996), or due to long term association and interaction between neem root and microorganisms found in the

rhizosphere environments (Lucas Garcia *et al.*, 2001). The bacterial phosphate solubilization activity is due to secretion of organic acids such as oxalic, citric, formic, acetic, propionic, lactic, succinic and gluconic acid which chelate the cation bound to phosphate and convert it to soluble forms through their hydroxyl and carboxyl groups and production of acid /alkaline phosphatase enzyme (Chen *et al.*, 2006).

Rhizospheric bacteria were isolated from neem and identified as *E. coli*, *Lactobacillus fermentum*, *Micrococcus luteus*, *Neisseria sicca*, *Sporosarcina* sp., *Streptococcus* sp. and *Streptococcus faecalis* (Pandey and Singh, 2013). Phosphate-solubilizing rhizosphere fungus, *Talaromyces funiculosus* SLS8, was isolated from neem (*A. indica*) on saline soil. The fungus was tolerant to environmental stressors, salinity and agricultural systemic fungicides (Kanase *et al.*, 2015). The rhizosphere soil of *neem* showed maximum population density of AM fungi, PSB, *Azotobacter* sp. and *Azospirillum* sp. (Maohan and Saranya Devi, 2015). A total of 27 bacterial cultures were isolated from the neem rhizosphere samples. Then three cultures were characterized and found to be *Micrococcus luteus*, *Sporosarcina* sp., and *Staphylococcus epidermidis* (Mhatre and Nanoty, 2015). Bacterial strains named RHSAN-1 to 6 were isolated from neem rhizosphere of North 24 Parganas district of West Bengal (Biswas *et al.*, 2016).

A total of six morphologically different fungal isolates (NS1, NS2, NS3, NS4, NS5, NS6) were isolated from the rhizospheric soil of neem and were identified as *Aspergillus* sp. (NS1, NS3, NS4, and NS6), *Fusarium* sp. (NS2) and *Penicillium* sp. (NS5) based on colony characterization (colony color, colony growth) and sporulating structures. One isolate was subjected for molecular characterization and found to be *Aspergillus niger* (Nisha Rani *et al.*, 2017). Arbuscular mycorrhizal fungi (AMF) species belonging to five genera (*Glomus*, *Acaulospora*, *Gigaspora*, *Sclerocystis* and *Scutellospora*) were isolated from the rhizosphere soil of *A. indica*. *Glomus* species was dominant followed by *Gigaspora* and *Acaulospora* (Anusha Duvva *et al.*, 2018). Eleven bacterial isolates that produced indole acetic acid (IAA) were obtained from the rhizosphere of *A. indica* (Damle and Kulkarni, 2018). N₂-fixing bacteria *Azotobacter paspali*, *Azotobacter vinelandii* and *Actinomycetes* sp., were isolated from the rhizosphere of neem (Hala and Ali, 2019).

Microorganisms are also intentionally introduced into the rhizosphere environments to enhance certain agriculturally beneficial activities mainly aiming at plant growth promotion (Tamilarasi *et al.*, 2008). Inoculation of neem rhizosphere with AM fungi (Habte *et al.*, 1993; Phavaphutanon *et al.*, 1996) reduced fertilizer requirement in plant production. The effect of inoculation of neem with VA-mycorrhizal fungi (*Glomus fasciculatum*) and PSB was examined

under nursery conditions to understand the compatibility between phosphate solubilizing and phosphate mobilizing organisms in the neem rhizosphere. The results clearly indicated that combined inoculation markedly increased the plant growth of the neem seedlings when compared to individual inoculants or uninoculated control, showing the synergistic effect (Kalavathi *et al.*, 2000).

Neem seedlings were inoculated with arbuscular mycorrhizal (AM) fungi, *Glomus intraradices*, *Azospirillum brasilense* and PSB. Microbial inoculation resulted in greater plant height, increased mycorrhizal colonization, leaf area and number, root collar diameter, biomass, phosphorus, nitrogen and potassium content, and seedling quality. Microbial inoculation effects were greatest when seedlings were inoculated with a combination of microbes rather than individually. This clearly indicated that these microorganisms act synergistically (Muthukumar *et al.*, 2001).

Bioprospecting of Rhizosphere Microorganisms

The isolates of bacteria, actinomycetes and fungi isolated from neem rhizosphere were evaluated for IAA production. Among them 62.5% of fungal isolates produced IAA followed by 52.17% of actinomycetes and 23.7% of bacterial isolates (Tamilarasi *et al.*, 2008). The microbial diversity of VAM and soil fungi observed in neem rhizosphere could be correlated with the azadirachtin-A content of the neem trees (Chary, 2011).

PSB isolates from neem rhizosphere N-B (col-1), N-C (col-2) showed potent antifungal activity against *Helminthosporium gramineum* and *Rhizopus oryzae*. Isolate N-B (col-1) also showed good antifungal activity against *Aspergillus niger* and *Ustilago maydis*. Comparitively, *R. oryzae*, *H. gramineum*, *A. niger* and *U. maydis* showed more sensitiveness to tested isolates than *Alternaria brassicicola*, *A. solani* and *Sclerotium rolfsii*. Both the isolates exhibited maximum antibacterial activity against *S. aureus*, followed by *Ps. aeruginosa* and *S. typhimurium* (Shankarrao, 2012). N-B (col-1) showed more than one PGPR trait such as phosphate solubilization, antifungal and antibacterial activity and phytohormone production. This isolate might promote plant growth directly, indirectly or synergistically in the soil environment (Shankarrao, 2012).

Rhizospheric bacteria isolated from neem were subjected for extraction of intracellular secondary metabolites using methanol and extracellular secondary metabolites using chloroform. These extracts exhibited significant antibacterial activity against *E. coli*, *Ps. aeruginosa* and *S. aureus*. *Sporosarcina* sp., *M. luteus* and *N. sicca* inhibited all the tree bacteria viz., *E. coli* (IZ 17.5, 12.5 and 13 mm), *Ps. aeruginosa* (21, 17.5 and 28.5 mm) and *S. aureus* (11.5, 13 and 27.5 mm) respectively. *Streptococcus* sp., and *S. faecalis* inhibited *E. coli* (36.5 and 17 mm) and *S. aureus* (11 and 10 mm) respectively. *Lactobacillus*

fermentum inhibited only *E. coli* (13.5 mm) and rhizosphere *E. coli* inhibited only *Ps. aeruginosa* (12.5 mm) (Pandey and Singh, 2013).

Phosphate solubilization under different nutritional conditions was investigated by culturing *T. funiculosus* SLS8 in Pikovskaya liquid medium. The highest concentration of solubilised phosphate (187 mg / l) was achieved after 5 days of incubation in the medium with glucose and ammonium sulphate (Kanase *et al.*, 2015). The soil fungi have been reported to solubilize insoluble phosphates by secreting weak organic acids (Maliha *et al.*, 2004). Three bacterial cultures *M. luteus*, *Sporosarcina* sp., and *S. epidermis* obtained from neem rhizosphere were screened for antibacterial activity using culture broth extract by agar well diffusion method. All the bacteria tested showed significant antibacterial activity. *M. luteus* exhibited IZ of 14, 13 and 13 mm, *Sporosarcina* sp. showed IZ of 16, 16.5 and 16 mm, and *S. epidermis* exhibited IZ of 14, 15 and 14 mm against *E. coli*, *Ps. aeruginosa* and *S. aureus*, respectively (Mhatre and Nanoty, 2015).

The culture filtrates of three fungal strains NS1, NS4 (*Aspergillus* sp.) and NS5 (*Penicillium* sp.) isolated from neem rhizosphere were screened for antibacterial activity by agar well diffusion assay. All the three isolates showed significant antibacterial activity against *E. coli* MTCC 40 with IZ of 20.33, 14.66 and 17.0 mm, respectively. NS1 that showed the best activity was identified as

A. niger and studied for optimization of fermentation conditions to maximize antibiotic production. Process using glucose as carbon source, ammonium nitrate as nitrogen source, at pH 5 and 25°C resulted in maximum yield of antibiotic (Nisha Rani *et al.*, 2017). Good amount of IAA was produced by bacterial isolates obtained from neem rhizosphere. The range of IAA of the isolates ranged from 10.425 to 43.404 µg/ ml. The highest amount of IAA was produced by the isolate 6 (Damle and Kulkarni, 2018).

Conclusion

Endophytic bacteria of neem are an under-investigated group of microorganisms that represent an abundant and renewable source of bioactive and chemically new compounds with potential for exploitation in a wide variety of fields including medicine, agriculture, and industry. The microbial population of the rhizosphere of this plant also has not been studied so far in detail. Further studies are required in this direction to explore and evaluate the enormous microbial population in these ecosystems. Endophytic bacteria with their peculiar potential compounds might provide a range of bioactive compounds catering to the need of novel drugs. The rhizosphere isolates of neem plant might have sufficient bioprospective potentiality like biofertilizer formulations for better crop production as well as therapeutic drugs for human diseases.

References

1. Agasimundin VB, Rangiah K, Sheetal A, Gowda M. 2019. Neem microbiome. *In: The Neem Genome, Compendium of Plant Genomes* (Eds. Gowda M, Sheetal A, Kole C). Springer, Cham. pp 111-123.
2. Anusha Duvva, Dayakar Govindu, Sharat Bellamkonda, Srinivas Podeti. 2018. Diversity of arbuscular mycorrhizal fungi in the rhizosphere soils of four agroforestry tree species of North Telangana. *Asian J. Microbiol. Biotechnol. Environ. Sci.*, 20(2): 277-283.
3. Arun Kumar G, Robert Antony A, Rajesh Kannan V. 2015. Exploration of endophytic microorganisms from selected medicinal plants and their control potential to multi drug resistant pathogens. *J. Med. Plants Studies* 3(2): 49-57.
4. Atkinson D, Watson CA. 2000. The beneficial rhizosphere: A dynamic entity. *Appl. Soil Ecol.*, 15: 99-104.
5. Barea JM. 1991. Vesicular arbuscular mycorrhizae as modifiers of soil fertility. *Adv. Soil Sci.*, 15: 1-40.
6. Biswas K, Basu J, Ghosh A, Giri P. 2016. Study of rhizospheric bacterial population of *Azadirachta indica* (neem) of North 24 Parganas district of West Bengal for bioprospective consideration. *Int. J. Exp. Res. Rev.*, 6: 62-66.
7. Boehm M, Madden V, Hoitink HAJ. 1993. Effect of organic matter decomposition level on bacterial species diversity and composition in relation

to *Pythium* damping off severity. *Appl. Environ. Microbiol.*, 59: 4171-4179.

8. Buchenauer H. 1998. Biological control of soil borne diseases by rhizobacteria. *J. Plant Dis. Protect.*, 105: 329-348.

9. Campbell R, Greaves MP. 1990. Anatomy and community structure of the rhizosphere. *In: The Rhizosphere* (Ed. Lynch JM). Wiley, New York. pp. 11-34.

10. Chary P. 2011. A comprehensive study on characterization of elite neem chemotypes through mycofloral, tissue-cultural, ecomorphological and molecular analyses using azadirachtin-A as a biomarker. *Physiol. Mol. Biol. Plants* 17(1): 49–64.

11. Chen YP, Rekha PD, Arun AB, Shen FT, Lai WA, Young CC. 2006. Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. *Appl. Soil. Ecol.*, 34: 33–41.

12. Damle N, Kulkarni S. 2018. *In Vitro* screening of indole acetic acid (IAA) producing rhizobacteria from some medicinal plants. *DAV Int. J. Sci.*, 7(1): 1-5.

13. Girish K, Shankara Bhat S. 2008a. Neem – A green treasure. *EJBio.*, 4(3): 102-111.

14. Gohain A, Gogoi A, Debnath R, Yadav A, Singh BP, Gupta VK, Sharma R, Saikia R. 2015. Antimicrobial biosynthetic potential and genetic diversity of endophytic actinomycetes associated with medicinal plants. *FEMS Microbiol.*

Lett., 362(19):

15. Gunatilaka AAL. 2006. Natural products from plant-associated microorganisms: Distribution, structural diversity, bioactivity and implication of their occurrence. *J. Nat. Prod.*, 69: 509-526.
16. Habte M, Muruleedhara BN, Ikawa H. 1993. Response of neem (*Azadirachta indica*) to soil P concentration and mycorrhizal colonization. *Arid Land Res. Manage.*, 7: 327–333.
17. Hala Y, Ali A. Isolation and characterization of *Azotobacter* from neem rhizosphere. *J. Phys.: Conf. Ser.* 1244 012019.
18. Jeffries P. 1987. Use of mycorrhizae in agriculture. *Crit. Rev. Biotechnol.*, 5: 319–357.
19. Kalavathi BP, Santhanakrishnan P, Divya MP. 2000. Effect of VA-mycorrhizal fungus and phosphorus solubilising bacterium in neem. *Indian For.*, 126(1): 67-70.
20. Kanse OS, Whitelaw-Wecker, M, Kadam TA, Bhosale HJ. 2015. Phosphate solubilization by stress-tolerant soil fungus *Talaromyces funiculosus* SLS8 isolated from the neem rhizosphere. *Ann. Microbiol.*, 65(1): 85–93.
21. Kennedy AC. 1999. The rhizosphere and spermosphere. *In: Principles and Applications of Soil Microbiology* (Eds. Sylvia DM, Fuhrmann JJ, Hartel PG,

Zuberer DA). Prentice Hall, New Jersey.

22. Kumar J, Sharma VK, Singh DK, Mishra A, Gond SK, Verma SK, Kumar A, Kharwar RN. 2016. Epigenetic activation of antibacterial property of an endophytic *Streptomyces coelicolor* strain AZRA 37 and identification of the induced protein using MALDI TOF MS/MS. *PLoS ONE* 11(2): e0147876.

23. Kuncharoen N, Kudo T, Ohkuma M, Tanasupawat S. 2019. *Micromonospora azadirachtae* sp. nov., isolated from roots of *Azadirachta indica* A. Juss. var. *siamensis* Valetton. *Antonie Van Leeuwenhoek* 112: 253–262.

24. Linh DN, Thien BV, A Ni TT, Duy NT, Minh NV, Dong TC. 2020. Studies on antimicrobial activities of endophytic bacteria isolated from Neem tree (*Azadirachta indica*). *Ho Chi Minh City Open Univ. J. Sci.*, 10(1): 72-80.

25. Lodewyckx C, Vangronsveld J, Porteous F, Moore ERB, Taghavi S, Mezgeay M., et al. (2002). Endophytic bacteria and their potential applications. *Crit. Rev. Plant Sci.*, 21: 583–606.

26. Lucas Garcia JA, Probanza A, Ramos B, Gutierrez Manero FJ. 2001. Genetic variability of rhizobacteria from wild populations of four *Lupinus* species based on PCR-RAPDs. *J. Plant Nutr. Soil Sci.*, 164: 1–7.

27. Maliha R, Samina K, Najma A, Sadia A, Farooq L. 2004. Organic acid production and phosphate solubilization by phosphate solubilizing microorganisms under *in vitro* conditions. *Pak. J. Biol. Sci.*, 7: 187–196.

28. Mhatre SR, Nanoty VD. 2015. Antimicrobial activity of rhizospheric bacteria of *Azadirachta indica* producing metabolites against human bacterial pathogens. *Int. J. of Life Sci.*, Special issue A3: 21-25.
29. Miller HJ, Henken G, Van Veen JA. 1989. Variation and composition of bacterial populations in the rhizosphere of maize, wheat and grass cultivars. *Can. J. Microbiol.*, 35(6): 656-660.
30. Mohan V, Saranya Devi K. 2015. Study on the status of beneficial microbes from afforested textile and urban waste water polluted sites in Tirupur district, Tamil Nadu, South India. *ENVIS Centre Newsletter* 13(1).
31. Muthukumar T, Udaiyan K, Rajeshkannan V. 2001. Response of neem (*Azadirachta indica* A. Juss) to indigenous arbuscular mycorrhizal fungi, phosphate-solubilizing and asymbiotic nitrogen-fixing bacteria under tropical nursery conditions. *Biol. Fertil. Soils* 34: 417-426.
32. Nisha Rani, Pranay Jain and Geetanjali. 2017. Isolation of antimicrobial compound producing fungi from the rhizospheric soil of the medicinal plant *Azadirachta indica*. *J. Chem. Pharma. Res.*, 9(9): 265-270.
33. Pande M, Tarafdar JC. 2004. Arbuscular mycorrhizal fungal diversity in neem-based agroforestry systems in Rajasthan. *Appl. Soil Ecol.*, 26: 233-241.
34. Pandey A, Singh A. 2013. A comparative study on secondary

metabolites producing microbes isolated from rhizospheric and non-rhizospheric region of *Azadirachta indica* and *Oscimum tenuiflorum*. *Int. J. Pharm. Res. Allied. Sci.*, 2: 36-48.

35. Pandey PK, Singh S, Singh MC, Singh AK, Yadav SK, Pandey AK., et al. (2018). Diversity, ecology, and conservation of fungal and bacterial endophytes. *In: Microbial Resource Conservation* (Eds. Sharma SK, Varma A.). Springer International Publishing, New York. Pp. 393–430.

36. Phavaphutanon L, Davies FTJr, Duray SA. 1996. Growth, root alteration, and nutrient uptake of neem tree (*Azadirachta indica* A. Juss) seedlings in response to vesicular-arbuscular mycorrhizal fungi and phosphorus nutrition. *Int. Tree Crops J.*, 9: 59-67.

37. Prashar P, Kapoor N, Sachdeva S. 2014. Rhizosphere: its structure, bacterial diversity and significance. *Rev. Environ. Sci. Biotechnol.*, 13: 63-77.

38. Rodrigo Mendes, Paolina Garbeva, Jos M. Raaijmakers. 2013. The rhizosphere microbiome: significance of plant beneficial, plant pathogenic, and human pathogenic microorganisms. *FEMS Microbiol. Rev.*, 37(5): 634–663.

39. Schulz B, Boyle C. 2006. What are endophytes? *Soil Biol.*, 9: 1-14.

40. Shankarrao O. 2012. Isolation and characterization of phosphate solubilizing bacteria from rhizospheric soil samples. *Online Int. Interdiscip. Res. J.*, 2(4): 28-39.

41. Singh AK, Sharma RK, Sharma V, Singh T, Kumar R, Kumari D. 2017. Isolation, morphological identification and *in vitro* antibacterial activity of endophytic bacteria isolated from *Azadirachta indica* (neem) leaves. *Veterinary World* 10(5): 510-516.
42. Singh MJ, Padmavathy S. 2014. Isolation, screening and characterization of endophytic PGPR actinomycetes present commonly in neem and tulsi leaves - *in vitro* study (tomato). *Int. J. Recent. Sci. Res.*, 5(3): 574-579.
43. Sorensen J. 1997. The rhizosphere as a habitat for soil microorganisms. *In: Modern soil Microbiology* (Eds. Van Elsas JD, Trevors JT, Wellington EMH). Marcel Dekker, New York. pp. 21-45.
44. Sylvia DM, Chellemi DO. 2001. Interactions among root-inhabiting fungi and their implications for biological control of root pathogens. *Adv. Agron.*, 73: 1-33.
45. Tamilarasi S, Nanthakumar K, Karthikeyan K, Lakshmanaperumalsamy. 2008. Diversity of root associated microorganisms of selected medicinal plants and influence of rhizomicroorganisms on the antimicrobial property of *Coriandrum sativum*. *J. Environ. Biol.*, 29(1): 127-134.
46. Tan RX, Zou WX. 2001. Endophytes: A rich source of functional

metabolites. *Nat. Prod. Rep.*, 18: 448-459.

47. Tiwari K, Thakur HK. 2014. Diversity and molecular characterization of dominant *Bacillus amyloliquefaciens* (JNU-001) endophytic bacterial strains isolated from native neem varieties of Sanganer region of Rajasthan. *J. Biodivers. Biopros. Dev.*, 1: 115.

48. Verma VC, Gond SK, Kumar A, Mishra A, Kharwar RN, Gange AC. 2009. Endophytic actinomycetes from *Azadirachta indica* A. Juss.: Isolation, diversity, and anti-microbial activity. *Microb. Ecol.*, 57: 749–756.

49. Verma VC, Singh SK, Prakash S. 2011. Bio-control and plant growth promotion potential of siderophore producing endophytic *Streptomyces* from *Azadirachta indica* A. Juss. *J. Basic Microbiol.*, 51: 550–556.

50. Vijayan VM, Radhakrishnan M, Balagurunathan R. 2014. Bioprospecting of endophytic actinomycetes for antiphytofungus activity. *Int. J. Chem. Tech. Res.*, 6(5): 2689-2694.

11

GREEN SUSTAINABILITY THROUGH HYDROPONICS: A SCIENTOMETRIC REVIEW

S.Rajeswari

Assistant Librarian

Department of Library

University College of Engineering BIT Campus,

Anna University

Tiruchirappalli.

E mail:dr Rajeswari19772009@gmail.com

Dr.K.Kanimozhi

Assistant Professor

Department of Chemistry

University College of Engineering BIT Campus,

Anna University

Tiruchirappalli.

E mail :kanirams47@gmail.com

Abstract

Soil based agriculture is currently experiencing problems, due to several caused by humans factors, like industrialization and urbanisation. Scientists have created a brand-new alternative cultivation method called hydroponics, sometimes known as soilless cultivation. In a water-based, nutrient-rich solution, plants are grown hydroponically. Many different kinds of plants, crops and vegetables can be grown with hydroponics. This method of farming is economical, free of disease, environmentally benign, and gaining appeal both in developed and developing nations. Along with advanced space research, it offers significant potential in many nations to fill the gap left by a lack of suitable cultivable land. The present research aims to provide academics with an overview of published publications on the subject of Hydroponics. As a result, the evaluation looks at the countries, organisations and authors who are most engaged in the field of study. Bibliometrix and VoS viewer software were used to compile the documents downloaded from Web of Science Core Collection from 2013 to 2022 and to identify the of greatest significance networks. The findings showed that 2022 will see a large number of publications in the growing field of hydroponic literature. 1729 documents were released, with green sustainability being the most widely read of them all. Collaboration among authors connected 98 Countries, with China having the

most significant. In order to narrow the lack of skills between workers and jobs, this research will be an essential tool for academics and policymakers in developing well-designed and better-oriented continuous training programmes.

Keywords :Scientometric, Hydroponics, Soil fertility, Nutrient rich solution, Web of Science core collections

Introduction

Hydroponics is the practise of growing plants without the use of soil (Savvas et.al,, 2017). In simple terms, hydroponics is the process of growing plants in a variety of substrates (chemically inert), such as sand, gravel, or liquid (water), without the use of soil. The term comes from the Greek words "hydro" (water) and "ponos" (labour). (Savvas et.al, 2003; Douglas et.al,, 1975). or Plants grown hydroponically have their roots submerged in fertiliser solution without using any soil. (Maharana and Koul, 2011). Professor William Gericke first used the term "hydroponics" in the early 1930s to refer to the practise of growing plants with their roots suspended in nutrient-rich water. France, the Netherlands, and Spain are the top three manufacturers in Europe, which is thought to be the largest market for hydroponics. The United States and the Asia-Pacific region are the next two largest markets. According to the most recent research, these systems are growing more prevalent worldwide.

(Jensen and Collins et.al., 1985), The hydroponics market is projected to increase globally by 18.8% between 2017 and 2023, reaching USD 490.50 million. Growers contend that only hydroponic systems allow for continuous production, meaning that plants may be grown everywhere, including in small places with a controlled atmosphere throughout the year and during a short growing season. (Hughes et.al., 2017). When asked about their better productivity and yields, growers frequently respond that hydroponics always frees them from the limitations of climatic and weather circumstances. (Sarah et.al., 2017). Additionally, producers frequently said that the greater quality of hydroponic produce was due to the highly controlled environment and more uniform production that was possible without any water or nutrient loss. Additionally, because hydroponics is not seasonal, its productivities are higher and more consistent throughout the year (Okemwa et.al., 2015). The fact that hydroponic products don't require cultural operations like weeding, ploughing, fertilising the soil, or rotating the crops, as well as being simpler and lighter than conventional ones, is another common complaint from growers (Nguyen et al., 2016). To prevent excessive salinization and to control microbiological illnesses and pests to prevent any production losses, it is also essential and effective to monitor nutritional solutions and daily measurements of liquid nutrients (Barbosa et al., 2015). However, growers frequently counter that this

method makes it possible to produce better food and reduces wastage. As the most hydroponically cultivated crop in the world, lettuce is a good example of how to reduce waste because 99% of the hydroponic leaves are still useful and may be sold for a price that is around 40% higher than lettuce that is grown conventionally (Barbosa et al., 2015). Additionally, because of their greater average nutritional quality and consumer acceptance, fresh food grown hydroponically has a better chance of being sold (Mehra et al., 2017). Growers also stated that hydroponics avoids some of the drawbacks of conventional agriculture, such as the excessive and inefficient use of water, the need for a lot of land, the use of high quantities of nutrients and pesticides, and soil degradation and erosive erosion (Treftz and Omaye, 2016; Horrigan et al., 2002). Due to the strong and well-established inverse correlation between vegetable consumption and the risk of numerous types of chronic and degenerative diseases like cancer, cardiovascular disease, and neurological disorders, consumers worldwide are becoming more and more interested in having more fresh vegetables that are friendly to the environment (Kris et al., 2002). The presence of health-promoting chemicals is now a crucial factor for fruit and vegetable growers as a result of the growing customer interest. Environmental elements (light, temperature, humidity, and atmospheric CO₂) can have an impact on these advantageous chemicals. Contrary to normal

agriculture, hydroponics relies on the manipulation of nutrients, which, according to many authors, enables having product with a large accumulation of particular advantageous nutrients (Sgherri et al., 2010; Buchanan and Omaye, 2013). Hydroponics is the cultivation methods of plants without any soils. It is a type of horticulture and a subset of hydroculture that involves growing plants, usually crops or medicinal plants, without soil, by using water-based mineral nutrient solutions. The concept of hydroponics existed thousands of years ago, with the earliest examples of Hanging Gardens of Babylon and the Floating Gardens of China. It is not familiar in the modern hydroponic systems did not thrive until the advent of the greenhouse and plastics industries (Rijck, G, 1998). Hydroponics is the technique not only used on Earth, but has also proven itself in plant production experiments in space. Hydroponics have been applied successfully in developed countries and can be very well deployed with simpler technologies in cities too with urban agriculture (C. J. Asher et al 2010).

The Scientometrics method is a prominent research tool that can systematically represent the nature of specific scientific disciplines by highlighting research hotspots and detecting research trends. The Web of Science (WOS), maintained by Thomson Reuters, is considered one of the main bibliographic sources of information. Our study accumulated extensive

bibliometric data on this field from the Web of Science database, between 2013 to 2022, and conducted a scientometric analysis using VOSviewer for analyzing the retrieved data. The leading journals, highly used keywords in the published articles, authors and papers with the highest citations, and relevant regions were all identified in the scientometric analysis. Our scientometric findings can help academics collaborate on research, form joint ventures, and implement sophisticated technologies for implementing hydroponics.

Need of Agriculture without soil:

1. Open Field Agriculture involves large space, lot of labour and large volume of water.
2. In metropolitan areas as the population is high, soil is not available for crops growing at all,
3. Scarcity of fertile cultivable aerable lands due to their unfavourable geographical or topographical conditions.
4. Due to water scarcity and the texture of soil with loss of nutrients.
5. Another serious problem experienced since is the difficulty to hire labour for conventional open field agriculture (Wilbert Michael Rodríguez Ortega et al., 2016).
6. Under such circumstances, soil-less culture ie., **HYDROPONICS** can be introduced successfully.

Hydroponics start-up

In India, Hydroponics was introduced in year 1946 by an English scientist, W. J. Shalton and he established a laboratory in Kalimpong area, West Bengal. He has also written a book on Hydroponics, named as Hydroponics The Bengal System. Later on during 1960s and 70s, commercial hydroponics farms were developed in Abu Dhabi, Arizona, Belgium, California, Denmark, Germany, Holland, Iran, Italy, Japan, Russian Federation and other countries. During 1980s, many automated and computerized hydroponics farms were established around the world. Home hydroponics kits became popular during 1990s.

Types of plants grown through Hydroponics:

Plants commonly grown hydroponically include tomatoes, peppers, cucumbers, strawberries, lettuces, and cannabis, usually for commercial use, as well as *Arabidopsis thaliana*, which serves as a model organism in plant science and genetics. Terrestrial or aquatic plants may grow with their roots exposed to the nutritious liquid or in addition, the roots may be mechanically supported by an inert medium such as perlite, gravel, or other substrates.

Tomato, pepper, cucumber, eggplant, strawberry, squash, root plants, such as carrot, turnip or beet, tubers such as potato, and bulbs, for example onion, and garlic plants.

Such soilless culture systems could be implemented as an alternative to the current field culture of saffron (Mollafilabi et al., 2013).



Fig. 1: Hydroponics practices of Farming

The advantages of soilless cultures in saffron production have been shown in several studies. Souret and Weathers (2000) noted that saffron corms grown hydroponically produced more flowers and leaves compared with corms grown in soil. They indicated that hydroponics conditions not only did not reduce saffron stigma production but also significantly increased the dry weight of the corms and the concentrations of crocin and crocetin in the dried stigmas.

Supply of Nutrients through Hydroponics:

Water culture such as NFT or DFT and substrate culture using some media such as rock wool or coconut-coir are included in it. In soil culture, only N, P, and K, the three major elements, are supplied to plant as fertilizer, and most of the

other elements are absorbed from soil naturally. In hydroponics as it does not contain soil, Sixteen minerals are supplied to grow the plant healthy. These minerals are called essential elements. All plant factories can use hydroponic systems, because of (a) Nine major elements C, H, O, N, P, K, Ca, Mg, and S, and seven minor elements Fe, Cu, Zn, Mn, Mo, B, and Cl are needed to supply to plants as fertilizer.

Desirable pH range of nutrient solutions:

In hydroponic systems, pH is constantly changing as the plant grows. Changes in pH of less than 0.1 unit are not significant (Rodríguez-Delfín Alfredo et al, 2023). Thus pH control is a necessity in hydroponic solutions. The pH range of 5.5 to 6.5 is optimal for the availability of nutrients from most nutrient solutions for most species, but species differ significantly and several can grow well outside of this range.

Techniques implement in Hydroponics:

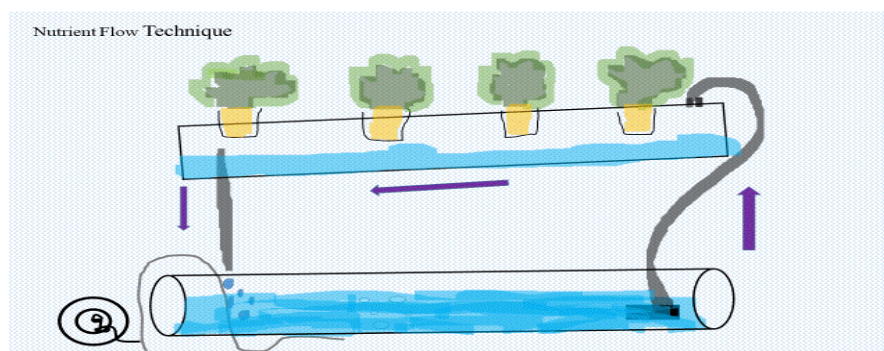


Fig. 2 Nutrient Flow Technique method

In a broad sense, the technique is solution culture include Circulating methods (closed system)/ Continuous flow solution culture a) Nutrient film technique (NFT) b) Deep flow technique (DFT). Flowing solution culture systems can provide a consistent nutrient environment for roots. They are highly amenable to automatic control but are subject to rapid plant desiccation if the flow of solution stops for any reason. Thus frequent attention is required.

ii) Non-circulating method (open systems)/ Static solution culture a) Root dipping technique b) Floating technique c) Capillary action technique.

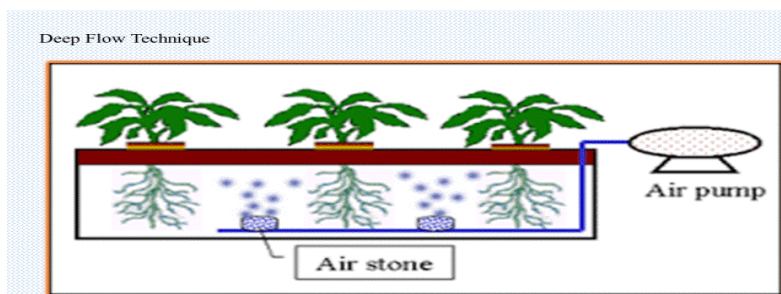


Fig. 3 : Deep Flow Technique

Suitable vessels for static systems include polythene beakers, pots, glass jar and containers lined with black polythene film. B. Media culture. The media culture method has a solid medium for the roots and is named for the type of inert medium, e.g. sand culture, gravel culture or rock wool culture. There are two main variations for each medium, sub-irrigation and top-irrigation. However, it is classified as follows: 1. Hanging bag technique 2. Grow bag technique 3. Trench or trough technique 4. Pot technique.

Advantages of hydroponics:

- ❖ Hydroponics offers many advantages, notably a decrease in water usage in agriculture.
- ✚ Case study: To grow 1 kilogram of tomatoes through intensive farming methods requires 214 litres of water; but using hydroponics 70 litres only required
- ❖ Hydroponic cultures lead to highest biomass and protein production compared to other growth substrates, of plants cultivated in the same environmental conditions and supplied with equal amounts of nutrients.
- ❖ In future people in harsh environments with little accessible water can also grow their own plant-based food hydroponically.
- ❖ automatic control of irrigation and fertilization,
- ❖ saving labor,
- ❖ keeping cultivation environment clean,
- ❖ Enabling to make cultivation beds multilayer, and so on.{T.Wada, 2019}
- ❖ It offers the potential for a larger variety of food, and it provides a biological aspect, called a bio-regenerative life support system(YouryPiiEtal, 2015).

Methodology [Variants] of hydroponic systems

The hydroponic cultures sustain with a nutrient solution to supply essential

elements to the plant. The roots also need to supply steady amount of oxygen. When roots become anoxic they are unable to take up and transport metabolites to the rest of the plant body. Hydroponic systems can be classified based on oxygen delivery and other nutrients to the roots.

Classical hydroponics First type: Delivery of oxygen by saturating the solution with air, without submerging the roots at all times, Second type: By allowing the roots to be completely exposed to the air. Alternatively, plants may also be grown on inert media with the help of rockwool, vermiculite, or clay pellets and subjected to wet-dry cycles by dripping solution through the media or periodically submerging the substrate in the nutrient solution (Lee & Tatukura et al 1995).

Preparation of Nutrient solutions for Hydroponic plant using Chemical Equilibria:

For hydroponic saplings, chemistry is the fundamental to ensure adequate nutrient supply plant uptake. To specify and preparing nutrient solutions, multiple chemical equilibria must be taken into account. Either solubilization/precipitation equilibria used in the preparation of salts or concentrated liquid stocks, (De Rijck and Schrevens, 1998b). Temperature roles a main factor in preparing the solutions and used it for the hydroponics plants. This is particularly crucial for areas where the overwarming of the

nutrient solution often occurs, impacting also at the physiological level of crops (Lee and Takakura, 1995 – spinach; Fazlillahi et al., 2017 – butterhead lettuce).

Precipitation reactions Cations and anions in aqueous solution combine to form an insoluble ionic solid (the precipitate). Attaining the maximum limit with the addition of cations and anions it reaches the Saturation level. The concentrations of ions in equilibrium with the precipitate (i.e., solubility) can be calculated using a specific equilibrium constant called solubility product, which is tabulated for many chemical compounds and depends on temperature. Besides temperature, precipitation equilibria can be also influenced by other parameters such as pH and ionic strength*. **Ionic strength: A parameter that considers the sum of the concentrations of all the ionic compounds in solution and their charge.* Cations may form insoluble hydroxides at alkaline pH by combining with OH⁻ anions or other insoluble precipitates by reacting with other anionic nutrients; thus, they must be carefully balanced and optimized to avoid losses from solution. In such cases, the values of pH and those of redox potential (Eh) must be continuously monitored or controlled. In this regard, pH values above 7 and positive Eh values may cause the precipitation of nutrients like iron (Fe), zinc (Zn), copper (Cu), nickel (Ni), and manganese (Mn^{II}) as insoluble (hydroxides. Precipitation of Fe^{III} may occur already at pH well below the neutrality (Takeno, 2005). **At negative Eh values and acidic pH, e.g., in**

uncontrolled hydroponic systems under anoxic conditions, the same elements might also precipitate as insoluble sulfides, when sulfate is reduced to sulfide. At high pH values and high dissolved CO₂ concentrations, macronutrients like Ca and magnesium (Mg) can precipitate as carbonates. Precipitation of phosphates (mostly hydrogen phosphates) is another process to avoid in hydroponic solutions. This process, besides depleting phosphorus (P) from nutrient solution, may also reduce the solubility of other nutrients such as Ca, Mg, Fe, and Mn^{II}. It is known that phosphate availability can be reduced at pH above 7 mostly due to precipitation with Ca. Different Ca-phosphate minerals can potentially form above this pH such as hydroxylapatite [Ca₅(PO₄)₃OH], amorphous tricalcium phosphate [Ca₃(PO₄)₂], and Ca₄H(PO₄)₃·3H₂O (Lee et al., 2017).

Also sulfur (S) availability can be limited by precipitation with Ca, as Ca-sulfate minerals (Packter, 1974). Silicon solubility is usually reduced at acidic pH, where SiO₂ precipitates may be produced (Takeno, 2005). Precipitation/dissolution phenomena are often promoted by pH changes and therefore pH must be continuously controlled or buffered. Addition of nutrients in the form of salts to hydroponic solutions may lead to hydrolysis reactions, which may result in the acidification or alkalization of the medium. Nitrogen (N) supply may also alter solution pH, if N is added only in the form of

NO_3^- (alkalinization) or NH_4^+ (acidification) (Asher and Edwards, 1983). Yet, both N forms are usually added to hydroponic solutions. In general, saturation conditions for a certain nutrient could be reached if its concentration is increased due to water evaporation from the hydroponic system (owing to high temperatures or plant evapotranspiration). However, it has been recently observed that water losses by 20% (or even more) do not significantly influence precipitation equilibria (Tomasi et al., 2015a).

Preparation of Hydroponic Culture

In this case, polystyrene boxes were used to hold the medium which was coir dust. Each box measured 50cm by 33cm by 9 cm where four plants were expected from each of them. The nutrient solution was then prepared as per the stated amount of mineral required in this experiment. This hydroponics solution was then passed through the grown plants to enable them absorb the nutrients. Random measurements of the parameters stated in this experiment were done when the plants had reached 30, 37, and 45 years. Four plants were picked randomly from both the hydroponics and soil culture for these measurements to be taken. Also, the number of leaves in the plants taken for the study was recorded.

Root lengths, dry weights and root: shoot ratios

The root lengths of the plants grown in the hydroponics were slightly higher than the lengths of the soil grown plants. These plants also had their roots being more resistant to growth as the initial lengths of their roots were close to that after the experiment. The hydroponically grown plants recorded higher shoot dry weights as compared to those from the soil which had high root dry weights. This is one of the best ways of determining the quality of the harvest one should expect after the plants have grown to maturity. The following is a set of data collected in this experiment. Mean root lengths, root dry weights, shoot dry weights and shoot: root ratios of hydroponically grown plants and soil grown plants.

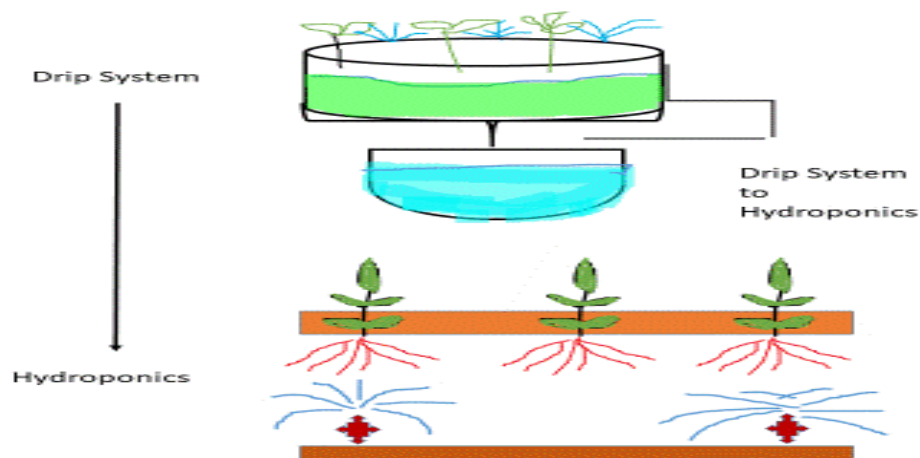


Fig.5 : Starting from Drip system to Hydroponics

Research Questions

Scholars and practitioners will be able to access an extensive review of the

Hydroponic literature that has been published in the Web of Science core collection as a result of this research. To do this, we shall solve the following issues:

1. Which one literary works on hydroponics are the most significant and inventive?
2. What are most probable areas for future research in the field of hydroponics?

Materials and Methods

The Web of Science (WoS) is the most widely used database in scientometric and bibliometric research. The WoS core collection database, with index dates covering the years 2013 to 2022, provided as the search's data source downloaded from WoSon 04 May 2023. The search strategy was "Topic = Hydrophonic" is shown in Figure 1. When we refined our search by Languages and used the WoS database: (English and Articles only) Period: 2013 to 2022. The outcome was discovered in 1729 peer-reviewed journal publications. All the data were downloaded from the WoS Core Collection and imported into the software for analysis. In this study, Microsoft Office Excel was used to create a figure on annual research output, and the bibliomerix tool and VOSviewer software were used to perform scientometric analysis. The VOSviewer was used to identify the co-author's countries, organizations, a co-authorship network, and to cluster visualization of co-occurrence keyword

analysis.

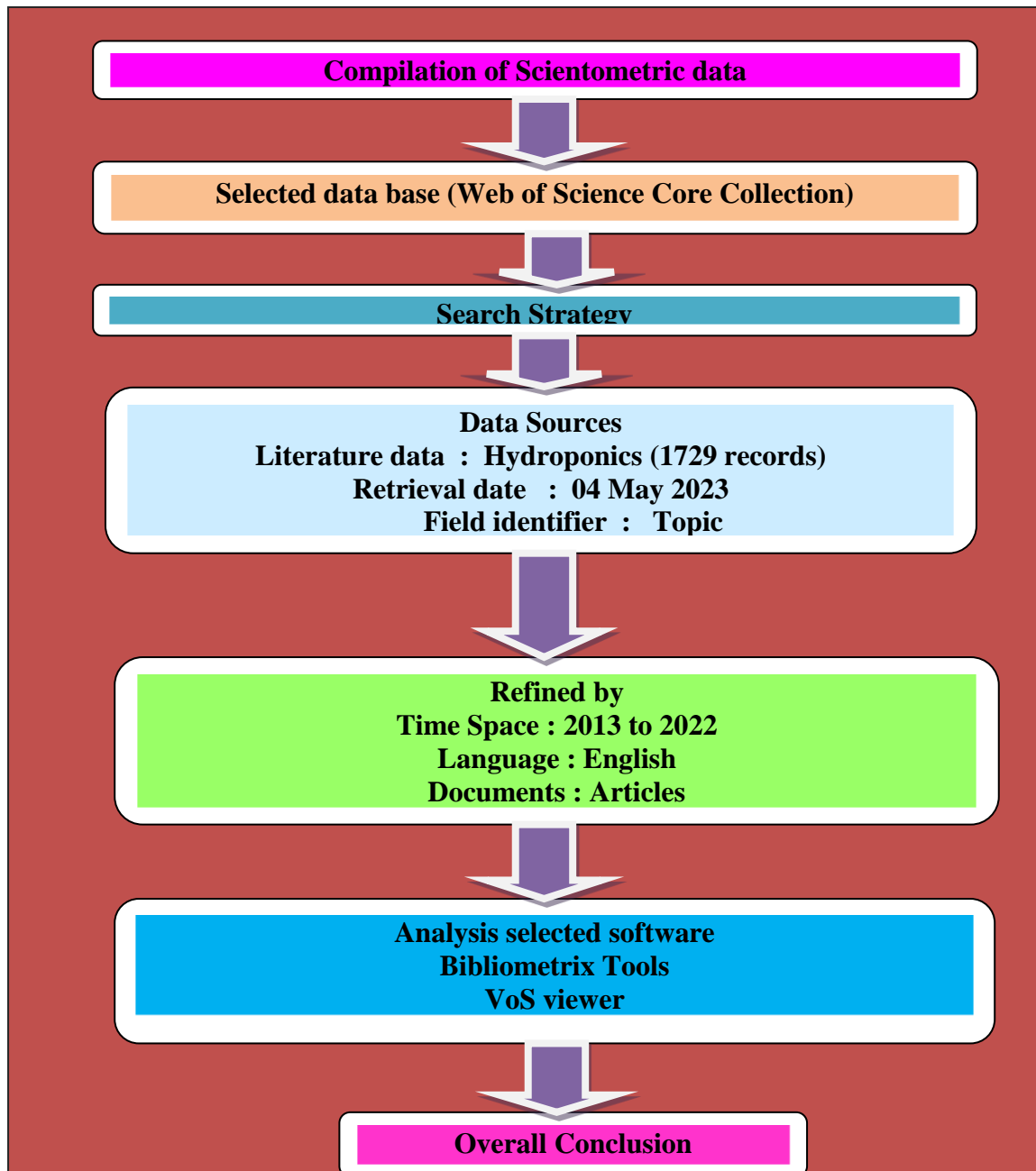


Fig.6: Research Design in the Domain of Hydroponic

Results and Analysis

Main Information regarding the hydroponics

The data collection of duration from 2013 to 2022 has been analysed. The outputs from this analysed shown in Table 1 indicate that Time span is 10 years. 1729 documents are collected from Web of Science, 482 Sources, 4.43 Average years from publication, 13.74 Average citations per documents, 2.288 Average citations per year per document and 62104 references. Authors details followed by 7111 authors, 9483 authors appearances, 26 Authors of single-authored documents and 7085 authors of multi-authored documents. Authors Collaboration as follows 26 Single-authored documents, 0.243 Documents per Author, 4.11 Authors per Document, 5.48 Co-Authors per Documents and 4.16 Collaboration Index.

Table 1 Descriptive Analysis : Main Information regarding the hydroponics

	Description	Results
	Main Information about Data	
1	Timespan	2013:2022
2	Sources (Journals)	482
3	Documents	1729
4	Average years from	4.43

	publication	
5	Average citations per documents	13.74
6	Average citations per year per doc	2.288
7	References	62104
	Authors	
1	Authors	7111
2	Author Appearances	9483
3	Authors of single-authored documents	26
4	Authors of multi-authored documents	7085
	Authors Collaboration	
1	Single-authored documents	26
2	Documents per Author	0.243
3	Authors per Document	4.11
4	Co-Authors per Documents	5.48
5	Collaboration Index	4.16

Annual Productivity

Table 2 observed that 1729 publications were recorded during the study period. The publications trend shows a positive growth in the study period. The

maximum number of productivity recorded during 2022 with 279 publications and the minimum recorded in the year 2013 100 publication.

Table 2 Annual Productivity

Year	Articles
2013	100
2014	105
2015	113
2016	137
2017	151
2018	159
2019	202
2020	227
2021	256
2022	279
	1729

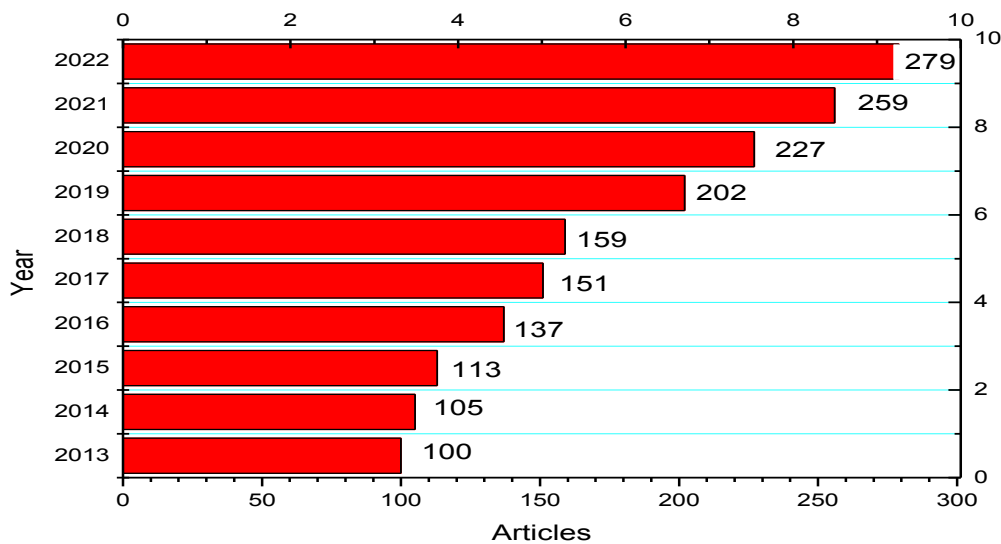


Fig. 7 : Author Productivity

Author Productivity through Lotka's Law

Lotka's law of scientific productivity has been applied to the collected dataset and the results are indicated in Table 3. A total of 1729 authors published articles between the fifty years of 2013 to 2022. Fig.3 depicts Lotka's Law, which computes the frequency distribution of scientific productivity. Here, Lotka's Law reveals that about 81.91% of the authors (5821 authors) have one publication, and approximately 11.55% of the authors (821 authors) have two publications. There are outliers, with very few authors with more than nine publications.

Table 3 Frequency distribution of scientific productivity applied by

Lotka's Law

Documents written	No. of Authors	Proportion of Authors %
1	5821	81.91
2	821	11.55
3	232	3.26
4	93	1.31
5	57	0.80
6	32	0.45
7	22	0.31
8	16	0.23
9	5	0.08
10	5	0.08
11	1	0.01
12	1	0.01

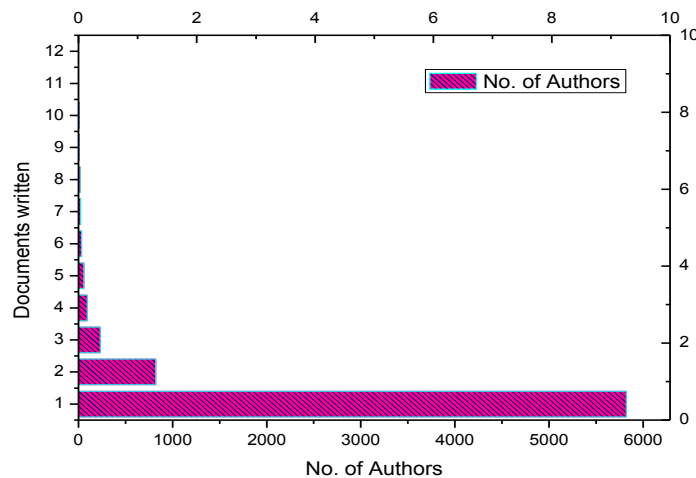


Fig. 8 : Frequency distribution of scientific productivity applied by Lotka's Law

Prolific of most Corresponding Author's Country

Table 4 and Fig.9 show the number of articles produced by the authors of different countries and each country's authors' co-operation rate with other countries' authors. For instance, authors of the China have produced 303 articles, but authorship co-authorship with other countries is about 79 papers. Subsequently, the USA authors ranked second with 186 papers, and the authorship rate for contributing articles to other authors with other countries is 24 papers and India authors ranked third 141 papers and the other authors with other countries 17 papers.

Table 4 Prolific of Most Corresponding Author's Country

Rank	Country	Articles	Freq	SCP	MCP	MCP_Ratio
1	China	303	0.17565	224	79	0.2607
2	USA	186	0.10783	162	24	0.129
3	India	141	0.08174	124	17	0.1206
4	Italy	119	0.06899	83	36	0.3025
5	Brazil	96	0.05565	79	17	0.1771
6	Japan	84	0.0487	60	24	0.2857
7	Pakistan	62	0.03594	33	29	0.4677
8	Germany	59	0.0342	34	25	0.4237
9	Spain	58	0.03362	31	27	0.4655
10	Australia	56	0.03246	25	31	0.5536
11	Korea	50	0.02899	40	10	0.2
12	Iran	39	0.02261	22	17	0.4359
13	France	34	0.01971	20	14	0.4118
14	United Kingdom	29	0.01681	17	12	0.4138
15	Mexico	27	0.01565	22	5	0.1852

16	Poland	27	0.01565	23	4	0.1481
17	Belgium	25	0.01449	15	10	0.4
18	Canada	25	0.01449	20	5	0.2
19	Greece	23	0.01333	10	13	0.5652
20	Cyprus	17	0.00986	3	14	0.8235

*(SCP: Single Country Publication; MCP: Multiple Country Publication)

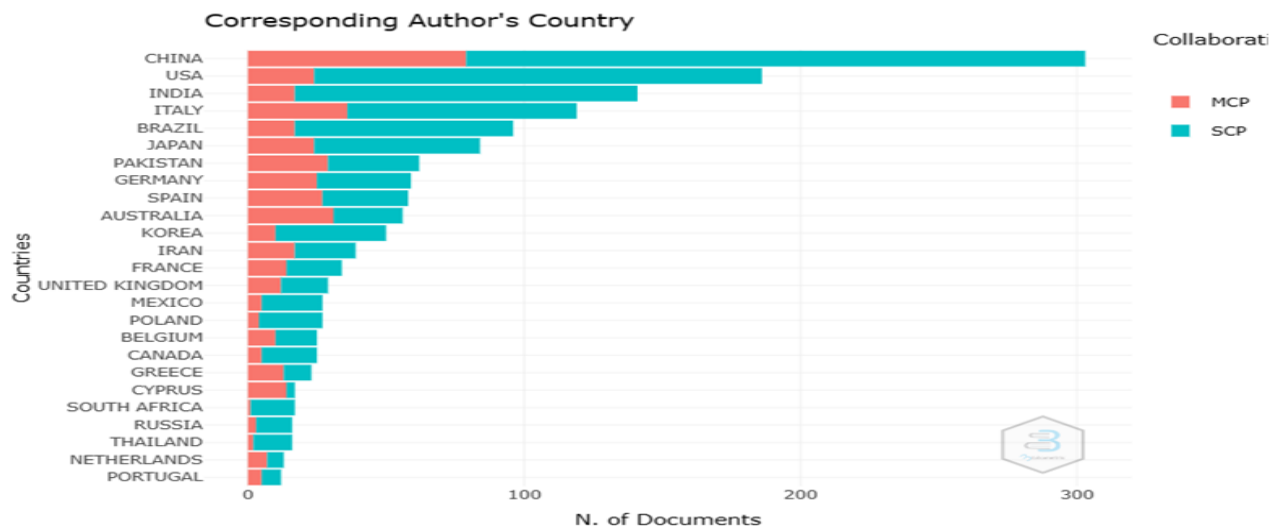


Fig. 9 : Prolific of Most Corresponding Author's Country

Country Productivity

Figure 10 shows the country productivity are represent leading 20 countries shown in the Table 5. The leading three countries productivity more than 300 publications. China is the first place and second place occupied USA. India is obtained third possion. More and 200 published countries are Italy than , Brazil, Pakistan and Japan.

Table 5 Country Productivity

Rank	Country	Frequency
1	China	754
2	USA	465
3	India	354
4	Italy	267
5	Brazil	263
6	Pakistan	226
7	Japan	223
8	Germany	186
9	Australia	172
10	Spain	138
11	South korea	134
12	France	120
13	UK	85
14	Poland	74
15	Iran	72
16	Mexico	72
17	Belgium	64
18	Canada	61
19	Greece	56
20	Thailand	51

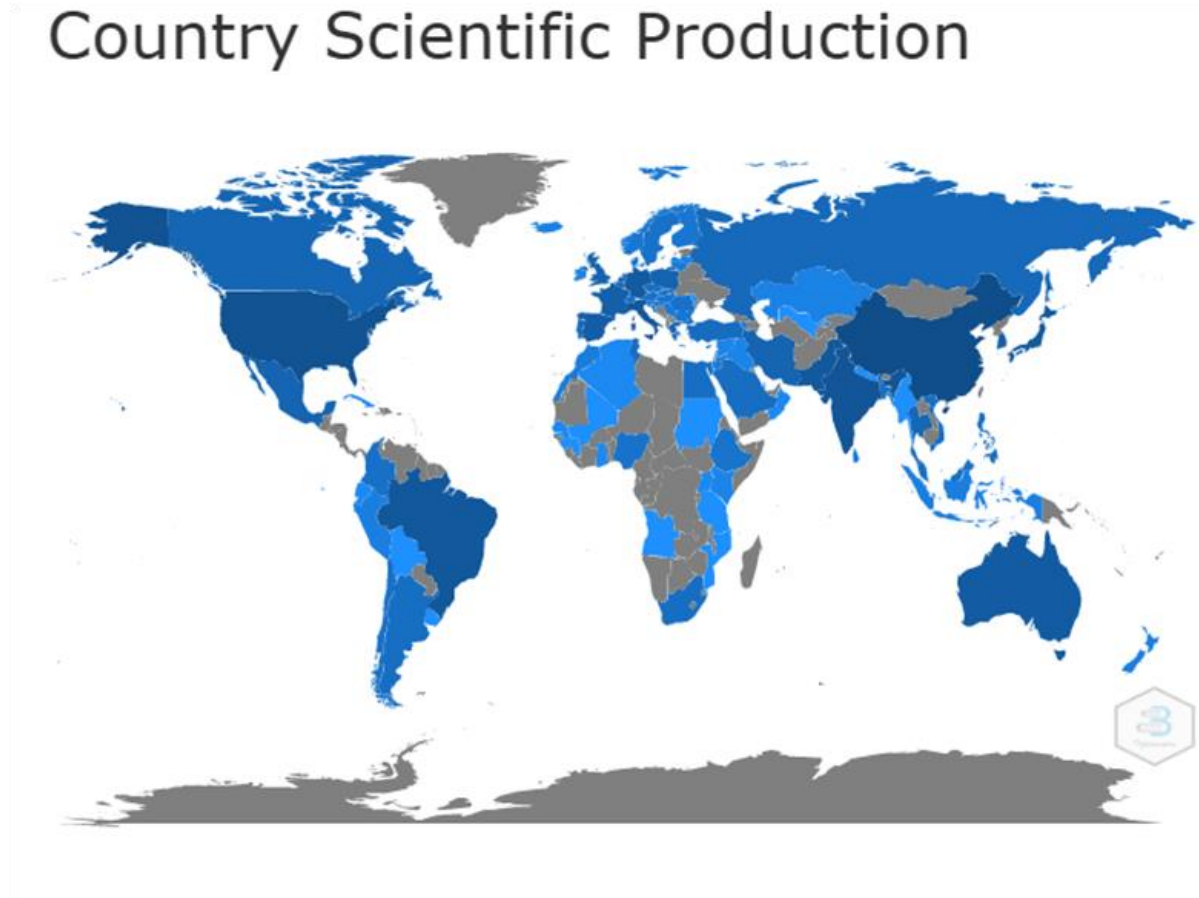


Fig.10 : Country Productivity

Author co-authorship analysis

The most common kind of collaboration network is the co-authorship network. The network visualization of authorship in the field of hydroponics Research is depicted in Figure 11. The circles (or nodes) represent an author and the size of the circles represents the number of papers published. There can be seen some link between two circles standing for cooperative relation between two authors and the thickness between the links represents the strength of cooperation. The threshold value of publications in cooperation is taken as 5,

that is authors with minimum number of papers in collaboration. A total of 7690 authors meets the threshold, out of which 97 are connected. The 97 authors are again divided into 10 clusters on the basis of their closeness in connection and work in a similar field. The largest cluster i.e., Cluster 1 (red color) has 15 authors. The second largest cluster (green color) has 12 authors. The third cluster (blue color) has 12 authors. The fourth cluster (yellow color) has 6 authors. The fifth cluster (violet color) has 6 authors. The sixth cluster (shallow blue color) has 5 authors. The seventh cluster (orange color) have 4 authors. The eighth cluster (brown color) has 4 authors. The ninth cluster (purple color) has 3 authors and The ten cluster has 3 (viridiscolor) researchers. The top 20 authors with least 10 or more papers in collaboration are Roupghael, Youssef, Savvas, Dimitrios, De Pascale, Stefania, Liu, Dan, Asao, Toshiki and Ntatsi, Georgia. The top 20 authors who published at least 10 or more papers and cluster, total citations and number of publications are presented in Table 8.

Table 6 Top 20 Author co-authorship analysis

Rank	Authors	cluster	Documents	Citations
1	Roupghael, Youssef	3	19	235
2	Savvas, Dimitrios	6	13	168
3	De Pascale, Stefania	3	12	129
4	Liu, Dan	2	11	358
5	Asao, Toshiki	9	10	126
6	Ntatsi, Georgia	6	10	108

7	Wang, Ying	2	9	286
8	Kim, Hye-Ji	4	9	173
9	Keesman, Karel J.	1	9	162
10	Chrysargyris, Antonios	3	9	161
11	Kloas, Werner	1	8	285
12	Ye, Zhengqian	2	8	253
13	Goddek, Simon	1	8	232
14	Miceli, Alessandro	10	8	183
15	Zacchini, Massimo	7	8	157
16	Schat, Henk	5	8	126
17	Gonnelli, Cristina	5	8	105
18	Pannico, Antonio	3	8	94
19	Chen, Junren	2	7	253
20	Baganz, Daniela	1	7	236

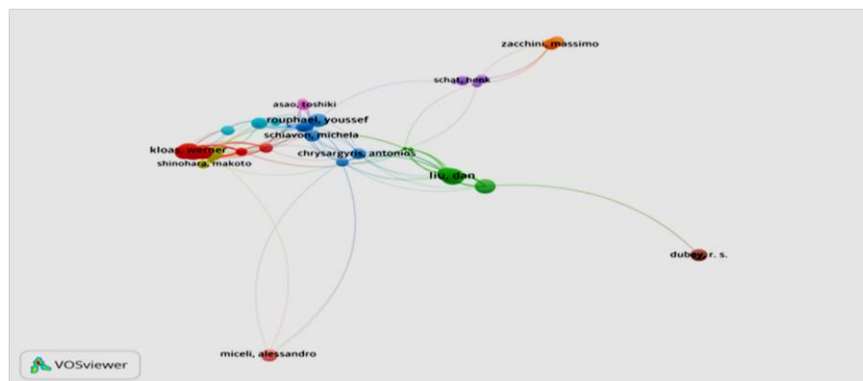


Fig.11 : Top 20 Author co-authorship analysis

Countries co-authorship analysis

The country affiliation provides the information on workplace of a researcher, the nation in which a researcher works within a particular organization producing certain research papers under the affiliation of the organization. If

the paper is multi-authored then each author contributes significantly to draft a manuscript so the country and author affiliation is considered to be very significant in evaluating the research output of a researcher. Now, the coauthorship analysis on the basis of countries is very important indicator indicating the network of the countries collaborating and by default the collaboration of organizations and authors. There are 98 countries meeting the threshold of 2 papers coauthored. VOSviewer software prepares a network map for the largest set of 57 connected countries. These countries are so connected that they form 7 clusters on the basis of their closeness. Countries with minimum of 57 publications in collaboration falls into the category of top collaborating countries. Table 9 gives a list of top 20 collaborating countries on the basis of number of papers independent of total citations and cluster. These countries produce total of 1726 papers. Their respective number of papers to the total papers from the top 20 countries are: 335 papers are from Peoples R China (5458 Citations), USA have number of 253 papers (3820 citations) and India ranks in 3th with 15papers (1610 citations) USA and India is same 4th cluster. International country co-authorship network map using VOSviewer software is presented in Figure 7, with circles representing a country. The map has 57 nodes (circles). The size of the circle is directly proportional to the number of articles published in collaboration with the countries which depicts

the research activity in the region. The bigger the size of the circles, the larger the number of publications in collaboration. The circular line is established when two countries have a collaborative relationship. The thickness of the lines reflects the extent of co-operation and the number of collaborations between the countries. There are total of 7 clusters in the dataset. Each cluster represents a group.

Table 7 Top 20 Countries co-authorship analysis

Rank	Countries	cluster	Documents	Citations
1	Peoples R China	2	335	5458
2	USA	4	253	3820
3	India	4	154	1610
4	Italy	7	141	2192
5	Brazil	3	110	1102
6	Germany	6	109	1916
7	Pakistan	2	98	2553
8	Japan	1	96	829
9	Australia	4	91	1541
10	Spain	6	80	1418
11	South Korea	3	56	762
12	France	2	48	1407
13	Iran	1	44	556
14	England	4	39	764
15	Greece	7	38	491
16	Netherlands	6	38	678
17	Canada	5	37	368
18	Belgium	3	36	634
19	Mexico	1	35	161
20	Poland	2	34	581

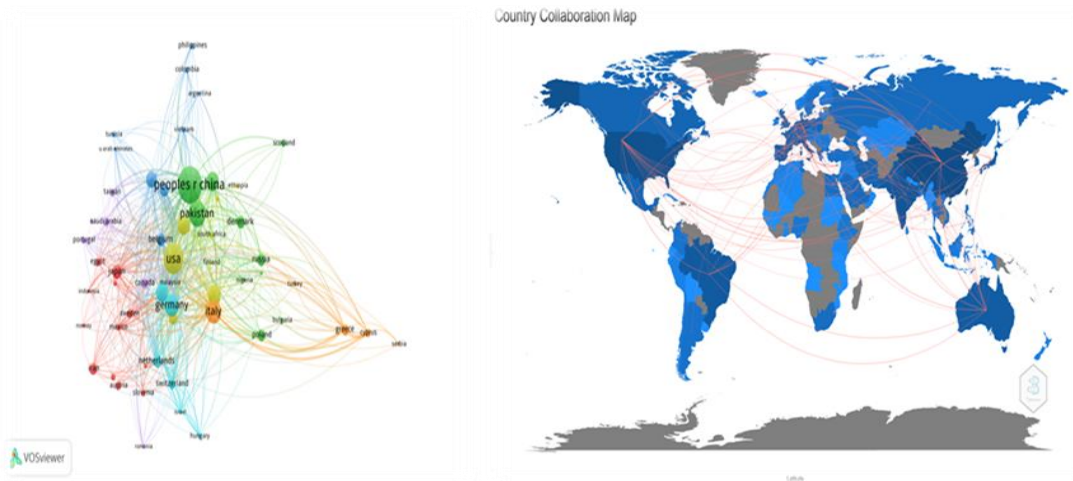


Fig. 12 : Top 20 Countries co-authorship analysis

Keyword on the basis of frequency of occurrences

Keyword's analysis is a significant aspect of Bibliometric analysis. Here, keyword analysis is done in order to know the keyword co-occurrences, frequency of occurrences, hot/ trending topics. A total of 4904, keywords are identified in hydroponics research. The keywords which are occurring at least 5 times are selected and a total of 239 meets this threshold. Out of these, network map of 1000 keywords are prepared (Figure 13). These are further divided into 11 Cluster, Top 20 Keywords on the basis of frequency of occurrences are Hydroponics, Aquaponics, Cadmium, Phytoremediation, Lettuce and Salinity.

Table 8 Top 20 Keywords on the basis of frequency of occurrences

Rank	Keywords	cluster	Occurrences
1	Hydroponics	2	586
2	Aquaponics	6	73
3	Cadmium	3	59
4	Phytoremediation	3	57
5	Lettuce	7	54
6	Salinity	5	52
7	Rice	1	47
8	Photosynthesis	2	39
9	Oxidative Stress	3	34
10	Nitrogen	10	33
11	Nitrate	4	31
12	Wheat	5	31
13	Phosphorus	10	28
14	Aquaculture	6	27
15	Nutrient Solution	2	27
16	Greenhouse	7	26
17	Maize	1	26
18	Soilless Culture	2	25
19	Tomato	7	24
20	Abiotic Stress	11	23

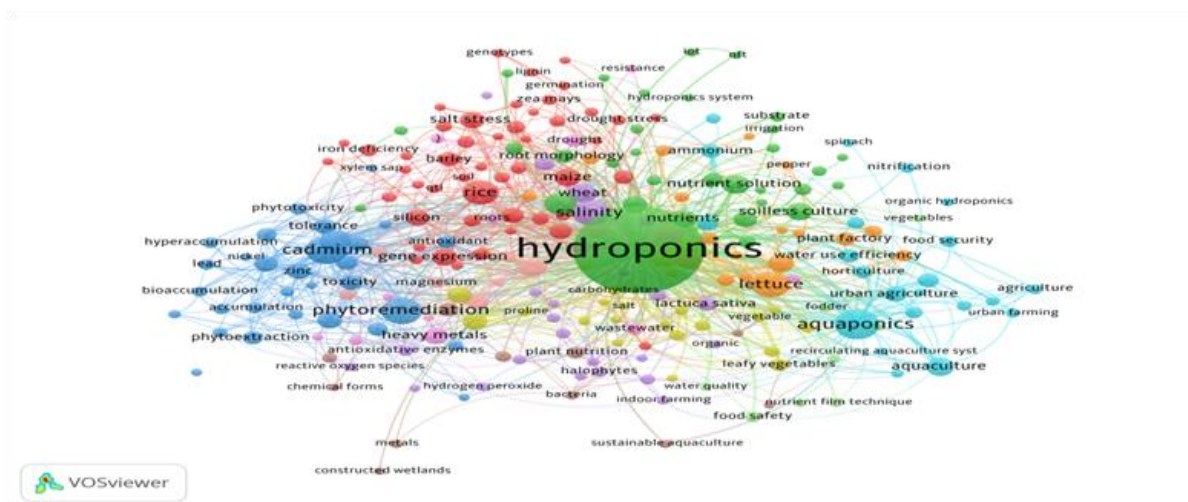


Fig. 13 : Top 20 Keywords on the basis of frequency of occurrences

Ranking of Organisation

Organisation analysis facilitates the researchers to identify the dominating institutions working actively in the specified research domain for their postdoctoral studies, research exchange activities and study tours. Organisation have participated in the studies related to hydroponics during the period of 2013to 2022. Top institutions are shown in Figure 14 and table 9. Chinese AcadSci is the largest contributor publishing 42 documents, Zhejiang Univ is the second position 31 documents .Chinese AcadAgrSci, UnivAgr Faisalabad and Univ Naples Federico Ii is the third position each 25 documents and remaining are below 25 documents.

Table 9 Top 20 Organisation

Rank	Organisation	Cluster	Documents	Citations
1	Chinese AcadSci	2	42	643
2	Zhejiang Univ	7	31	821
3	Chinese AcadAgrSci	2	25	184
4	UnivAgr Faisalabad	2	25	430
5	Univ Naples Federico Ii	6	25	234
6	Univ Florida	3	24	249
7	Univ Chinese AcadSci	2	20	213
8	Purdue Univ	1	19	247
9	Nanjing AgrUniv	5	18	305
10	Tottori Univ	9	18	181
11	Univ Western Australia	2	18	338
12	Cornell Univ	1	17	304
13	Northwest A&F Univ	2	17	317
14	AgrUniv Athens	6	16	205
15	HuazhongAgrUniv	2	16	317

16	South China AgrUniv	2	16	165
17	Univ Padua	6	16	310
18	China AgrUniv	4	15	245
19	GovtCollUniv	7	15	1024
20	Univ Bonn	4	15	145

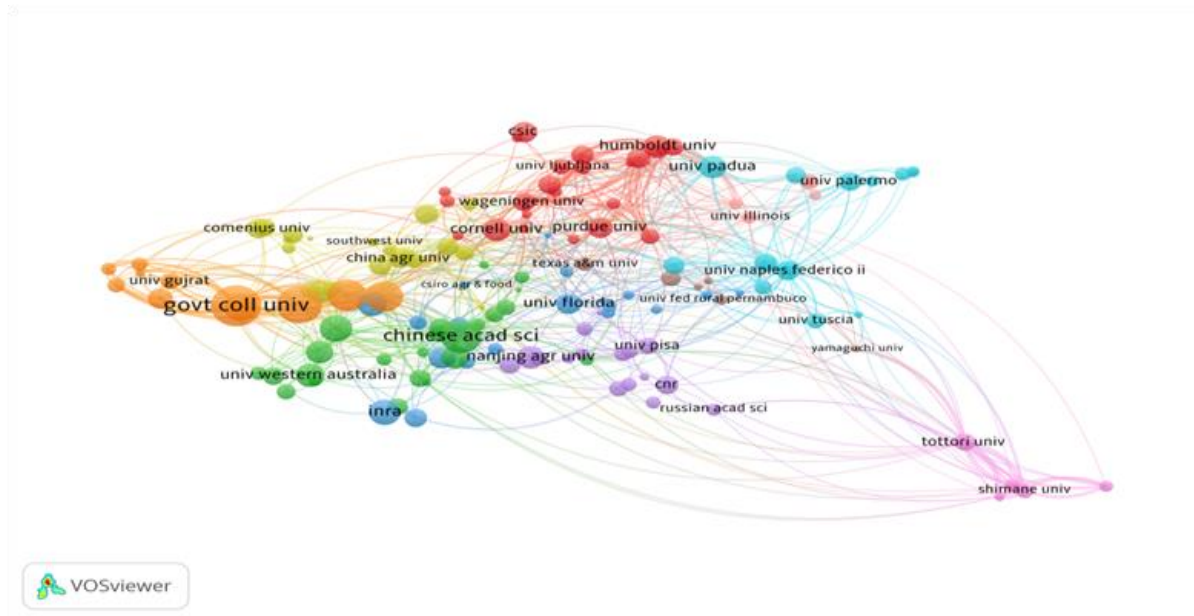


Fig.14 : Top 20 Organisation

Ranking of Sources

Table 10 and Figure 15 presented the ranking of Journal with numbers of literature published on the subject. The Journals were only highlighted since it can be seen from the Figure that, Frontiers in plant sciencerank the highest with 66 (971Citation) literature published, followed by Horticulturae64 (405Citation), Agronomy-basel54 (600Citation) and other remaining publication below 50 records.

Table 10 Top 20 Sources

Rank	Sources	cluster	Documents	Citations
1	Frontiers in plant science	2	66	971
2	Horticulturae	5	64	405
3	Agronomy-basel	8	54	600
4	Journal of plant nutrition	8	49	340
5	Scientiahorticulturae	9	48	1126
6	Environmental science and pollution research	1	42	1077
7	Plants-basel	3	41	310
8	Plant and soil	1	37	629
9	Plant physiology and biochemistry	1	29	595
10	Hortscience	6	28	196
11	Environmental and experimental botany	1	24	553
12	Science of the total environment	1	24	365
13	Ecotoxicology and environmental safety	1	22	683
14	Plos one	4	20	474
15	Journal of cleaner production	4	19	442
16	Agricultural water management	6	18	223
17	Journal of the science of food and agriculture	3	18	124
18	Sustainability	6	18	236
19	Chemosphere	1	17	334
20	Actaphysiologiaeplantarum	3	16	329



Fig. 15 Top 20 Sources

Three fields in Hydroponics

In the current study on hydroponics, the three fields are connected in a three-field plot, which is highlighted in Figure 16. Making a three-field plot required the usage of the Bibliometrix tool. The left-field displays the writers who have contributed the most to hydroponics, the center field shows the author names and the right-field lists references. The authors with the most significant contributions to hydroponics were Schat.h, Dresler.S, and Ye.Zq.

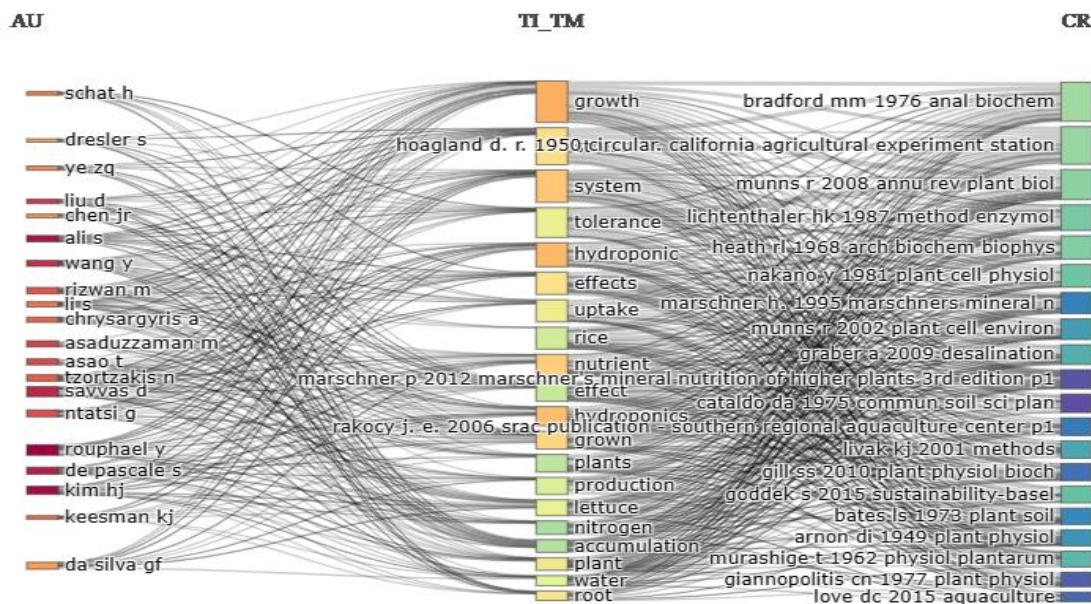


Fig. 16 Three fields in Hydroponics

Cited Articles

Keller et al (2016) investigated the potential role of silicon in im-proving

tolerance and decreasing cadmium (Cd) toxicity in durum wheat (*Triticum turgidum* L. durum) either through a reduced Cd uptake or exclusion/sequestration in non-metabolic tissues. For this, plants were grown in hydroponic conditions for 10 days either in presence or absence of 1 mM Si and for 11 additional days in various Cd concentrations (0, 0.5, 5.0 and 50 μ M). After harvesting, morphological and physiological parameters as well as elemental concentrations were recorded. Cadmium caused reduction in growth parameters, photosynthetic pigments and mineral nutrient concentrations both in shoots and roots. Shoot and root contents of malate, citrate and aconitate increased, while contents of phosphate, nitrate and sulphate decreased with increasing Cd concentrations in plants. Addition of Si to the nutrient solution mitigated these adverse effects: Cd concentration in shoots decreased while concentration of Cd adsorbed at the root cell apoplasmic level increased together with Zn uptake by roots. Overall, total Cd uptake decreased in presence of Si. There was no co-localisation of Cd and Si either at the shoot or at the root levels. No Cd was detected in leaf phytoliths. In roots, Cd was mainly detected in the cortical parenchyma and Si at the endodermis level, while analysis of the outer thin root surface of the plants grown in the 50 μ M Cd+1 mM Si treatment highlighted non-homogeneous Cd and Si enrichments. These data strongly suggest the existence of a root localised protection mechanism

consisting in armoring the root surface by Si- and Cd-bearing compounds and in limiting root–shoot translocation.

Ali et al., (2014) A Comparative study was made in this research article in between the conventional agriculture and the land, water, and energy requirements of hydroponics by growing the lettuce production in Yuma, Arizona, USA. This is the first quantitative comparison of conventional and hydroponic produce production by example of lettuce grown in the southwestern United States. Data were obtained from crop budgets and governmental agricultural statistics, and contrasted with theoretical data for hydroponic lettuce production derived by using engineering equations populated with literature values. Yields of lettuce per greenhouse unit (815 m²) of 41 ± 6.1 kg/m² /y had water and energy demands of 20 ± 3.8 L/kg/y and $90,000 \pm 11,000$ kJ/kg/y (\pm standard deviation), respectively. In comparison, conventional production yielded 3.9 ± 0.21 kg/m² /y of produce, with water and energy demands of 250 ± 25 L/kg/y and 1100 ± 75 kJ/kg/y, respectively. Hydroponics offered 11 ± 1.7 times higher yields but required 82 ± 11 times more energy compared to conventionally produced lettuce. It identified energy availability as a major factor in assessing the sustainability of hydroponics, and it points to water-scarce settings offering an abundance of renewable energy (e.g., from solar, geothermal, or wind power) as particularly attractive regions

for hydroponic agriculture.

Main conclusion was erected by *Keller et al.*, (2015) that aqueous Si limits Cu uptake by a Si accumulating plant via physicochemical mechanisms occurring at the root level. Sufficient Si supply may alleviate Cu toxicity in Cu-contaminated soils. Little information is available on the role of silicon (Si) in copper (Cu) tolerance while Cu toxicity is widespread in crops grown on Cu-contaminated soils. A hydroponic study was set up to investigate the influence of Si on Cu tolerance in durum wheat (*Triticum turgidum* L.) grown in 0, 0.7, 7.0 and 30 μM Cu without and with 1.0 mM Si, and to identify the mechanisms involved in mitigation of Cu toxicity. Si supply alleviated Cu toxicity in durum wheat at 30 μM Cu, while Cu significantly increased Si concentration in roots. Root length, photosynthetic pigments concentrations, macroelements, and organic anions (malate, acetate and aconitate) in roots, were also increased. Desorption experiments, XPS analysis of the outer thin root surface ($B_{100} \text{ \AA}$) and XRF analyses showed that Si increased adsorption of Cu at the root surface as well as Cu accumulation in the epidermis while Cu was localised in the central cylinder when Si was not applied. Copper was not detected in phytoliths. This study provides evidences for Si mediated alleviation of Cu toxicity in durum wheat. It also shows that Si supplementation to plants exposed to increasing levels of Cu in solution induces non-simultaneous

changes in physiological parameters. They proposed a three-step mechanism occurring mainly at the root level and limiting Cu uptake and translocation to shoots: (i) increased Cu adsorption onto the outer thin layer root surface and immobilisation in the vicinity of root epidermis, (ii) increased Cu complexation by both inorganic and organic anions such as aconitate and, (iii) limitation of translocation through an enhanced thickening of a Si-loaded endodermis.

Halden et al (2015) explained that, Phytoextraction is an eco-friendly and cost-effective technique for removal of toxins, especially heavy metals and metalloids from contaminated soils by the roots of high biomass producing plant species with subsequent transport to aerial parts. Lower metal bioavailability often limits the phytoextraction. Organic chelators can help to improve this biological technique by increasing metal solubility. The aim of the present study was to investigate the possibility of improving the phytoextraction of Cd by the application of citric acid. For this purpose, plants were grown in hydroponics under controlled conditions. Results indicated that Cd supply significantly decreased the plant growth, biomass, pigments, photosynthetic characteristics and protein contents which were accompanied by a significant increase in Cd concentration, hydrogen peroxide (H_2O_2), electrolyte leakage, malondialdehyde (MDA) accumulation and decrease in antioxidant capacity. The effects were dose dependent with obvious effects at

higher Cd concentration. Application of CA significantly enhanced Cd uptake and its accumulation in plant roots, stems and leaves. Citric acid alleviated Cd toxicity by increasing plant biomass and photosynthetic and growth parameters alone and in combination with Cd and by reducing oxidative stress as observed by reduction in MDA and H₂O₂ production and decreased electrolyte leakage induced by Cd stress. Application of CA also enhanced the antioxidant enzymes activity alone and under Cd stress. Thus, the data indicate that exogenous CA application can increase Cd uptake and minimize Cd stress in plants and may be beneficial in accelerating the phytoextraction of Cd through hyper-accumulating plants such as *Brassica napus* L.

In this article David C. Love et.al., (2015) narrated about the Aquaponics [the integration of aquaculture and hydroponics]. There is expanding interest in aquaponics as a form of aquaculture that can be used to produce food closer to urban centers. Commercial aquaponics uses methods and equipment from both the hydroponics and aquaculture industries. f this research was to document the production methods, crop and fish yields, and profitability of commercial aquaponics in the United States (US) and internationally. An online survey was used for data collection, and 257 respondents met the inclusion criteria for the study. Eighty-one percent of respondents lived in the US, and the remaining respondents were from 22 other countries. The median year that respondents

had begun practicing aquaponics was 2010. A total of 538 fulltime workers, 242 part-time workers, and 1720 unpaid workers or volunteers were employed at surveyed organizations. The most commonly raised aquatic animals by percent were tilapia (69%), ornamental fish (43%), catfish (25%), other aquatic animals (18%), perch (16%), bluegill (15%), trout (10%), and bass (7%). Production statistics, gross sales revenue, investments, and sales outlets for operations are reported and compared to other fields of aquaculture and agriculture. A multivariable logistic regression model was used to study which factors were associated with profitability (as a binary outcome) in the past 12 months. Several factors were significantly associated with profitability: aquaponics as the respondents' primary source of income (p < 0.01; Odds Ratio: 5.79; 95% Confidence Interval: 3.8–9.0), location in US Department of Agriculture plant hardiness zones 7–13 (p < 0.01; OR: 4.17; 95% CI: 3.2–5.5), gross sales revenue \geq \$5000 (p < 0.01; OR: 3.58; 95% CI: 2.2–5.8), greater aquaponics knowledge (p < 0.01; OR: 2.37; 95% CI: 2.0–2.9), and sales of non-food products (e.g., supplies, materials, consulting services, workshops, and agrotourism) (p = 0.028; OR: 2.13; 95% CI: 1.1–4.2).

Table 11 Cited Articles

Authors	Articles Title	Country	TC	TC per Year	Journal name	Research Areas
(Keller et.al., 2016)	Silicon alleviates Cd stress of wheat seedlings (<i>Triticumturgidum</i> L. cv. Claudio) grown in hydroponics	France	267	33.375	Environ. Sci. Pollut. Res.	Environmental Sciences & Ecology
(Ali et.al., 2014)	Citric acid assisted phytoremediation of cadmium by <i>Brassica napus</i> L	Pakistan	241	24.1	Ecotox. Environ. Safe.	Environmental Sciences & Ecology; Toxicology
(Keller et.al., 2015)	Effect of silicon on wheat seedlings (<i>Triticumturgidum</i> L.) grown in hydroponics and exposed to 0 to 30 A mu M Cu	France	218	24.2222	Planta	Plant Sciences
(Halden et.al., 2015)	Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic vs. Conventional Agricultural Methods	USA	203	22.5556	Int. J. Environ. Res. Public Health	Environmental Sciences & Ecology; Public, Environmental & Occupational Health
(Love et.al., 2015)	Commercial aquaponics production and profitability: Findings from an international survey	USA	194	21.5556	Aquaculture	Fisheries; Marine & Freshwater Biology

Conclusion

Based on the Web of Science database, this document provides a brief overview of the most cited papers, organizations, and nations in hydroponics research.

According to the research's findings, there were 1729 papers published by

7111 authors on the study's subject between 2013 and 2022, a period of 10 years. We used the Bibliometrix tool and the VOS viewer program to investigate. Based on the materials released, maybe due to the vast increase in recently published works with comparable topics. The amount of research has grown during the last few years, with China now having the most published authors in this area. The cooperation network between nations, active nations, and source productivity all contribute to China's dominance in the industry. According to our research, the authors with the most citations have studied, including Schat.h, Dresler.S, and Ye.Zq. . The most influential journal is Frontiers in plant science.

Future prospect

A "new" door in science is opened by the use of hydroponics, which can increase crop output for food, fodder, and ornamental purposes while also producing higher-quality yields. (Putra and Yuliando, 2015). In locations with high population densities, hydroponics can generate high yields of regional crops like green vegetables or flowers. All plants and agricultural products might be grown worldwide if the hydroponics method could be modernised. Where there is a lack of water, land, and crops, hydroponics can feed millions of people in Asia and Africa. The management of crop and food production is thus given a gleam of hope by hydroponics. (Maharana and Koul, 2011). Japan has

begun using hydroponics to produce rice in order to feed its citizens. (De Kreijet *al.*, 1999). Israel utilises hydroponics to grow vast numbers of berries, citrus fruits, and bananas despite its dry and arid climate. (Van Os, 2002). Honestly, the hydroponics approach can be useful in both high-tech space stations and rural or urban settings. For growing food in harsh environments like hilly areas, deserts, or arctic towns, hydroponics can be an effective technique. The need for hydroponic farming has recently increased in both industrialised and developing nations. (Trejo-Téllez and Gómez-Merino, 2012). Therefore, the government should establish public regulations and provide subsidies for these types of manufacturing systems. In conclusion, hydroponics is becoming more and more popular all over the world, and these systems present producers and customers with a variety of new chances to produce high-quality products, including vegetables boosted with bioactive components. Hydroponics can be a huge help to the less fortunate and landless people, just as soil-less culture can be grown in small spaces with little labour and little time. Additionally, it can raise people's standards of living and accelerate a nation's economic development. The hydroponics sector in India is anticipated to expand rapidly in the next years. The development of low cost hydroponic technologies that lessen reliance on human labour and lower overall start-up and operational expenses is crucial to promoting commercial

hydroponic farming.

Tests were performed with different cultivated vegetables, mainly using the floating root system and containers with natural growing media, such as quarry and river sand. With time the formula has been adjusted to improve it and is currently offered to cultivate different crops, even for commercial purposes, such as the fruits cultivation. Hydroponics also will be important to the future of the space program. NASA has extensive hydroponics research plans in place, which will benefit current space exploration, as well as future, long-term colonization of Mars or the Moon.

Reference

1. A. Mollafilabi, Alireza Koocheki Ferdowsi University Of Mashhad. H. Moeinerad L. Kooshki 2013: *Acta Horticulture* Effect of plant density and weight of corm on yield and yield components of saffron (*crocus sativus* l.) under soil, hydroponic and plastic tunnel cultivation, 997(997):51-58,
2. Barbosa, G.L., Gadelha, F.D.A., Kublik, N., Proctor, A., Reichelm, L., Weissinger, E., Wohlleb, G.M. and Halden, R.U. 2015. Comparison of land, water, and energy requirements of lettuce grown using hydroponic vs. conventional agricultural methods. *International Journal of Environmental Research and Public Health*, 12:6879-6891.
3. C. J. Asher & D. G. Edwards *Part of the Encyclopedia of Plant Physiology book*

series (*PLANT*, volume 15) Modern Solution Culture Techniques Inorganic Plant Nutrition pp 94–119.

4. Douglas, J.S. 1975. Hydroponics. *Bombay Oxford*: 1-3.
5. Genhua Niu, Joseph Masabni, 2022: *Applications and Advances, Plant Factory Basics*.
6. Horrigan, L., Lawrence, R.S. and Walker, P. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives*, 110:445-456.
7. Jensen, M.H and Collins, W.L. 1985. Hydroponic vegetable production. *Horticultural Reviews*, 7: 483-558.
8. Kreij, C.D., W. Voogt and R. Baas.1999. Nutrient solutions and water quality for soil-less cultures. *Research Station for Floriculture and Glasshouse Vegetables*, 196.
9. Kris-Etherton, P.M., Hecker, K.D., Bonanome, A., Coval, S.M., Binkoski, A.E., Hilpert, K.F., Griel, A.E. and Etherton, T.D. 2002. Bioactive compounds in foods: Their role in the prevention of cardiovascular disease and cancer. *The American Journal of Medicine*, 113:71-88.
10. Lee, Y.D. and Takakura, T. 1995. *Acta Horticulture*, Root cooling for spinach in deep hydroponic culture under high air temperature conditions.. 399, 121-
11. Maharana, L. and Koul, D.N. 2011. The emergence of Hydroponics. 55: 39-

40.

12. Mehra, S., Leng, T.W., Yamashita, Y. 2017. Are Singaporeans Ready for Hydroponics.
13. Ms. Mamta D. Sardare¹ , Ms. Shraddha V. Admane, 2013: *Int. J.of Res in Engg.& Tech*, A review on plant without soil – hydroponics. 02(03):299-304,
14. Nga T Nguyen, Samuel A McInturf, David G Mendoza-Cózatl, 2016 *Hydroponics: A Versatile System to Study Nutrient Allocation and Plant Responses to Nutrient Availability and Exposure to Toxic Elements*. Jul 13;(113):54317.
15. Nguyen, N.T., Mcinturf, S.A., Mendoza-cózatl, D.G. 2016. Hydroponics: A versatile system to study nutrient allocation and plant responses to nutrient availability and exposure to toxic elements. *Journal of Visualized Experiments*, 10: 3791-54317.
16. Okemwa, E. 2015. Effectiveness of aquaponic and hydroponic gardening to traditional gardening. *International Journal of Scientific Research and Innovative Technology*, 2:2313-3759.
17. Omaye, S.T. and Buchanan, D. N. 2013. Comparative study of ascorbic acid and tocopherol concentrations in hydroponic and soil grown lettuces. *Food and Nutrition Sciences*, 4:1047-1053.
18. Panel David Sanjuan- Delmás, Alejandro Josa, Pere Muñoz , Santiago Gassó ,

- Joan Rieradevall, Xavier Gabarrell 2020 *Scientia Horticulturae*: Applying nutrient dynamics to adjust the nutrient-water balance in hydroponic crops. A case study with open hydroponic tomato crops from Barcelona, Vol. 261, 108908.
19. Putra, P.A. and Yuliando, H. 2015. Soilless Culture System to Support Water Use Efficiency and Product Quality. *Agriculture and Agricultural Science Procedia*,3:283-288.
20. Rijck, G. de; Schrevens, E. 1998. *Journal of plant nutrition (USA)* Cationic speciation in nutrient solutions as functions of pH ISSN : 0190-4167
21. Rodríguez-Delfín Alfredo, 2023:*Peruvian hydroponics in Urban and Regional Agriculture*,
22. Sarah, W. S. 2017. hydroponics-vs-soil reasons why hydroponics is better than soil.
23. Savvas, D. 2003. Hydroponics: A modern technology supporting the application of integrated crop management in greenhouse. *Food, Agriculture and Environment*, 1:80-86.
24. Seerat Jan, Zahida Rashid, Tanveer Ahmad Ahngar, Sadaf Iqbal, M. AbbassNaikoo, Shabina Majeed, Tauseef Ahmad Bhat, Razia Gul and InshaNazir. 2020. Hydroponics – A Review. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 1779-1787.

25. Teruo Wada 2019 - *Elsevier* Theory and Technology to Control the Nutrient Solution of Hydroponics, in Plant Factory Using Artificial Light, Hydroponics.
26. Treftz, C. and Omaye, S.T. 2016. Hydroponics: Potential for augmenting sustainable food production in non-arable regions. *Nutrition and Food Science*, 46:672-684.
27. Treftz, C. and Omaye, S.T. 2016. Hydroponics: Potential for augmenting sustainable food production in non-arable regions. *Nutrition and Food Science*, 46:672-684.
28. Trejo-Téllez, L.I., and Merino, F. C. G. 2012. Nutrient Solutions for Hydroponic Systems.
29. Wan FazilahFazlillahi, Desa Ahmad. 2017 *SainsMalaysiana*A Study on the Physical and Hydraulic Characteristics of Cocopeat Perlite Mixture as a Growing Media in Containerized Plant Production. June 46(6):975-980
30. Wilbert Michael Rodríguez Ortega, Vicente Martínez, Rosa M Rivero, José MaríaCámara-Zapata 2016: *Agricultural Water Management*, Use of a smart irrigation system to study the effects of irrigation management on the agronomic and physiological responses of tomato plants grown under Different temperatures regimes 183.

Chapter–XII

12

EXTENDED-SPECTRUM B-LACTAMASE DETECTION IN BACTERIA

Jayalakshmi K.R

Research Scholar, Department of Studies in Microbiology,

Davangere University, Davangere-577007, Karnataka,

India. E-mail: jayalakshmiseema@gmail.com

Ramalingappa. B

Professor, Department of Studies in Microbiology,

Davangere University, Davangere-577007, Karnataka,

India. E-mail: ramalingappa.88@gmail.com

ABSTRACT

Extended-spectrum β -lactamase (ESBL)-producing *Enterobacteriaceae* are well recognised as important nosocomial infections because of the emergence of microbial resistance caused by these enzymes.

In order to identify and confirm the presence of ESBL-producing microbes, a number of phenotypic assays have been suggested, although procedures are often carried out on isolated organisms after antibiotic susceptibility testing and culture.

Keywords: Extended-Spectrum β -Lactamases; Carbapenemase; CLSI; Phenotypic Methods; Broth Microdilution; Three Dimensional Test; Disc Diffusion Test; Double Disc Synergy Test; Combination Disc Test; E Test.

INTRODUCTION

Nearly two-thirds of current hospital prescriptions include antibiotics, and those in the β -lactam class are particularly crucial to the practise of medicine in the 21st century (Bush *et al.*, 2016). **Penicillins, cephalosporins, carbapenems, and monobactams** are the four main chemical families in which the most prevalent β -lactam-containing drugs fall (Fig. 1). The medical profession is very concerned that medication

resistance is continuing to rise around the globe because these agents are so valuable (ECDC, 2018., WHO, 2019., Perez *et al.*, 2019) Despite the possibility that resistance patterns vary spatially, the risk that any novel resistance mechanism may spread quickly to other regions still exists.

The most of the resistance of the β -lactams is due to the enzymes that inactivate these molecules, i.e., the β -lactamases, (Bush *et al.*, 2018) The World Health Organisation (WHO, 2017), as well as the Centres for Disease Control and Prevention (CDC, 2013), have identified β -lactamase-producing Gram-negative bacteria as one of the world's most significant or critical dangers. Pharmaceutical companies have had some clinical and scientific success in their attempts to inhibit or contain these enzymes by creating new compounds with broader clinical applications. Six new β -lactam-containing medications have received FDA approval in the previous ten years: ceftaroline, ceftolozane-tazobactam, meropenem-vaborbactam, imipenem-cilastatin-relebactam, and cefiderocol (Bush *et al.*, 2019).

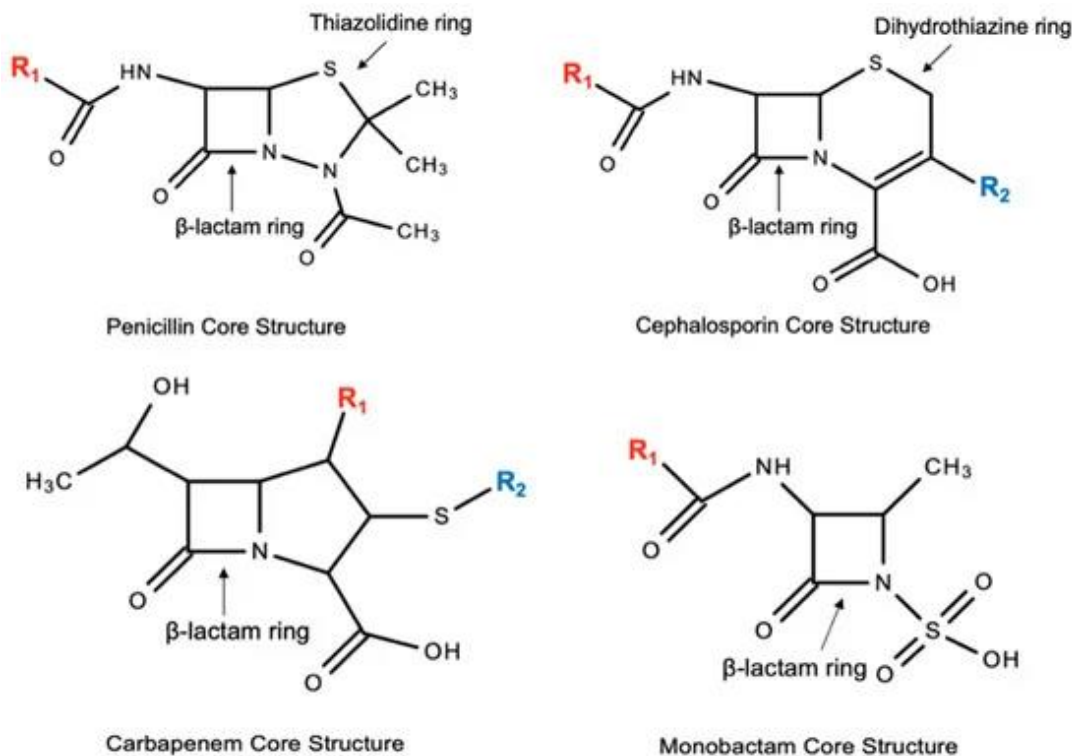


Fig 1: Generic structures of β -lactams most important in clinical medicine.

By breaking open the ring of **penicillins** and **cephalosporins**, β -lactamases are enzymes that render β -lactam antibiotics inactive and stop their antibacterial activity. For a large number of species of gram-positive and gram-negative bacteria, beta-lactamases have been identified. Some β -lactamases are chromosomally mediated (such as many species of gram-negative bacteria), whereas others are plasmid-mediated (such as the *penicillinase* of *Staphylococcus aureus* (Moland *et al.*, 2008).

β -Lactamases.

The significance of β -lactamases as the main factor influencing β -lactam resistance in Gram-negative bacteria. In essence, these enzymes bind to the medication, break the amide bond of the four-membered azetidinone ring that is present in every β -lactam (Fig.2), and add a water molecule to the ring-opened molecule to abolish the killing activity of β -lactams. There are different processes for β -lactamases that hydrolyse using an active-site serine and enzymes that need at least one divalent Zn atom. In contrast to MBLs, where Zn^{2+} facilitates the creation of a noncovalent reactive complex with the -lactam, serine β -lactamases work by first generating a covalent acylated enzyme. (Bush *et al.*,2018, Bush *et al.*,2019, Toole *et al.*,2019, Meini *et al.*, 2019). Notably, the product of both reactions is the same molecule that is incapable of building an enzymatically productive compound with a PBP and is microbiologically inactive. The bacterial cell continues to survive as a result.

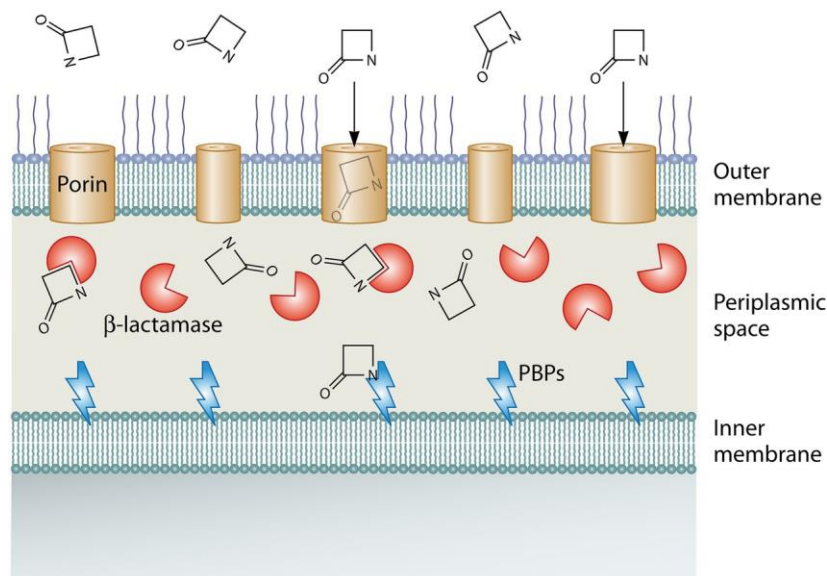


Fig 2: Schematic showing the interaction of β -lactam antibiotics with β -lactam interactive proteins in Gram-negative bacteria.

The two key characteristics of these physiologically significant enzymes, namely their structure and activity, provide the basis for the naming of β -lactamases. Ambler introduced the concept of structural classes in 1980 (Ambler 1980), describing class A enzymes with a serine in the active site and class B MBLs utilising the four β -lactamase amino acid sequences that were then known. Based on molecular size and characteristic homologous patterns, class C and class D serine-based β -lactamases have since been identified (Jaurin *et al.*, 1981 & Huovinen *et al.*, 1988).

Recently recommended class A β -lactamases as subclasses, which would

modify the Ambler system (Philippon *et al.*,2019). Over 50 years have passed since the first functional classification methods were reported, based on biochemical characteristics such substrate profiles, relative hydrolysis rates in comparison to reference β -lactams, and interactions with inhibitors (Sawai *et al.*,1968). An updated functional nomenclature based on a mix of biochemical characteristics and structural class designations in 1995, and Bush and Jacoby added more subgroups in 2010. When describing β -lactamases that belong to more than one group or class, other functional designations are sometimes employed (Bush *et al.*,2010).

DETECTION OF ESBLs IN THE CLINICAL MICROBIOLOGY LABORATORY.

1.DISC DIFFUSION METHOD.

For the purpose of detecting the development of ESBL by *Klebsiella*, *Escherichia coli*, and *Proteus mirabilis*, the CLSI has recommended disc diffusion methods. By recording particular zone sizes that suggest a high level of suspicion for ESBL formation, laboratories using disc diffusion methods for antibiotic susceptibility testing can check for ESBL

production. You could take **cefpodoxime**, **ceftazidime**, **aztreonam**, **cefotaxime**, or **ceftriaxone**. However, the sensitivity of detection is increased when using multiple of these agents for screening. ESBL production should be suspected if any of the zone diameters do, in which case phenotypic confirming tests should be employed to make the diagnosis (CLSI 2009).

Since cefpodoxime isn't frequently used in inpatient settings, it should be mentioned that it can be utilised as a screening antibiotic (Thomson *et al.*,1997). It was noted that the susceptibility to **cefpodoxime** measured by disc diffusion consistently distinguished between *Klebsiella pneumoniae* and *Escherichia coli* that produced ESBLs and those that did not. Initially, the CLSI advised using a 10-g **cefpodoxime** disc with a zone diameter of around 22 mm as a screening test for the development of ESBLs. Unfortunately, when employed to check *Escherichia coli* isolates for the development of ESBL, the cefpodoxime screening test with a zone diameter of 22 mm lacks specificity. As a result, the CLSI now advises changing the **cefpodoxime** screening zone diameter to 17 mm, which means that isolates having a **cefpodoxime** zone diameter of 17 mm

should undergo phenotypic confirmatory tests for ESBL formation (CLSI 2009). fig:3

2. DILUTION ANTIMICROBIAL SUSCEPTIBILITY TEST.

The CLSI has suggested dilution techniques for checking for the formation of ESBL by *Escherichia coli* and *Klebsiella*. The screening concentration for **ceftazidime**, **aztreonam**, **cefotaxime**, or **ceftriaxone** is 1 g/ml. Growth at this screening antibiotic concentration (i.e., MIC of the cephalosporin of 2 g/ml) raises concerns about the development of ESBL and is a sign that the organism has to undergo a phenotypic confirmation test (CLSI 2009).

When **cefepodoxime** was first being considered for screening, it was suggested that isolates with the potential to create ESBLs have MICs of less than 2 g/ml. However, it was discovered that none of the 59 strains with **cefepodoxime** MICs of 2 or 4 g/ml developed ESBLs in a study of the mechanisms causing decreased susceptibility of *Escherichia coli* to **cefepodoxime**. The most frequent cause of decreased susceptibility to **cefepodoxime** was TEM-1 β -lactamase development in conjunction with the loss or modification of a key porin protein. Other strains exhibited

porin alterations but no TEM-1 synthesis. These strains occasionally also displayed a little increase in the chromosomal AmpC β -lactamase production. Finally, a few of the isolates were OXA-30 β -lactamase producers (Ooliver *et al.*,2002). FIG :4

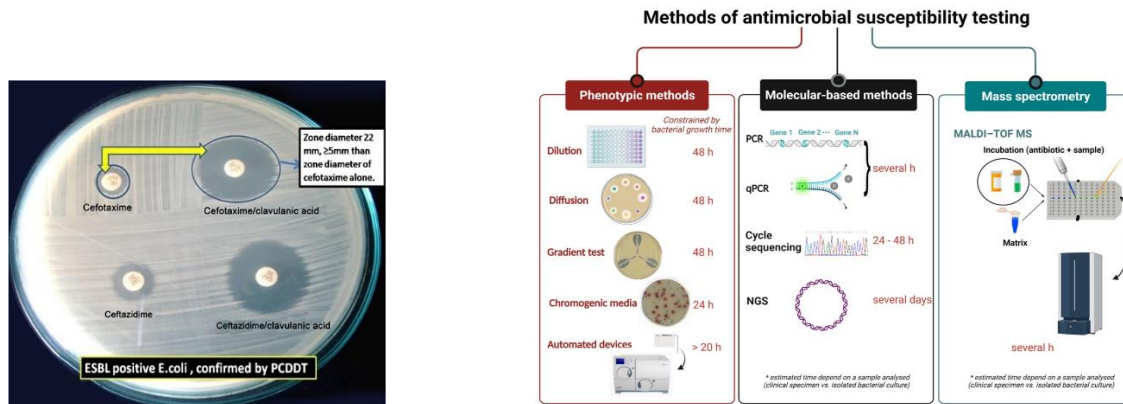


Fig 3: Disc diffusion method **Fig 4:** Dilution antimicrobial susceptibility test

CONFIRMATORY TESTS FOR ESBL PRODUCTION

PHENOTYPIC TESTS:

1. Cephalosporin/Clavulanate Combination discs.

For phenotypic confirmation of the presence of ESBLs in *klebsiellae* and *Escherichia coli*, the CLSI recommends using **cefotaxime** (30 g) or **ceftazidime** discs (30 g) with or without **clavulanate** (10 g). It was suggested that **clavulanic acid** solution be administered to the **cephalosporin** discs within an hour before they are applied to the agar

plates prior to the availability of the combination discs. The CLSI advises performing the disc tests when Mueller-Hintonagar is experiencing confluent growth. It is considered phenotypic proof of ESBL development when there is a difference of 5 mm between the zone widths of either of the **cephalosporin** discs and their respective **cephalosporin/clavulanate** disc.

A modification of this test, in which discs inoculated with **clavulanic acid** were used instead of the **amoxicillin-clavulanic acid** discs, has been described. The results of this method were comparable to the double-disc synergy test (Schooneveldt *et al.*,1998).

2. BROTH MICRODILUTION.

Broth microdilution tests utilising **ceftazidime** (0.25 to 128 g/ml), **ceftazidime** plus **clavulanic acid** (0.25/4 to 128 g/ml), **cefotaxime** (0.25 to 64 g/ml), and **cefotaxime** plus **clavulanic acid** (0.25/4 to 64 g/ml) can also be used for phenotypic confirmatory testing. It needs to be emphasised that **cefotaxime** and **ceftazidime** should both be used. Standard procedures are used to perform the broth microdilution. In

comparison to its MIC when tested alone, phenotypic confirmation is defined as a 3-fold drop in the MIC of either cephalosporin in the presence of **clavulanic acid** (Queenan *et al.*,2004).

3. DOUBLE-DISC DIFFUSION TEST.

outlined a disc diffusion test whereby synergy between **cefotaxime** and **clavulanate** was discovered by spacing a disc of **amoxicillin/clavulanate** (20 g/10 g, respectively) and a disc of **cefotaxime** (30 g), 30 mm apart (centre to centre) over an inoculated agar plate (Jarlier *et al.*,1988). In order to confirm the presence of an ESBL, the 30-g antibiotic discs of **ceftazidime**, **aztreonam**, and **ceftriaxone** were also placed on the plate, 30 mm (centre to centre) away from the **amoxicillin/clavulanate** disc. This was done because, occasionally, this keyhole effect was not observed with **cefotaxime** but is with other β -lactam antibiotics containing the oxalate.

3.AGAR SUPPLEMENTED WITH CLAVULANATE.

Described a procedure for adding 4 g/ml of clavulanate to Mueller-Hinton agar. On the clavulanate-containing agar and on ordinary Mueller-Hinton agar plates without **clavulanate**, 30-g antibiotic discs of **ceftazidime**,

cefotaxime, ceftriaxone, and aztreonam were used (Ho *et al.*,2002). On the two media, a difference in β -lactam zone width of less than 10 mm was seen as favourable for ESBL formation. The method's requirement for newly made **clavulanate**-containing plates is a significant limitation. After 72 hours, **clavulanic acid**'s efficacy starts to decline (Bedenic *et al.*,2001).

4.THREE-DIMENSIONAL TEST.

Without requiring proof of β -lactamase inactivation by a β -lactamase inhibitor, the three-dimensional test provides phenotypic evidence of ESBL-induced inactivation of extended-spectrum cephalosporins or aztreonam. In this test, a susceptible organism to the disc's β -lactam antibiotic is utilised to inoculate the susceptibility plate's surface following the accepted practises for disc diffusion testing. A spot is produced in the agar 7-8mm away from the β -lactam antibiotic disc, or a slit is cut in the agar 5mm from the edge of the β -lactam antibiotic disc in an outward radial direction. The slit or spot is filled with 25 l of a milky suspension of the tested strain in broth (McFarland number 5 turbidity criteria). The three-dimensional test is interpreted as positive following

an overnight incubation at 37°C when the inhibition zone surrounding the β -lactam antibiotic disc is deformed by the growth of the tested organism, resulting in a decrease in the diameter of the inhibition zone (Shahid *et al.*,2004).

COMMERCIAL METHODS FOR ESBL DETECTION.

1.E-TEST FOR ESBLs.

A plastic drug-impregnated strip made by AB Biodisk (Solna, Sweden) has a gradient of **ceftazidime** on one end (MIC test range: 0.5 to 32 g/ml) and a gradient of **ceftazidime** plus a constant concentration of **clavulanate** (4 g/ml) on the other. There are now similar strips on the market that contain **cefotaxime** and **cefotaxime/clavulanate**. As a phenotypic confirmatory test for ESBLs, the approach has a stated sensitivity range of 87% to 100% and a specificity range of 95% to 100%. Depending on the ratio of the utilised **cephalosporin/clavulanate/cephalosporin** MICs, the method's sensitivity and specificity can be altered. The manufacturer advises an 8-fold decrease in **cephalosporin** MICs when **clavulanate** is present. Due to the clavulanic acid diffusing from the opposite ends of the strip, the inhibition zone might occasionally be altered when reading the

MIC of a **cephalosporin** when it is used alone. Some people choose to assess the MIC of the **cephalosporin** using a second conventional strip that contains only ceftazidime or cefotaxime in these circumstances. The capacity to detect ESBL types that preferentially hydrolyze **cefotaxime**, such as CTX-M-type enzymes, is enhanced by the availability of **cefotaxime** and **ceftazidime** strips (Sturenburg *et al.*,2004).

2.AUTOMATED METHODS.

ESBL-producing pathogens are found using automated bacterial identification and susceptibility testing techniques. To assess the growth response to **ceftazidime**, **cefotaxime**, **ceftriaxone**, and **cefpodoxime**, with or without **clavulanate**, the BD Phoenix System (BectonDickinson Biosciences, Sparks, MD) uses its "expert software." Similar to this, the BioMerieux Vitek 2 system (Marcy L'Etoile, France) makes use of a card that contains **ceftazidime** and **cefotaxime** both individually and in conjunction with clavulanate. Another medication utilised in the MicroScan Walkaway-96 System (Dade Behring, Inc., West Sacramento, CA) is **ceftazidime** or **cefotaxime** plus **betalactamase** inhibitors. The ability of the three semi-automated approaches mentioned above to

identify ESBL generation in well-characterized *Enterobacteriaceae*, such as *Enterobacter* spp., *Citrobacter freundii*, and *Serratia marcescens*, was recently compared to the traditional phenotypic confirmatory assays. The system with the highest sensitivity was Phoenix (99%), followed by Vitek 2 (86%) and MicroScan (84%) (Rice *et al.*, 2004).

CONCLUSION.

Over the past 20 years, ESBLs have seen significant change. Future therapeutic challenges will undoubtedly be brought on by their presence and the possibility for plasmid-mediated quinolone and carbapenem resistance. In order to treat such multi resistant illnesses, it is unlikely that many novel antibiotic alternatives will become available in the next 5 to 10 years. Therefore, improved infection control together with antibiotic stewardship programmes is crucial in preventing the spread of ESBL-producing pathogens. In the future, the ESBLs will undoubtedly grow more complicated and diverse, as was already mentioned. This will make it more difficult for those developing guidelines for ESBL detection in clinical microbiology laboratories. It may be required to change antibiotic susceptibility breakpoints, but this must be carefully examined in

conjunction with pharmacokinetic, pharmacodynamic, and clinical data.

REFERENCES

1. Ambler, R. P. (1980). The structure of β -lactamases. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, 289(1036), 321-331.
2. Bedenic, B., Randegger, C., Boras, A., & Haechler, H. (2001). Comparison of five different methods for detection of SHV extended-spectrum β -lactamases. *Journal of chemotherapy*, 13(1), 24-33
3. Bradford PA. 2018. Epidemiology of resistance. In Fong IW, Shlaes D, Drlica K (ed), Antimicrobial resistance and implications for the 21st century, 2nd ed. *Springer International Publishing*, New York, NY
4. Bradford, P. A. (2001). Extended-spectrum β -lactamases in the 21st century: characterization, epidemiology, and detection of this important resistance threat. *Clinical microbiology reviews*, 14(4), 933-951.
5. Bush, K., & Jacoby, G. A. (2010). Updated functional classification of β -lactamases. *Antimicrobial agents and chemotherapy*, 54(3), 969-976.
6. Bush, K. (2018). Past and present perspectives on β -lactamases. *Antimicrobial agents and chemotherapy*, 62(10), e01076-18.

7. Bush, K., & Bradford, P. A. (2016). β -Lactams and β -lactamase inhibitors: an overview. *Cold Spring Harbor perspectives in medicine*, 6(8), a025247.
8. Bush, K., & Bradford, P. A. (2019). Interplay between β -lactamases and new β -lactamase inhibitors. *Nature Reviews Microbiology*, 17(5), 295-306.
9. Centres for Disease Control and Prevention (2013). Antibiotic resistance threats in the United States, 2013. CDC, Atlanta, GA. WHO. 2017. Prioritization of pathogens to guide discovery, research and development of new antibiotics for drug-resistant bacterial infections, including tuberculosis. World Health Organization, Geneva, Switzerland.
10. ECDC. (2018). Surveillance of antimicrobial resistance in Europe—annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net) (2017). European Centre for Disease Prevention and Control, Stockholm, Sweden.
11. Ho, P. L., Chan, W. M., Wong, S. S., Young, K., & Tsang, K. W. (2002). Bacteremia caused by *Escherichia coli* producing extended-spectrum beta-lactamase: a case-control study of risk factors and outcomes. *Scandinavian journal of infectious diseases*, 34(8), 567-573.

12. Ho, P. L., Chow, K. H., Yuen, K. Y., Ng, W. S., & Chau, P. Y. (1998). Comparison of a novel, inhibitor-potentiated disc-diffusion test with other methods for the detection of extended-spectrum beta-lactamases in *Escherichia coli* and *Klebsiella pneumoniae*. *The Journal of antimicrobial chemotherapy*, 42(1), 49-54.
13. Jaurin, B., & Grundström, T. (1981). ampC cephalosporinase of *Escherichia coli* K-12 has a different evolutionary origin from that of beta-lactamases of the penicillinase type. *Proceedings of the National Academy of Sciences*, 78(8), 4897-4901.
14. Meini S, Tascini C, Cei M, Sozio E, Rossolini GM. (2019). AmpC beta-lactamase-producing *Enterobacterales*: what a clinician should know. *Infection* 47:363–375.
15. Moland, E. S., Kim, S. Y., Hong, S. G., & Thomson, K. S. (2008). Newer β -lactamases: clinical and laboratory implications, part II. *Clinical Microbiology Newsletter*, 30(11), 79-85.
16. Perez, F., & Bonomo, R. A. (2019). Carbapenem-resistant Enterobacteriaceae: global action required. *The Lancet. Infectious diseases*, 19(6), 561-562.

17. Perez, F., El Chakhtoura, N. G., Yasmin, M., & Bonomo, R. A. (2019). Polymyxins: to combine or not to combine? *Antibiotics*, 8(2), 38.
18. Perez, F., Endimiani, A., Hujer, K. M., & Bonomo, R. A. (2007). The continuing challenge of ESBLs. *Current opinion in pharmacology*, 7(5), 459-469.
19. Philippon, A., Jacquier, H., Ruppé, E., & Labia, R. (2019). Structure-based classification of class A beta-lactamases, an update. *Current research in translational medicine*, 67(4), 115-122.
20. Queenan, A. M., Foleño, B., Gownley, C., Wira, E., & Bush, K. (2004). Effects of inoculum and β -lactamase activity in AmpC-and extended-spectrum β -lactamase (ESBL)-producing *Escherichia coli* and *Klebsiella pneumoniae* clinical isolates tested by using NCCLS ESBL methodology. *Journal of clinical microbiology*, 42(1), 269-275
21. Rice, L. B., Carias, L. L., Hujer, A. M., Bonafede, M., Hutton, R., Hoyen, C., & Bonomo, R. A. (2000). High-level expression of chromosomally encoded SHV-1 β -lactamase and an outer membrane protein change confer resistance to ceftazidime and piperacillin-tazobactam in a clinical isolate of *Klebsiella pneumoniae*. *Antimicrobial agents and chemotherapy*,

44(2), 362-367.

22. Sawai, T., Mitsuhashi, S., & Yamagishi, S. (1968). Drug Resistance of Enteric Bacteria: XIV. Comparison of β -Lactamases in Gram-negative Rod Bacteria Resistant to α -Aminobenzylpenicillin. *Japanese journal of microbiology*, 12(4), 423-434.
23. Schooneveldt, J. M., Nilvimo, G. R., & Giffard, P. (1998). Detection and characterisation of extended spectrum β -lactamases in *Klebsiella pneumoniae* causing nosocomial infection. *Pathology*, 30(2), 164-168.
24. Shahid, M., Malik, A., Agrawal, M., & Singhal, S. (2004). Phenotypic detection of extended-spectrum and AmpC β -lactamases by a new spot-inoculation method and modified three-dimensional extract test: comparison with the conventional three-dimensional extract test. *Journal of Antimicrobial Chemotherapy*, 54(3), 684-687.
25. Stürenburg, E., Sobottka, I., Noor, D., Laufs, R., & Mack, D. (2004). Evaluation of a new cefepime–clavulanate ESBL Etest to detect extended-spectrum β -lactamases in an *Enterobacteriaceae* strain collection. *Journal of antimicrobial chemotherapy*, 54(1), 134-138.
26. Thomson, K. S., & Sanders, C. C. (1997). A simple and reliable

method to screen isolates of *Escherichia coli* and *Klebsiella pneumoniae* for the production of TEM-and SHV-derived extended-spectrum β -lactamases. *Clinical Microbiology and infection*, 3(5), 549-554.

27. Tooke, C. L., Hinchliffe, P., Bragginton, E. C., Colenso, C. K., Hirvonen, V. H., Takebayashi, Y., & Spencer, J. (2019). β -Lactamases and β -Lactamase Inhibitors in the 21st Century. *Journal of molecular biology*, 431(18), 3472-3500.
28. WHO. (2019) No time to wait: securing the future from drug-resistant infections. Report to the Secretary-General of the United Nations. World Health Organization, Geneva, Switzerland.

13

THE CURRENT OPPORTUNITIES AND FUTURE PROSPECTS OF MICROBIAL NANOTECHNOLOGY

Koushik.B.R.

Research Scholar, Department of Studies in Biotechnology,
Davangere University, Davangere-577007, Karnataka, India.
E-mail: koushikreddybr96@gmail.com

Dr. Seema J Patel

Associate Professor, Department of Studies in Biotechnology,
Davangere University, Davangere-577007, Karnataka, India.
E-mail: ssjp176@gmail.com

ABSTRACT

The science of nanoparticles and nanostructures, which are smaller than 100 nm and have a high surface-to-volume ratio and may change the physical, chemical, and biological aspects of chemical compositions, is known as nanotechnology. The prospective applications of nanoscience in the pharmaceutical, medical diagnostics and disease treatment, energy, electronics, agricultural, chemical, and space sectors have captured the interest of the scientific community globally during the last several decades. Nanoparticles' (NPs) characteristics rely on their size and form. These distinctive properties of nanoparticles may be investigated for a wide range of further applications, including computer transistors, chemical sensors, electrometers, memory systems, reusable catalysts, biosensing, antimicrobial activities, nanocomposites, medical imaging, tumour detection, and drug delivery. It is therefore essential for the aforementioned applications to synthesise nanoparticles with the necessary size, structure, monodispersity, and morphology. Recent developments in nanotechnology attempt to synthesise nanoparticles and nanomaterials utilising dependable, non-toxic, and cutting-edge environmentally friendly methods. In contrast to conventional procedures, employing microbial machinery to biosynthesize nanoparticles of a

desired type and shape is not only faster and safer, but also more ecologically beneficial. Recently, it has been shown that a variety of microorganisms, including bacteria, actinobacteria, fungi, yeast, microalgae, and viruses, may synthesise metal, metal oxide, and other significant NPs through both intracellular and extracellular processes. Exopolysaccharides, nanocellulose, nanoplates, and nanowires are just a few examples of the unique nanomaterials that some bacteria and microalgae are capable of producing. Moreover, genetic engineering techniques can be used to improve their capacity for nanoparticle synthesis. Therefore, using microbes to create nanoparticles is novel and has great promise for the future. The current study gives detailed information on several methods for making nanoparticles from microbial cells, their uses in bioremediation, agriculture, medicine, and diagnostics, and their prospects for the future.

Keywords: Nanoparticles, Microbial nanoparticles, Microbial nanotechnology, Nanoscale, Nanostructures.

INTRODUCTION:

Microbial nanotechnology is an emerging field that combines the disciplines of microbiology and nanotechnology. This field has the potential to create new materials, devices, and systems at the nanoscale level. The integration of

microorganisms and nanotechnology has resulted in the development of novel approaches for the synthesis and assembly of nanoscale materials, as well as the manipulation of microbial systems at the nanoscale level.

Basic Principles of Microbial Nanotechnology

Microbial nanotechnology involves the use of microorganisms, such as bacteria, fungi, and viruses, to synthesize and assemble nanoscale materials. Microorganisms are capable of producing a wide range of nanoscale materials, including metal nanoparticles, semiconductor nanoparticles, and magnetic nanoparticles. These materials can be synthesized through a variety of mechanisms, such as bio reduction, biomineralization, and biosorption.

In addition to this, Microbial nanotechnology involves creating nanoparticles as well as studying and experimenting with microbial systems using nanotechnology technologies. Researchers can observe and explore microbial systems at the nanoscale level using nanotechnology instruments like scanning electron microscopy, atomic force microscopy, and nanopore sensors.

Microbial Synthesis of Nanoparticles

Microorganisms have the ability of forming and positioning nanoparticles together in a controlled manner. For instance, certain bacteria can convert gold ions into metallic gold to make gold nanoparticles. Similar to this, certain fungi have the ability to convert silver ions into metallic silver in order to make silver

nanoparticles.

In comparison to conventional approaches, microbial synthesis of nanoparticles provides a number of benefits, such as cheap cost, environmentally benign procedures, and the capacity to create nanoparticles with specified sizes and shapes. These benefits make microbial nanoparticle synthesis a desirable choice for large-scale manufacturing.

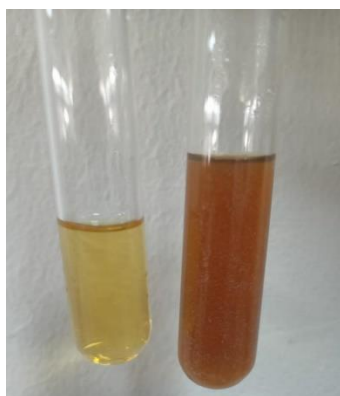


Figure 1: nanoparticles synthesized by microorganisms.

Applications of microbial nanotechnology in different fields.

1. Application of microbial nanotechnology in food sector.

Nanotechnology improves the food bioavailability, texture, taste, and consistency, achieved via modification of particle size, possible cluster formation, and surface charge of food nanomaterials. Nanotechnology not only helps in increasing the shelf life of various types of food materials, but also in reducing the level of food wastage because of microbial spoilage. (Donia *et al* 2021)

Bacterial cellulose (BC) for food packaging

Bacterial cellulose (BC) is a nanostructured material produced by certain bacteria, such as *Acetobacter xylinum*. BC has high mechanical strength, high water holding capacity, and excellent gas permeability, which makes it an ideal material for food packaging. BC-based films have been shown to have good barrier properties against oxygen, moisture, and UV light, which can help to extend the shelf life of food products. (Gorgieva, S., & Trcek, J. 2011)

Fungal mycelium for meat substitutes

Fungal mycelium is the vegetative part of fungi that forms a network of fine, branching filaments. Fungal mycelium can be grown on agricultural waste to produce meat substitutes that have similar texture and flavour to meat. The mycelium-based meat substitutes have a high protein content, low-fat content, and are sustainable and environmentally friendly. (Sánchez-González, M., & Ocio, M. J. 2021)

Virus-like particles (VLPs) for food vaccines

Virus-like particles (VLPs) are self-assembling nanostructures that resemble viruses but are non-infectious. VLPs can be used as vaccines for various diseases, including foodborne illnesses. VLP-based vaccines have been developed for hepatitis E, norovirus, and avian influenza. These vaccines can provide effective protection against the diseases and can be administered

orally, which is a convenient method for the food industry. (He, Y., & Zhang, X. 2021)

Yeast nanobiotechnology for food flavoring

Yeast is a single-celled fungus that is commonly used in the food industry for fermentation. Yeast can also be engineered to produce specific flavour compounds, such as vanillin, which is commonly used in food flavoring. Vanillin produced by yeast is a sustainable and cost-effective alternative to synthetic vanillin, which is derived from petrochemicals. (Krivoruchko, A *et al* 2019)

These applications can help to improve the sustainability, safety, and quality of food products. The use of microbial nanostructures in the food industry is still in its early stages, but it holds great promise for the future of food production and consumption.

2. Application of microbial nanotechnology in medicine and pharma.

Due to continuous exposure towards antibiotics the pathogens develop resistance towards the antibiotics, to overcome this bio-fabricated microbial nanoparticles are the boon in sector. larger surface area and small size of bio-fabricated nanoparticles are useful in efficiently interact with the microbial cell membrane and penetrate the cells to interfere with the metabolic pathways and DNA replication. (Fariq A. *et al* 2017)

Nanomaterials can be effectively used as a vehicle for targeted drug delivery

and are a very useful tool in enhancing the bioavailability, stability, and bioactivity of drugs. Major drug delivery nanomaterials include liposomes, nanospheres, polymeric micelles, water-soluble polymers, nano emulsions, and NP-coated natural antibodies. (Silva J *et al* 2014) (Omlor A. J *et al* 2015), microbial nanoparticles have their application also in cancer therapy and wound healing.

3. Application of microbial nanotechnology in agriculture.

Microbial nanoparticles have applications in agriculture as nanofertilizers, nanopesticides and nanoinsecticides.

Excellent antifungal capabilities may be found in metal NPs and metal oxides.

The most harmful plant pathogens that cause various plant diseases are fungi.

According to some recent research, pathogenic fungi including *Pythium ultimum*, *Alternaria alternata*, *Fusarium oxysporum*, and *Aspergillus niger* respond well to copper and copper oxide nanoparticles made from *Streptomyces* species. (Hassan *et al* 2019)

In a recent research article, Bisinoti *et al.*, 2019, employed soil fertilisers made of carbon-based nanomaterials instead of chemical fertilisers, and they came to the conclusion that this might minimise the usage of chemical fertilisers.

4. Application of microbial nanoparticles towards environmental concern.

For wastewater treatment and subsequent uses, it is essential to remove very

persistent and xenobiotic water pollutants such cationic dyes, acid dyes, azo dyes, and other similar pollutants. These contaminants worsen existing water contamination and harm aquatic life. NPs can either serve as a catalyst or absorb the contaminants over their greater surface area because of their bigger surface area and smaller size. Numerous studies have examined the ability of various NPs to reduce hazardous contaminants by catalysing the reaction between biological elements. (Zaho *et al* 1998). Bhargava *et al*, 2016 demonstrated that AuNPs can also be used as an adsorbent for organic dyes. It was observed that AuNPs having surface proteins synthesized from fungus *Cladosporiumoxysporum* AJP03 efficiently improved the adsorption of rhodamine-B organic dye. (Bhargava *et al* 2016)

Conclusion and future perspectives.

Microbial cells can be employed for the faster, safer generation of NPs with the necessary nature and structure since they are quick-growing, simple to maintain, and fast-growing. To achieve a consistent shape, symmetry, composition, and size of NPs, which is influenced by environmental factors, such as temperature and medium pH, is one of the numerous difficulties associated with the biosynthesis of NPs by microbial synthesis. (Hulkoti *et al* 2014) Although recent studies have demonstrated the enormous potential of microbes for the synthesis of novel NPs and their use in biomedicines and

cancer treatment (Hamida *et al* 2020), the methods of microbe-based biosynthesis need to be modified for commercial production, and the synthesis of NPs needs to be scaled up in comparison to conventional methods. The toxicity, biocompatibility, and possible impact of NPs on the immune system, respiratory system, hepatobiliary system, reproductive system, kidney, eyes, skin, and other organs all need to be thoroughly studied. (Xu *et al* 2020) In this field, it is innovative to fabricate NPs with the appropriate form and size using genetically modified microbes. In comparison to traditional bioproduction of nanomaterials, genetically modified organisms provide a number of benefits, including a higher rate of biosynthesis, lower generation costs, and greater energy efficiency. Although employing recombinant organisms to biofabricate NPs offers a lot of benefits, such as environmental safety, economic effectiveness, and viability of NP synthesis, it is still quite uncommon. To enhance NP synthesis utilising genetically modified organisms, concerns including repeatability, purity and separation of NPs, as well as the survival of recombinant strains, still need to be addressed. Researchers also encounter difficulties when employing genetically modified organisms for the production of NPs because of issues with public acceptability, biosafety, biosecurity, and transgene escape. But in the near future, it is anticipated that the biofabrication of NPs using genetically modified organisms would garner a lot of interest and

become the preferred approach for the sustainable production of nanoparticles. NPs therefore offer enormous promise in a variety of applications. Prior to the commercialization of NPs, however, issues including toxicity, dosages, and host immune response during treatment must to be resolved. (Iravani *et al* 2019)

REFERENCES

1. Bisinoti M.C., Moreira A.B., Melo C.A., Fregolente L.G., Bento L.R., dos Santos J.V., Ferreira O.P. (2019). Application of Carbon-Based Nanomaterials as Fertilizers in Soils *Nanomaterials Applications for Environmental Matrices: Water, Soil and Air*. Elsevier; Amsterdam, The Netherlands. pp. 305–333.
2. Do Nascimento, R., Ferreira, O. P., De Paula, A. J., & Neto, V. D. O. S. (Eds.). (2019). *Nanomaterials applications for environmental matrices: Water, soil and air*. Elsevier.
3. Donia A, Al-Madboly LA, Bokhari H, (2021). *Microbial Nanotechnology. Importance & Applications of Nanotechnology*, MedDocs Publishers. Vol. 6, Chapter 2, pp. 10-15.
4. Fariq, A., Khan, T., & Yasmin, A. (2017). Microbial synthesis of nanoparticles and their potential applications in biomedicine. *Journal of Applied Biomedicine*, 15(4), 241-248.

5. Gorgieva, S., & Trcek, J. (2011). Bacterial cellulose: production, modification and perspectives in biomedical applications. *Nanomaterials*, 1(1), 254-286.
6. Hamida, R. S., Albasher, G., & Bin-Meferij, M. M. (2020). Oxidative stress and apoptotic responses elicited by nostoc-synthesized silver nanoparticles against different cancer cell lines. *Cancers*, 12(8), 2099.
7. Hamida, R. S., Ali, M. A., Goda, D. A., Khalil, M. I., & Al-Zaban, M. I. (2020). Novel biogenic silver nanoparticle-induced reactive oxygen species inhibit the biofilm formation and virulence activities of methicillin-resistant *Staphylococcus aureus* (MRSA) strain. *Frontiers in bioengineering and biotechnology*, 8, 433.
8. Hassan, S. E. D., Fouda, A., Radwan, A. A., Salem, S. S., Barghoth, M. G., Awad, M. A., ... & El-Gamal, M. S. (2019). Endophytic actinomycetes *Streptomyces* spp mediated biosynthesis of copper oxide nanoparticles as a promising tool for biotechnological applications. *JBIC Journal of Biological Inorganic Chemistry*, 24, 377-393.
9. He, Y., & Zhang, X. (2021). Virus-like particles as a platform for food vaccines. *Trends in Food Science & Technology*, 112, 65-72.
10. Hulkoti, N. I., & Taranath, T. C. (2014). Biosynthesis of nanoparticles using microbes—a review. *Colloids and surfaces B: Biointerfaces*, 121, 474-483.

11. Iravani, S., & Varma, R. S. (2019). Biofactories: engineered nanoparticles via genetically engineered organisms. *Green Chemistry*, 21(17), 4583-4603.
12. Krivoruchko, A., Siewers, V., & Nielsen, J. (2019). Opportunities for yeast metabolic engineering: lessons from synthetic biology. *Biotechnology Journal*, 14(4), e1800421.
13. Omlor, A. J., Nguyen, J., Bals, R., & Dinh, Q. T. (2015). Nanotechnology in respiratory medicine. *Respiratory Research*, 16(1), 1-9.
14. Sánchez-González, M., & Ocio, M. J. (2021). Fungal mycelium as a novel food ingredient. *Trends in Food Science & Technology*, 115, 153-165.
15. Silva, J., Fernandes, A. R., & Baptista, P. V. (2014). Application of nanotechnology in drug delivery. *Application of nanotechnology in drug delivery*, 127-154.
16. Zhao, J., Wu, T., Wu, K., Oikawa, K., Hidaka, H., & Serpone, N. (1998). Photoassisted degradation of dye pollutants. 3. Degradation of the cationic dye rhodamine B in aqueous anionic surfactant/TiO₂ dispersions under visible light irradiation: evidence for the need of substrate adsorption on TiO₂ particles. *Environmental science & technology*, 32(16), 2394-2400.

14

BREAKING NEW GROUND: LEVERAGING ARTIFICIAL INTELLIGENCE FOR PRECISION MEDICINE IN NEURODEGENERATION RESEARCH

Priyanjalee Banerjee

Assistant Professor & Head,
Department of Zoology,

Raiganj Surendranath Mahavidyalaya,
Uttar Dinajpur, West Bengal.

Email: dr.pbanerjee.rsmzoology@gmail.com

Abstract:

The future of neurodegeneration research is being continuously driven towards greater precision and a better comprehension of the complex mechanisms of the disease. Artificial intelligence (AI) is a critical tool in achieving this, providing avenues for researchers to combine diverse data sources and integrating results to further understand the underlying disease process. Through this chapter, we hope to contribute to the current discussions on AI applications in neurodegeneration research, identify gaps in the field, and propose future directions for AI-enabled research that align with the goals of precision medicine.

Keywords

Neurodegeneration, Artificial Intelligence, Precision medicine, Alzheimer's disease, Mild cognitive impairment

Introduction:

The field of neurodegeneration is witnessing tremendous growth, as scientists strive to understand the many diseases that affect the nervous system, such as Alzheimer's, Parkinson's, Huntington's and ALS [1,2]. Despite the progress made in recent years, there remain significant challenges in identifying the underlying mechanisms of neurodegeneration [3,4,5], predicting the

progression of the disease, and developing effective treatments. AI, with its vast potential to revolutionize medicine, presents a great opportunity to overcome those challenges and lead us into uncharted territories in the field of neurodegeneration research [6].

AI-powered techniques such as big data analysis, machine learning, and deep learning are making it possible to exploit the massive datasets generated by neurodegenerative disease research. These techniques are helping researchers to detect hidden patterns in data, improve and personalize disease diagnosis, and develop predictive models that can estimate disease risks and progression with greater accuracy [7]. AI also enables new drug discoveries to be made more efficiently and cost-effectively, reducing the barriers to entry that traditional drug discovery methods present [8].

Furthermore, the integration of AI with neuroimaging technologies is enabling the visualization of neuropathology and neural activity with finer detail and resolution than previously possible. This allows us to better understand the complexities of the brain and its involvement in neurodegeneration, leading to the development of more effective therapeutic strategies.

Despite the great promise of AI in neurodegeneration research, the technology is not without its challenges. There are ethical, social, and legal considerations that must be considered in using AI, including the need to ensure that these

technologies are deployed in a way that is accessible and equitable for all populations [9]. Additionally, there are significant technical challenges related to the aggregation and use of large and heterogeneous data sets, and the development of AI models that are interpretable and robust in the face of noise and uncertainty.

This chapter aims to provide a comprehensive review of the current state of AI in neurodegeneration research, including its potential applications for precision medicine in neurodegenerative diseases. The chapter will explore how AI techniques are being applied in the various areas of neurodegeneration research, including drug discovery, neuroimaging, and patient diagnosis. We will also examine the challenges that arise in the use of AI and the ethical implications of AI-enabled tools in patient treatment and care.

Artificial Intelligence in deciphering the master organ-BRAIN

Artificial intelligence can comprehend vast amounts of data from various sources, including electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET). These tools in turn, help researchers identify biomarkers for early diagnosis and monitor patients' disease progression [10].

One study published in 2020 used machine learning to distinguish between different types of dementia based on EEG recordings of patients [11]. The study

found that this method had high diagnostic accuracy, up to 99.47% in some cases, and could help with early diagnosis and personalized treatment. Another research conducted in 2019 used fMRI to investigate the neural basis of semantic and episodic memory in patients with Alzheimer's disease [10]. The researchers employed a deep learning algorithm to analyze the data and found that hippocampal atrophy was associated with semantic memory dysfunction, while prefrontal cortical atrophy was related to episodic memory impairment. AI is also useful in analysing motor impairment and predicting disease progression in dementia. An example of this is a recent study that used machine learning to analyse gait patterns in patients with Alzheimer's disease [12]. The study found that an AI model could predict a patient's functional and cognitive decline over the next six months, indicating the potential for early intervention and personalized treatment.

Anatomical Aspects of Dementia Brain

AI has been used to analyse volumetric changes and structural abnormalities in the dementia brain, which play a significant role in disease progression. As highlighted in a report published in 2020 deep learning was used to identify and classify cortical thickness changes in patients with Alzheimer's disease [13]. The researchers found significant atrophy in regions associated with memory and cognitive functions, which corresponded with the patients' clinical

presentation.

Another article published in 2019 implemented deep learning to analyse brain scans from patients with vascular dementia and Alzheimer's disease [14]. The researchers found that the two conditions had different patterns of structural changes, which could help with proper diagnosis and personalized treatment.

Physiological Aspects of Dementia Brain

AI has been widely used to indicate physiological changes in the dementia brain, such as changes in metabolic activity, blood flow, and oxygenation levels. These changes can be detected using neuroimaging techniques such as PET and near-infrared spectroscopy (NIRS).

As published in 2023 used machine learning to analyse PET scans from patients with mild cognitive impairment (MCI) and Alzheimer's disease [15]. The researchers found that a model based on deep learning had high accuracy for predicting the progression from MCI to Alzheimer's disease.

According to another published article in 2022 used NIRS to investigate the association between cerebral blood flow and cognitive function in patients with Alzheimer's disease [16]. The researchers employed a machine learning algorithm to analyze the data and found that NIRS could predict cognitive function with high accuracy.

Application of AI in Neuroimaging Studies

AI has been instrumental to neuroimaging studies to improve diagnoses and treatments for dementia. One area where this has been particularly useful is in the analysis of amyloid-beta ($A\beta$) and tau protein deposits, which are pathological hallmarks of Alzheimer's disease. Various PET tracers have been developed to detect $A\beta$ and tau deposits [17], and AI has been used to interpret the data from these scans.

As evident in published journal in 2022, machine learning was used to analyse PET scans from patients with Alzheimer's disease and healthy controls [17]. The researchers found that an AI model could accurately detect $A\beta$ and tau deposits, providing a more efficient and cost-effective method for diagnosis.

Overview of Machine Learning (ML) and Deep Learning (DL) with respect to neural network in healthcare

Machine learning and deep learning have revolutionized the way we address problems in healthcare. Machine learning and deep learning have been shown to be powerful tools for predictive modelling and forecasting in healthcare by allowing the ability to derive insights not possible from standard regression or correlation analysis. For predictive modelling in healthcare, this means that analysts can make better predictions about patient outcomes based on factors like patient demographics and clinical data.

By understanding how neural networks function, healthcare researchers can

develop models that predict which patients will experience certain health problems. This information can then be used to steer patients towards interventions like drug therapies or surgery that are most likely to be effective. While there are many potential applications of machine learning and deep learning in healthcare, there is still much to be explored. The fields of machine learning and deep learning are always evolving, and new applications of these techniques are being developed all the time. As healthcare continues to rely more and more on machine learning and deep learning, it is essential that researchers keep up with the latest developments [18].

Big Data- Multi Omics and Health Data Interpretation

Multiomics is the study of varied array of datasets including biochemical, genetic and other biological sources, as well as clinical data. This data can be analysed to better understand the pathology of neurodegenerative disorders, and to develop new therapies [19]. However, this data is often too large to be analysed using conventional software. Instead, new methods, such as machine learning, are needed to comprehend it. Once processed, 'data interpretation' process transforms raw data into information that can be used to make decisions. This process can be difficult, because the data can be in many different formats and can contain many errors.

Together, multiomics and big data are helping us to understand the pathology

of neurodegenerative disorders better and to develop new therapeutic strategies.

Artificial Intelligence for Precision Medicine in neurodegeneration research

Artificial intelligence (AI) has been increasingly used in precision medicine, which is the application of precision diagnosis and treatment of diseases. In neurodegeneration brain dementia research, AI has been used to help identify which features of a patient's brain scan represent changes indicative of the disease and to help predict the likelihood of a patient developing the disease.

One approach that has been used to apply AI to neurodegeneration brain dementia research is to use deep learning. Deep learning is a type of AI that allows machines to learn from data without being explicitly programmed. It involves training a computer to learn how to "analyze and understand complex datasets". This approach has been used to train neural networks to recognize changes in brain scans that are indicative of neurodegeneration brain dementia.

Another approach that has been used to apply AI to neurodegeneration brain dementia research is to use a so-called "cancerBALL". CancerBALL is an AI system that was designed to help clinicians identify cancerous lesions in brain scans [20]. CancerBALL relies on a number of machine-learning algorithms,

including a deep learning algorithm, to identify changes in brain scans that are indicative of cancer.

The use of AI in neurodegeneration brain dementia research has had several benefits. First, AI has been able to help identify changes in brain scans that are indicative of neurodegeneration brain dementia. This has helped to improve the accuracy of diagnostic tests. Second, AI has been able to help predict the likelihood of a patient developing the disease. This has allowed physicians to treat the disease more effectively. Finally, AI has allowed researchers to explore new ways to prevent and treat neurodegeneration brain dementia.

Table 1. Databases for Neurodegenerative Disease (ND) Research

Database	Applications in Neurodegeneration Research	Reference
Human Protein Reference Database (HPRD)	PPI data supply and protein dysfunction in NDs	[21]
Molecular Interaction Database (MINT)	Molecular interaction data related to proteins of NDs	[22]
PubMed	Literature survey for NDs datasets	[21]
Interologous Interaction Database (I2d)	ND protein interaction networks	[23]
NeuroDNet	Protein gene interactions study related to NDs	[24]
Online Mendelian	Information about	[25]

Inheritance in Man (OMIM)	genes involved in NDs	
National Alzheimer's Coordinating Center (NACC)	Retrieval of data of Alzheimers' disease research	[26]
Online Predicted Human Interaction Database (OPHID)	Pathway interaction study for NDs	[27]
IntAct	Molecular interactions data analysis for NDs	[28]
Human Gene Mutation Database (HGMD)	Information about mutated or inherited genes involved in NDs	[29]
ALSOD	Information gathering about ALS	[30]
Database of Interacting Protein (DIP)	Molecular interactions study of ND proteins	[31]
InnateDB	Gene interactions of innate immune response candidates related to NDs	[32]
Biological General Repository for Interaction Datasets (BioGRID)	PPI and genetic networks data acquisition for NDs research	[29]
Protein Data Bank (PDB)	3D protein structures study of NDs	[33]
Genetic Home Reference	Genetic variations data related to NDs	[34]

Adapted from: Usman et al. J. Integr. Neurosci. 2022 vol. 21(1), 1-10:

Precision Medicine Research in Neurodegeneration

Precision medicine is a medical approach that uses individual variability in genes, environment, and lifestyle to tailor treatment and prevention strategies to the specific needs of each patient. Precision medicine offers a promising solution to the challenges posed by neurodegenerative diseases like Alzheimer's disease, Parkinson's disease, Huntington's disease, amyotrophic

lateral sclerosis (ALS), and multiple sclerosis (MS) which are characterized by the progressive loss of cognitive and motor functions, leading to disability and ultimately death [35]. Through the mechanism of identifying the genetic and environmental factors that contribute to the development and progression of these diseases, precision medicine can help to develop targeted therapies that are effective and safe for individual patients.

One of the key challenges in precision medicine research in neurodegeneration is the heterogeneity of these diseases. Neurodegenerative diseases are complex disorders that involve multiple biological pathways and cellular processes. As a result, they can present with different clinical features and progress at different rates in different patients. To overcome this challenge, precision medicine research in neurodegeneration has focused on identifying biomarkers [36] that can help to stratify patients into more homogeneous subgroups based on their underlying disease mechanisms.

Biomarkers are measurable indicators of biological processes that can be used to diagnose, monitor, and predict the course of a disease. In neurodegeneration, biomarkers can be used to identify patients at risk of developing the disease, to diagnose the disease at an early stage, and to monitor disease progression and response to treatment. Biomarkers can also help to identify new targets for drug development and to evaluate the efficacy and safety of new therapies.

Several types of biomarkers have been identified in neurodegeneration, including imaging biomarkers, fluid biomarkers, and genetic biomarkers [36]. Imaging biomarkers include magnetic resonance imaging (MRI), positron emission tomography (PET), and functional MRI (fMRI). These techniques can be used to visualize changes in brain structure and function that are associated with neurodegeneration. Fluid biomarkers include cerebrospinal fluid (CSF) and blood biomarkers. These biomarkers can be used to measure levels of proteins and other molecules that are associated with neurodegeneration. Genetic biomarkers include mutations in genes that are associated with neurodegeneration. These mutations can be used to identify patients at risk of developing the disease and to develop targeted therapies.

Precision medicine research in neurodegeneration has also focused on developing new therapies that target specific disease mechanisms. One example is the development of disease-modifying therapies that target the accumulation of abnormal proteins in the brain, such as beta-amyloid in Alzheimer's disease and alpha-synuclein in Parkinson's disease [37]. These therapies aim to slow or halt disease progression by reducing the burden of abnormal proteins in the brain.

Another instance is the development of therapies that target inflammation and oxidative stress, which are thought to contribute to the development and

progression of neurodegeneration. These therapies aim to reduce inflammation and oxidative stress in the brain, thereby protecting neurons from damage and improving cognitive and motor function [37].

Precision medicine research in neurodegeneration is a rapidly evolving field that holds great promise for improving the diagnosis, treatment, and prevention of these devastating diseases. However, significant challenges remain, including the need for more effective biomarkers, the development of new therapies, and the identification of the best strategies for implementing precision medicine in clinical practice.

Opportunities and Applications of Artificial Intelligence for Precision Medicine in Recent Neurodegeneration Research

Precision medicine is a promising approach to treating complex neurodegenerative diseases like Alzheimer's disease, Parkinson's disease, and Huntington's disease. Precision medicine aims to tailor treatment and prevention strategies to the specific needs of each patient by using individual variability in genes, environment, and lifestyle. Artificial intelligence (AI) has emerged as a powerful tool for precision medicine in neurodegeneration research. AI can be used to identify biomarkers, stratify patients into more homogeneous subgroups, develop targeted therapies, and evaluate the efficacy

and safety of new treatments.

1. Biomarker Identification:

One of the key opportunities of AI in precision medicine for neurodegeneration research is the identification of biomarkers [36]. AI can be used to analyze large datasets of patient information, including genetic data, imaging data, and clinical data, to identify biomarkers that are associated with neurodegenerative diseases. For example, AI can be used to identify patterns in brain imaging data that are associated with Alzheimer's disease, such as the accumulation of beta-amyloid plaques and tau tangles.

2. Patient Stratification:

Another opportunity of AI in precision medicine for neurodegeneration research is patient stratification [38]. Neurodegenerative diseases are complex disorders that involve multiple biological pathways and cellular processes. As a result, they can present with different clinical features and progress at different rates in different patients. AI can be used to identify subgroups of patients that share similar disease mechanisms and clinical features. This can help to develop targeted therapies that are effective and safe for individual patients.

3. Drug Development as well as Drug Repurposing

AI can also be used to develop new drugs for neurodegenerative diseases. AI can further be utilized to screen large libraries of compounds to identify

molecules that have the potential to target specific disease mechanisms and repurpose those drugs for new treatment [39]. AI can also be used to predict the efficacy and safety of new drugs based on their chemical properties and biological activity. This can help to accelerate the drug development process and reduce the cost of developing new treatments.

4. Treatment Optimization:

AI contributes to optimize treatment for neurodegenerative diseases. AI can be used to analyze patient data, including genetic data, imaging data, and clinical data, to predict the response of individual patients to different treatments. This can help to personalize treatment and improve outcomes for patients [39].

5. Clinical Decision Support:

AI can also be used to provide clinical decision support for healthcare providers. AI can be used to analyze patient data in real-time to provide recommendations for diagnosis, treatment, and monitoring. This can help to improve the accuracy and efficiency of clinical decision-making and reduce the risk of errors [38].

Challenges and Limitations of AI in Precision Medicine for Neurodegeneration Research

Artificial intelligence (AI) has emerged as a promising tool for precision medicine in neurodegeneration research. AI can be used to identify biomarkers,

stratify patients into more homogeneous subgroups, develop targeted therapies, optimize treatment, and provide clinical decision support. However, there are also significant challenges and limitations to the use of AI in precision medicine for neurodegeneration research.

1. Data Quality:

One of the key challenges of AI in precision medicine for neurodegeneration research is data quality [40]. AI relies on large datasets of patient information, including genetic data, imaging data, and clinical data, to identify biomarkers, stratify patients, and develop targeted therapies. However, the quality of these datasets can vary widely, and incomplete or inaccurate data can lead to biased or incorrect results.

2. Data Privacy and Security:

Another challenge of AI in precision medicine for neurodegeneration research is data privacy and security. Patient data is sensitive and must be protected to ensure patient privacy and confidentiality. However, AI relies on large datasets of patient information, which can be vulnerable to cyber-attacks and data breaches. This can lead to significant ethical and legal concerns [40,41].

3. Lack of Standardization:

One more limitation of AI in precision medicine for neurodegeneration research is the lack of standardization. Neurodegenerative diseases are

complex disorders that involve multiple biological pathways and cellular processes. As a result, there can be significant variability in the way that patient data is collected and analyzed [38, 40]. This can lead to inconsistent results and make it difficult to compare results across studies.

4. Interpretability:

Shortcomings of AI in precision medicine for neurodegeneration research in the field of interpretability could not be ignored. AI algorithms can be complex and difficult to interpret, making it difficult to understand how they arrived at their conclusions [42]. This can make it difficult to validate results and can lead to mistrust of AI-based approaches.

5. Integration into Clinical Practice:

Another challenge of AI in precision medicine for neurodegeneration research is the integration of AI-based approaches into clinical practice. AI-based approaches can be expensive and require specialized expertise, making it difficult to implement them in clinical settings [41,42]. There is also a need for clear guidelines and standards for the use of AI-based approaches in clinical practice.

Conclusion

Future Directions and Research Priorities

In a nutshell, the application of AI in neurodegeneration research has enhanced

our understanding of the functional, anatomical and physiological aspects of the disease, as well as its diagnosis and treatment. Furthermore, AI has the potential to transform precision medicine in neurodegeneration research. AI technologies such as machine learning, natural language processing, and deep learning have been shown to improve the accuracy and efficiency of neuroimaging studies, elevating their potential for clinical use. Looking ahead, AI is poised to play a significant role in early diagnosis, personalized treatment and disease prevention strategies for dementia and other neurological conditions. While there are still challenges to overcome, including the need for larger and more diverse datasets, the potential benefits of using AI in neurodegeneration research till date are substantial. However, addressing these challenges will be essential to realizing the full potential of AI in precision medicine for neurodegeneration research.

Ethics approval and consent to participate

Not applicable.

Acknowledgment

I would like to thank the administration of Raiganj Surendranath Mahavidyalaya for their constant support and encouragement.

Funding

This research received no external funding.

Author information: Authors and Affiliations

Dr. Priyanjalee Banerjee, Assistant Professor, Raiganj Surendranath Mahavidyalaya, Uttar Dinajpur, West Bengal-733134.

Corresponding author:

Correspondence to Dr. Priyanjalee Banerjee.

References

1. Cummings, J. L., Morstorf, T., & Zhong, K. (2014). Alzheimer's disease drug-development pipeline: Few candidates, frequent failures. *Alzheimer's Research and Therapy*, 6(4), 37.
2. Miller, D. B., & O'Callaghan, J. P. (2015). Biomarkers of Parkinson's disease: Present and future. *Metabolism: Clinical and Experimental*, 64(3)(Suppl. 1), S40–S46.
3. Hampel, H., O'Bryant, S. E., Molinuevo, J. L., Zetterberg, H., Masters, C. L., Lista, S., Kiddle, S. J., Batrla, R., & Blennow, K. (2018). Blood-based biomarkers for Alzheimer disease: Mapping the road to the clinic. *Nature Reviews. Neurology*, 14(11), 639–652.
4. Jucker, M., & Walker, L. C. (2011). Pathogenic protein seeding in Alzheimer disease and other neurodegenerative disorders. *Annals of Neurology*, 70(4), 532–540.
5. Liddelow, S. A., & Barres, B. A. (2017). Reactive astrocytes: Production,

- function, and therapeutic potential. *Immunity*, 46(6), 957–967.
6. Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine*, 25(1), 44–56.
 7. Tăuțan, A.-M., Ionescu, B., & Santarnecchi, E. (2021). Artificial intelligence in neurodegenerative diseases: A review of available tools with a focus on machine learning techniques. *Artificial Intelligence in Medicine*, 117, 102081.
 8. Kashyap, K., & Siddiqi, M. I. (2021, August). Recent trends in artificial intelligence-driven identification and development of anti-neurodegenerative therapeutic agents. *Molecular Diversity*, 25(3), 1517–1539.
 9. Nithesh, N., Zeeshan, H. B. M., Shetty Dasharathraj, K., Dishant, S., Milap, S., Rahul, P., Kaivalya, A., Sufyan, I., Vathsala, P., Komal, S., Suyog, S., Prasad, R. B., & Piotr, C., Somani Bhaskar K. Legal and ethical consideration in artificial intelligence in healthcare: Who takes responsibility? *Frontiers in surgery*, VOLUME=9. (2022).
 10. Allen, B., Jr., Seltzer, S. E., Langlotz, C. P., Dreyer, K. P., Summers, R. M., Petrick, N., Marinac-Dabic, D., Cruz, M., Alkasab, T. K., Hanisch, R. J., Nilsen, W. J., Burleson, J., Lyman, K., & Kandarpa, K. (2019). A road map for translational research on artificial intelligence in medical imaging: From

- the 2018 National Institutes of Health/RSNA/ACR/The Academy Workshop. Journal of the American College of Radiology. Rehabilitation Society of North America/American College of Rheumatology Research and Education Foundation. /The Academy Workshop, 16(9 Pt A), 1179–1189.
11. Ieracitano, C., Mammone, N., Hussain, A., & Morabito, F. C. (2020, March). A novel multi-modal machine learning based approach for automatic classification of EEG recordings in dementia. *Neural Networks*, 123, 176–190.
 12. Ghoraani, B., Boettcher, L. N., Hssayeni, M. D., Rosenfeld, A., Tolea, M. I., & Galvin, J. E. (2021, February). Detection of mild cognitive impairment and Alzheimer's disease using dual-task gait assessments and machine learning. *Biomedical Signal Processing and Control*, 64, 102249.
 13. Rebsamen, M., Rummel, C., Reyes, M., Wiest, R., & McKinley, R. (2020, December). Direct cortical thickness estimation using deep learning-based anatomy segmentation and cortex parcellation. *Human Brain Mapping*, 41(17), 4804–4814.
 14. Taeho, J., Kwangsik, N., Andrew, S., & Learning, J. D. (2019). Alzheimer's disease: Diagnostic classification and prognostic prediction using neuroimaging data. In *Frontiers in Aging Neuroscience*, VOLUME=11.
 15. Zhao, Z., Chuah, J. H., Lai, K. W., Chow, C. O., Gochoo, M., Dhanalakshmi,

- S., Wang, N., Bao, W., & Wu, X. (2023, February 6). Conventional machine learning and deep learning in Alzheimer's disease diagnosis using neuroimaging: A review. *Frontiers in Computational Neuroscience*, 17, 1038636.
16. Ho, T. K. K., Kim, M., Jeon, Y., Kim, B. C., Kim, J. G., Lee, K. H., Song, J. I., & Gwak, J. (2022, April 26). Deep learning-based multilevel classification of Alzheimer's disease using non-invasive functional near-infrared spectroscopy. *Frontiers in Aging Neuroscience*, 14, 810125.
17. Amini, M., Pedram, M. M., Moradi, A., Jamshidi, M., & Ouchani, M. (2022, August 9). GC-CNNnet: Diagnosis of Alzheimer's disease with PET images using genetic and convolutional neural network. *Computational Intelligence and Neuroscience*, 2022, 7413081.
18. Wang, T., Shao, W., Huang, Z., Tang, H., Zhang, J., Ding, Z., & Huang, K. (2021). MOGONET integrates multi-omics data using graph convolutional networks allowing patient classification and biomarker identification. *Nature Communications*, 12(1), 3445.
19. Termine, A., Fabrizio, C., Strafella, C., Caputo, V., Petrosini, L., Caltagirone, C., Giardina, E., & Cascella, R. (2021, April 7). Multi-layer picture of neurodegenerative diseases: Lessons from the use of big data through artificial intelligence. *Journal of Personalized Medicine*, 11(4), 280.

20. Koh, D. M., Papanikolaou, N., Bick, U., Illing, R., Kahn, C. E., Kalpathi-Cramer, J., Matos, C., Martí-Bonmatí, L., Miles, A., Mun, S. K., Napel, S., Rockall, A., Sala, E., Strickland, N., & Prior, F. (2022). Artificial intelligence and machine learning in cancer imaging. *Communications Medicine*, 2, 133.
21. Tanabe, M., Limviphuvadh, V., & Kanehisa, M. (2010). Knowledge-based analysis of protein interaction networks in neurodegenerative diseases. *Neuroproteomics*, 5, 147–162.
22. Cesareni, G., Chatr-aryamontri, A., Licata, L., & Ceol, A. (2008). Searching the MINT database for protein interaction information. *Current Protocols in Bioinformatics*, Chapter(8)(8), 8.5.1–8.5.13.
23. Nguyen, T. P., Caberlotto, L., Morine, M. J., & Priami, C. (2014). Network analysis of neurodegenerative disease highlights a role of toll-like receptor signaling. *BioMed Research International*, 2014, 686505.
24. Vasaikar, S. V., Padhi, A. K., Jayaram, B., & Gomes, J. (2013). NeuroDNet – An open source platform for constructing and analyzing neurodegenerative disease networks. *BMC Neuroscience*, 14, 3.
25. Keane, H., Ryan, B. J., Jackson, B., Whitmore, A., & Wade-Martins, R. (2015). Protein–protein interaction networks identify targets which rescue the MPP+ cellular model of Parkinson’s disease. *Scientific Reports*, 5, 17004.

26. Spring, C. C., Hobson, V., Lucas, J. A., Menon, C. V., Hall, J. R., & O'Bryant, S. E. (2012). Diagnostic accuracy of the MMSE in detecting probable and possible Alzheimer's disease in ethnically diverse highly educated individuals: An analysis of the NACC database. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 67(8), 890–896.
27. Brown, K. R., & Jurisica, I. (2005). Online predicted human interaction database. *Bioinformatics*, 21(9), 2076–2082.
28. Li, P., Nie, Y., & Yu, J. (2015). An effective method to identify shared pathways and common factors among neurodegenerative diseases. *PLOS ONE*, 10(11), e0143045.
29. Panda, A., Begum, T., & Ghosh, T. C. (2012). Insights into the evolutionary features of human neurodegenerative diseases. *PLOS ONE*, 7(10), e48336.
30. Wroe, R., Wai-Ling Butler, A., Andersen, P. M., Powell, J. F., & Al-Chalabi, A. (2008). ALSOD: The amyotrophic lateral sclerosis online database. *Amyotrophic Lateral Sclerosis*, 9(4), 249–250.
31. Casas, C., Isus, L., Herrando-Grabulosa, M., Mancuso, F. M., Borrás, E., Sabidó, E., Forés, J., & Aloy, P. (2015). Network-based proteomic approaches reveal the neurodegenerative, neuroprotective and pain-

related mechanisms involved after retrograde axonal damage. *Scientific Reports*, 5, 9185.

32. Srinivasa Rao, V., Srinivas, K., Kumar, G. N., & Sujin, G. N. (2013). Protein inter- action network for Alzheimer's disease using computational approach. *Bioinformatics*, 9(19), 968–972.
33. Mehra, R., & Kepp, K. P. (2019). Computational analysis of Alzheimer-causing mutations in amyloid precursor protein and presenilin 1. *Archives of Biochemistry and Biophysics*, 678, 108168.
34. Nataf, S., Guillen, M., & Pays, L. (2019). Common neurodegeneration-associated proteins are physiologically expressed by human B lymphocytes and are interconnected via the inflammation/autophagy-related proteins TRAF6 and SQSTM1. *Frontiers in Immunology*, 10, 2704.
35. Nuzziello, N., Ciaccia, L., & Liguori, M. (2019, December 27). Precision medicine in neurodegenerative diseases: Some promising tips coming from the microRNAs' world. *Cells*, 9(1), 75.
36. Tondo, G., & De Marchi, F. (2022, August 3). From biomarkers to precision medicine in neurodegenerative diseases: Where are we? *Journal of Clinical Medicine*, 11(15), 4515.
37. Strafella, C., Caputo, V., Galota, M. R., Zampatti, S., Marella, G., Mauriello, S., Cascella, R., & Giardina, E. (2018, August 23). Application of

- precision medicine in neurodegenerative diseases. *Frontiers in Neurology*, 9, 701.
38. Fabrizio, C., Termine, A., Caltagirone, C., & Sancesario, G. (2021, August 14). Artificial intelligence for Alzheimer's disease: Promise or challenge? *Diagnostics*, 11(8), 1473.
39. Fang, J., Zhang, P., Wang, Q., Chiang, C. W., Zhou, Y., Hou, Y., Xu, J., Chen, R., Zhang, B., Lewis, S. J., Leverenz, J. B., Pieper, A. A., Li, B., Li, L., Cummings, J., & Cheng, F. (2022, January 10). Artificial intelligence framework identifies candidate targets for drug repurposing in Alzheimer's disease. *Alzheimer's Research and Therapy*, 14(1), 7.
40. Kelly, C. J., Karthikesalingam, A., Suleyman, M., Corrado, G., & King, D. (2019). Key challenges for delivering clinical impact with artificial intelligence. *BMC Medicine*, 17(1), 195.
41. Martínez-García, M., & Hernández-Lemus, E. (2021). Data integration challenges for machine learning in precision medicine. *Frontiers in Medicine*, 8, 784455.

Chapter–XV

15

EXPLORING NUMERICAL ANALYSIS IN ITS FIELD OF DIVERGENCE

D.Jeyanthi Prassanna

**Assistant Professor, Department of Mathematics, Rathinam
College of Arts & Science, Coimbatore, Tamil Nadu.**

Abstract:

Maths and skill have a lengthy and ill-defined relationship that is becoming more significant for both parties. The fundamental building block of science, its common language, and its primary supply of intellectual resources is mathematics. In turn, mathematics is stimulated and inspired by science, which generates new ideas, raises new questions, and ultimately shapes mathematics' value system. Physical science and physical phenomenon engineering are two fields that have always been heavily reliant on mathematics. Many of the problems in sciences like biology, physiology, and medicine that have not traditionally relied heavily on mathematics are animated from verbal description and taxonomy to psychoanalysis and explanation; as a result, they require exploration with newly developed mathematical techniques.

KEYWORDS: Numerical Analysis, Types of Numerical Methods, Application etc

Introduction:

The relationships between maths and science cannot be fully covered in the current document. Its goal is to present examples of scientific breakthroughs made possible by a close fundamental frequency fundamental interaction between science and mathematics and derive generalisations from them that should hold true regardless of the examples. We have given the instances labels

that indicate the scientific content they contain, but we could have used mathematical categories instead and come to the same results. A section on statistics would have described its contributions to the examination of the enormous data sets related to cosmology, finance, usefulness, loan-blend system theory, materials science, mixing, physiology, and moving boundaries. A section on "partial differential gear equations" would have described its roles in these fields as well. MRI,

Internet Analysis, Reliability, and Security:

One of the recent twentieth century's most widely discussed and written about phenomenon is the Internet. Since the early 1980s, the amount of information transacted online has increased dramatically. In 1982, there were 235 information science hosts online; in 1989, there were 100,000; and in 1998, there were more than 30 million. The Web's ongoing growth has consistently eluded even the most optimistic extrapolations, which is why it is referred to as a "success disaster" by internet researchers since it has outperformed everyone's predictions but is ill-prepared to deal with the fallout. As the Web becomes more widespread, problems with cyberspace are likely to worsen; as a result, it is important to consider the effectiveness, reliability, and security of the internet.

However, any belief that the known mathematics of the tele traffic theory can

be applied to online transactions is bound to failure. Internet traffic and voice traffic are completely dissimilar in every way. The previous undeniable properties are no longer valid since computers do not communicate with other computers in the same way that humans communicate over the phone. Information connections may last for days. Both duration and transmission rates for data traffic vary across scales that are out of the ordinary for voice connections. Additionally, information web transactions exhibit multiscale burstiness -- they happen in fits and starts, However, any belief that the known mathematics of the tele traffic theory can be applied to online transactions is bound to failure. Internet traffic and voice traffic are completely dissimilar in every way. The previous undeniable properties are no longer valid since computers do not communicate with other computers in the same way that humans communicate over the phone. Information connections may last for days. Both duration and transmission rates for data traffic vary across scales that are out of the ordinary for voice connections. Additionally, information web transactions exhibit multiscale burstiness -- they happen in fits and starts,

Diagnosis Using Variational Probabilistic Inference:

Mathematics is facing new difficulties as a result of the information sciences' rapid advancement. Although it is often necessary to develop completely free of

doubt theories, the field of unmistakable noesis is broad, and there are times when the use of old analogies is necessary to allow for the application of outdated concepts in novel ways. In a recent success story, a challenging challenge in probabilistic diagnosis was resolved by combining methods from mechanical engineering, statistical physics, and quantum mechanics. The issue of diagnosis is an illustration of the problem that "inductive inference" or, more colloquially, "reasoning backward" generally causes. Think about the difficulty of diagnostic abstract cognition in medicine, for instance. A undefined observes a patient's type of symptoms and wishes.

Scientists have begun to develop probabilistic diagnostic techniques for use in a variety of strange fields, such as manufacturing, transportation, and communications, in addition to medical. Building these tools has increased understanding of the undeniable problems that underlie backwards reasoning. In the past ten years, a master superior general mathematical possibility has emerged that yields an undefined specification of the complexity of diagnosing in probabilistic systems and permits the definition of optimal algorithms, leading to significant progress in a field known as written modelling. The hidden Andre Mark of simulate and the Kalman trickle, two common classical probabilistic methods employed in estimate theory and voice recognition, respectively, are particular examples of this superior generic approach.

The earlier discourse of explaining away hinted at a generic mathematical difficulty underpinning probabilistic inference, which takes the shape of a series of nonlinear equations with each undefined having an exponentially high number of terms. Given a set of symptoms, it is roughly necessary to multiply the probabilities of the unregenerate symptoms (using a nonlinear operation) and then multiply that result by the total number of uncommon disease configurations (using a sum of 2599 terms), in order to determine the likelihood of a disease in the QMR network. The actual computation is not as awful as this because the network is not completely interconnected (for example, diseases have no probability of causing specific symptoms), but it is nonetheless intractable.

Variational inference is a recently discovered estimate method for illation that is quite similar to mean field theory and finite element analysis. Instead of explicitly acting out inference on a dense quantity network, the variational set about considers a simple web where a significant portion of the linkages are absent. For each lost link, roughly speaking, a variational parameter is introduced. This parametric quantity roughly captures the high-order amount dependency created while that link is present in the network. Instead of placing demands on values, the simple network is selected to impose boundaries on the probabilities of matter.

Education:

The value of having strong connections between maths and skill is clear from the examples given, albeit they are only a small sampling from a larger, more impressive pool. One of the issues that must be overcome is how to prepare more people due to the unfortunate lack of people who can bridge the gap between maths and the sciences. To us, it goes without saying that students of science should be taught about maths and that maths students should be required to grasp science problems. Each skill area has its own distinctive characteristics, yet all of the areas share similar traits that have a strong mathematical bent. Modelling, computation, and problem-solving themes.

Modeling:

The simple substitution class described by "do this experiment, plot the data, and observe that they almost lie on a straight line" is not sufficient for students studying science and mathematics. They need to master more complex concepts. Students should be instructed to build an unquestionable model given a physical issue and/or data, explain why the model is appropriate, perform mathematical psychoanalysis or a machine simulation, come up with experiments to verify the accuracy of their model, then improve the simulate and take over the process.

Computation:

The idea that "anyone can compute" is fallacious in the same way that "anyone can set up a telescope" is untrue. Learning how is necessary. A large portion of the feed's deliberate instruction is faulty; a "cookbook" method of applying transcribed programmes without paying attention to the basics is totally ineffective. On the other hand, researchers shouldn't waste time re-inventing the wheel or using tried-and-true information structures and techniques. Science and maths students need to be informed about the concepts and ideas behind contemporary computer science.

Problem-solving:

The context is stripped away and made simpler in typical academic presentations of scientific and mathematical topics so that students can concentrate on the most important details. However, students mustness teach how to approach poorly specified, poorly stated situations -- an area in which training is deficient -- especially when gaining undeniable discoveries. There are no short cuts; experiential learning is the primary method of learning.

We make a number of suggestions for scientific and mathematical breeding. We can't begin to turn to the problem of math and science education for everyone; our main goal is to breed kids who specialise in math or science.

1. Encourage the establishment of programmes in areas that are crucial for making linkages between math and science. Each educational activity should permit the formation of
 - (a) For high school, undergraduate, and calibrate students, develop moulding courses. Moulding can be taught to kids in high school (at a basic level), unlike many other skills. There would be significant advantages if a one-year moulding course were included in the core curriculum for science, engineering, mathematics, and computer science at the undergraduate level. While enhancing the indisputable talents of scientific students, fine-tune mould courses will deepen the field of study noesis of mathematics students.
 - (b) Encourage the development of courses that combine mathematics, science, and the fundamentals of data processing. All scientists and mathematicians should receive instruction in programming, denotative analysis, information structures, and algorithms, each of which has a sober mathematical foundation.
 - (c) Promote activity experimentation
3. Subscribe to summer institutes in (i) technological themes with solid content and (ii) mathematical issues with technological applicability.
4. Provide financial support for research teams that incorporate (i) a true quislingism between scientists and mathematicians and (ii) a novel

educational plan for graduate students, postdoctoral fellows, and perhaps undergraduates. Such support should be as long-term as possible in order to be effective; if it is simply temporary, researchers are unlikely to devote the significant amounts of time required to create group structures that will support multidisciplinary cooperation.

5. Specified post-doctoral fellowships in settings that combine superiority in science with proficiency in mathematics. Efforts to create industry postdoc programmes should be broadened to create postdoctoral fellowships that are jointly funded by universities and national research laboratories as well as short-term fellowships for scientists.

Conclusions:

There are and are thriving strong connections between mathematics and the sciences, but there should be many more. Such linkages should be prevalent in order to boost technology advancement, and it is wise technological insurance to actively foster them. Making linkages between maths and the sciences more relevant is very important. While mathematicians should be aware of current scientific thought, scientists and engineers should have access to the most recent mathematical tools. Within a few years of its creation, Einstein could apply Levi Civita's geometry in a geological era of modest research. New mathematical

discoveries may go unnoticed by scientists and engineers for extended periods of time due to today's massively expanded technological industry and increased specialisation.

References

1. Willinger and V.\ Paxson (1998), Where mathematics meets the Internet, Notices of the American Mathematical Society 45, 961---970.
2. T. S. Jaakkola, T. S. and M. I. Jordan (1999). Variational methods and the QMR-DT database, submitted to Journal of Artificial Intelligence Research.
3. M. I. Jordan (1998), Learning in Graphical Models, MIT Press, Cambridge, Massachusetts

Chapter-XVI

16

A REVIEW ON BACTERIAL MULTIDRUG RESISTANCE

J. Albino Wins

Department of Botany,
Holy Cross College (Autonomous), Nagercoil -4,
Kanyakumari District, TamilNadu, India.

M. Murugan

Department of Biomedical Engineering,
Noorul Islam Centre for Higher Education, Kumaracoil,
Kanyakumari District, TamilNadu, India.

Introduction:

Multiple drug resistance (MDR) is an antimicrobial resistance propelled by some microorganisms to several antimicrobial drugs. MDR microorganisms promptly threatening to public health because they resist multiple antibiotics. Other MDR include those that are resistant to multiple antifungal, antiviral, and anti-parasitic drugs (Magiorakos, 2014; WHO, 2018).

Classification of Multi Drug Resistance:

The process of intaking different dosage of drugs in appropriate duration with the survival of various microbes intimate a strong development of drug resistance in the person. Multi drug resistance can be primary or secondary resistance (Tanwar *et al.*, 2014).

Primary resistance:

This particular type of resistance occurs when the microbe has not been known to the particular drug in the person i.e. the particular person has not experienced to the particular dosage of drug (Mathur, *et al.*, 2000; Paramasivan *et al.*, 2000; Hemvani *et al.*, 2001). Tuberculosis drugs are the best example of primary resistance. Primary drug resistance are mainly caused by the dissemination of drug-resistant strains (Jassal and Bishai, 2009).

Secondary resistance:

If the drug resistance occurs in an particular organism after an exposure to the drug, it is known as secondary resistance (Loeffler and Stevens, 2003; Khalilzadeh *et al.*, 2006). This resistance can be commonly seen in the patients of chemotherapy (Mathur, et al., 2000; Paramasivan *et al.*, 2000; Hemvani *et al.*, 2001; Van Rie, *et al.*, 2000).

Mechanism Of Multidrug Resistance:**Mutational Modifications**

Man-made antibiotics like fluoroquinones are mostly inactivated by the enzymatic mutations. The target protein gets altered due to mutational conformation. Fluoroquinolone resistance occurs mainly by mutations of DNA topoisomerase enzyme. Fluoroquinolones usually kill the bacterial cell with drug susceptibility enzyme. Here, the gene coding for a drug-resistant enzyme will not allow the bacteria to be resistant, and hence plasmid-mediated transfer of the mutated target gene may occur.

Sulfa drugs are usually selected for drug-resistant mutants of the selective enzymes. The production of drug-resistant target enzymes from plasmids can make the bacteria resistant, and the resistant genes will mostly rely on plasmids.

Inactivation of Enzymatic Compounds

The aminoglycoside drugs related to kanamycin, tobramycin, and amikacin, are mostly inactivated by enzymatic phosphorylation with the enzyme aminoglycoside phosphoryltransferase and aminoglycoside acetyltransferase. The β -lactam antibiotics like penicillins, cephalosporins, and carbapenems are mostly inactivated by enzymatic hydrolysis of β -lactamases. The genes coding for this inactivating enzymes produce resistance related to the genetic components, with special reference to plasmids.

Target Bypassing Genes

The antibiotic Vancomycin, is the fermentation product obtained from the microbe Streptomyces. Here, there is no possibility of inhibiting an enzyme, instead there is binding of enzyme to the substrate.

the lipid-linked disaccharidepentapeptide attach to the precursor in the peptidoglycan, present in bacterial cell wall. So, it is very difficult to create resistance towards vancomycin. Nowadays the vancomycin antibiotic resistance is prevalent among the normal flora of intestinal tract Enterococci. The enterococci are resistant to β -lactam antibiotics, aminoglycosides, macrolides, and tetracycline. They become dominant in a hospital environment causing nosocomial infection, that are highly dangerous to treat.

The antibiotic resistance mechanism of this particular antibiotic showed the end product pentapeptide, D-Ala-D-Ala. Here, vancomycin binding occurs, and they are replaced by an ester component D-Ala-D-lactic acid, and this compound cannot be accepted by vancomycin.

Prevention of Target

Normally, the drug access to the target can be reduced locally or by active efflux process. In gram-negative bacteria, the access can be reduced by decreasing the influx across the outer membrane barrier.

Tet(M) or Tet(S) proteins, produced by plasmid-coded genes in gram-positive bacteria, bind to ribosomes with high affinity and solely change the ribosomal conformation, and prevent the association of tetracyclines to ribosomes. Plasmid-coded Qnr proteins are now more prevalent to protect DNA topoisomerases from quinolone compounds.

REFERENCE:

1. Magiorakos, P., Srinivasan, A., Carey, R. B., Carmeli, Y., Falagas, E., Giske C. G., Harbath, J.F. (2011). Multi-drug resistant, extensively drug resistant and pan drug resistant bacteria. *Clinical microbiology and infection*. 8: 12-19.
2. World Health Organization. 10 Facts on Antimicrobial Resistance. Available online: <http://www.who.int/>

features/factfiles/antimicrobial_resistance/en/ (accessed on 10 June 2018).

3. Tanwar, J., Das, S., Fatima, Z. and Hameed, S. (2014). Multidrug Resistance: An Emerging Crisis. *Interdisciplinary Perspectives on Infectious Diseases*. pp 1-7.
4. Mathur, M.L., Khatri, P.K. and Base, C.S. (2000). Drug resistance in tuberculosis patients in Jodhpur district. *Indian Journal of Medical Science*. 54: 55-8.
5. Paramasivan, C.N., Bhaskaran, K., Venkataraman, P., Chandrasekaran, V. and Narayanan, P.R. (2000). Surveillance of drug resistance in tuberculosis in the state of Tamil Nadu. *Indian Journal of Tuberculosis*, 47:27-33.
6. Hemvani, N., Chitnis, D.S., Bhatia, G.C. and Sharma N.(2001). Drug resistance among tubercle bacilli from pulmonary tuberculosis cases in central India. *Indian Journal of Medical Science*.55: 382-92.
7. Jassal, M. and Bishai, W.R. (2009). Extensively drug-resistant tuberculosis. *The Lancet Infectious Diseases*.9:1930.
8. Loeffler, J. and Stevens, D. A. (2003). Antifungal drug resistance, *Clinical Infectious Diseases*, 36(1): pp. S31–S41.

9. Khalilzadeh, S., Boloorsaz, M.R., Safavi, A., Farnia, P. and Velayati, A.A.(2006). “Primary and acquired drug resistance in childhood tuberculosis,” Eastern Mediterranean Health Journal. 12 (6) 909–914.
10. Van Rie, A., Warren, R. and Richardson, M. (2000). Classification of drug-resistant tuberculosis in an epidemic area. The Lancet Infectious Diseases. 356:22-5.

Chapter–XVII

17

STRATEGIC HUMAN RESOURCE MANAGEMENT

V.RAJESWARI

**Assistant Professor of Business Administration,
Excel College for Commerce and Science,
Namakkal, Tamil Nadu.
E-Mail: rajivibooshna@gmail.com**

R.Shanthi

**Associate Professor
PG & Research Department of Commerce CA
Kaamadhenu Arts and Science College,
Sathyamangalam.
E-mail: rangasamyshanthi@gmail.com**

INTRODUCTION:

In today's digital era, the role of HR has been at risk of being downgraded to position different from those that come into core business goals. Furthermore, the challenges of handling operations with a constantly evolving workflow made the HR leaders emphasize on improving workplace productivity to assist businesses in staying ahead of their competitors. This gives birth to the concept of SHRM. Strategic Human Resource Management (SHRM) is set of processes to develop and implement effective HR practices within the organization. Which is include Hiring, Developing, Retaining and Rewarding Employees while ensuring they are treated fairly.

Keywords: Human Resource, Strategic, Effectiveness, Outcome.

MEANING AND DEFINITION OF SHRM:

Meaning of SHRM:

Strategic Human Resource Management (SHRM) means managing HR practices and operations in such a way that they connect or join workforce with the core goals, objectives and strategic of the company. It covers the establishing practices that promote flexibility to give an edge over competitors and ensuring superior workplace productivity and most important to building a fun and an engaging workplace effectively.

The main aim of SHRM is to ensure that the organizations culture, style, structure, employee quality, commitment and motivation contribute fully to achieving business goal and objectives.

Definition of SHRM:

Professionals define SHRM from a different perspective. Some of the important definitions are listed below:

“Strategic Human Resource Management means formulating and executing human resource policies and practices that produce the employee competencies and behaviors that the company needs to achieve its strategic aims.”- Gary Dessler.

“Strategic Human Resource Management is an approach to making decisions on the intentions and plans of the organization concerning the employment relationship and the organization’s recruitment, training, development, performance management and the organizations strategies, policies and practices” – Armstrong.

Strategic Human Resource Management (SHRM) is define as “The pattern of planned human resource deployments and activities intended to enable an organization to achieve its goals.” – Wright & McMahan

SHRM focuses on actions that differentiate the firm from its competitors (Purcell, 1999). It is suggested by Hendry and Pettigrew (1986) that has these

meanings:

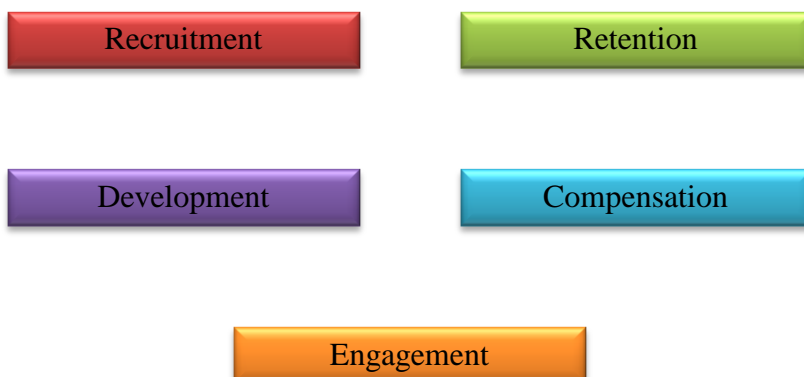
- The use of planning,
- A coherent approach to the design and management of personnel,
- Systems based on an employment policy and workforce strategy and often underpinned by a 'Philosophy'.

THE OBJECTIVES OF STRATEGIC HUMAN RESOURCE MANAGEMENT:

Strategic HR planning stresses resolving issues like-

- Hierarchy structure
- Performance challenges
- Organization culture
- Role matching
- Effectiveness of operations

However, there are five key objectives of SHRM principles:



Recruitment:

Hire the right people for the job.

Retention:

Keep good employees from leaving the company.

Development:

Provide training and career advancement opportunities so employees can grow within the organization.

Compensation:

Pay employees fairly based on their skills and experience level.

Engagement:

Make employees feel like their opinions matter by including them in decision making processes.

- The main components of SHRM focuses on an organizations human resources people as the primary source of the organizations competitive advantages.
- The activities highlight the HR programs, policies and practices as the means through which the organizations people can be deployed to gain a competitive advantages.
- The pattern and plan imply a fit between strategy and the organizations business strategy (vertical fit) and all HR activities (Horizontal fit).
- The people, practices and planned patterns are purposeful and directed towards achieving the organizations goals.

A COMPREHENSIVE APPROACH SHRM:

Strategic HR management integrated system the HR department becomes a key player in business growth and development. Companies implementing strategic HR policies have an HR department connecting with every business vertical including marketing, operations or IT. It assists in creating business plans that are well synced with company goals and overall company objectives.

Moreover Strategic HR Management also lets you focus on the proper utilization of opportunities and talent available within the organization to benefit everyone.

WHAT LEADS TO THIS DIFFERENCE?

The quality of HR and their contribution to the organization determine its performance and therefore, its success. An organization uses a combination of several tangible and intangible resources to pursue its objectives. There mainly grouped into three basic types.

- Physical capital resources- the plant, equipment and finances.
- Organizational capital resources- the organizations structure planning, HR systems, history and organizational culture.
- Human capital resources- the employees skills, knowledge, judgment and intelligence.

Every organization may have huge capital and the most advanced machinery but if it does not have capable, motivated and high-performing employees, it is not likely to demonstrate sustained levels of high performance. Since all physical and capital resources depend on people for efficient use, management and maintenance the effective and quality an organization's people is important in attaining a competitive advantage.

TRADITIONAL HRM VERSUS SHRM:

Strategic human resource management and the traditional HR function differ in several ways. The major differences are given below.

S.No	Particulars	Traditional HRM	SHRM
1.	Responsibility	HR Staff Personnel only.	Line Managers.
2.	Focus of activities	Employee relations.	Partnership with internal and external groups.
3.	Role	Transactional and Reactive	Transformational and Proactive.
4.	Initiative for change	Slow	Fast
5.	Time horizon	Short-term	Consider various time frames as necessary.
6.	Control	Bureaucratic	Organic Control

		Control	
7.	Job design	Focus on scientific management principles.	Broad job design.
8.	Important investments	Capital, Products, Technology and Finance.	People and their knowledge, skills and abilities.
9.	Accountability	Cost Center.	Investment Center.

HOW DOES STRATEGIC HUMAN RESOURCE MANAGEMENT (SHRM) WORK?

SHRM planning is vital in developing HR and retaining the best talent. It helps businesses to make their employees feel appreciated and valued, so they are always motivated to work with your company. But before moving ahead, they require effective and efficient HR strategic planning with the help of the following steps:

- Identify the gaps in HR processes within your organization.
- Investigate why these gaps exist, and who is affected by them.
- Brainstorm with HR professionals and key stakeholders to generate ideas for making these changes happen.
- Determine what changes need to be made based on the results of your investigation.

- Select the most promising ideas based on their impact on employees, cost to implement, and impact on other parts of the organization.
- Document these ideas as a list of actionable that can be used in your organizations overall strategic HR planning process.

HERE ARE SOME BENEFITS OF STRATEGIC HR MANAGEMENT:

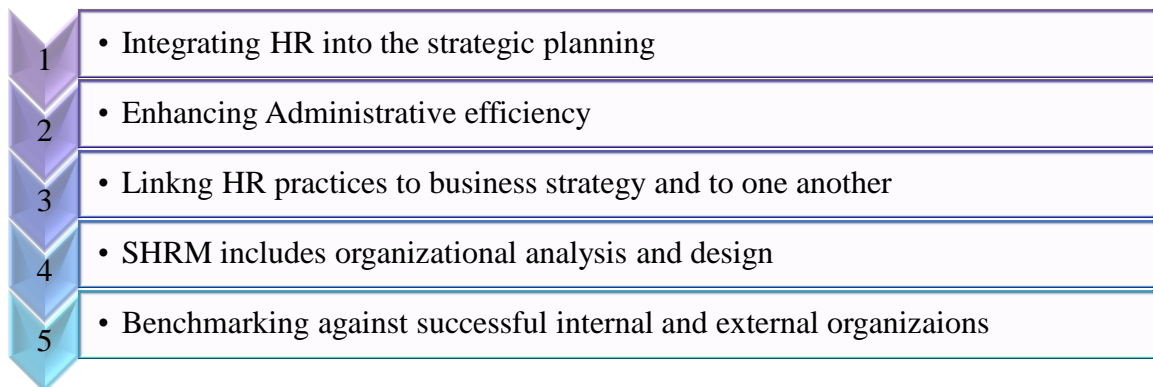
- Improved work culture
- Boosted productivity
- Increased employee retention
- Better resource management
- Enhanced customer satisfaction score
- A proactive way to manage the workforce.

ESSENTIAL ELEMENT OF SHRM:

- Change in structure
- Change is culture
- Development of distinctive activities
- Organizational performance
- Development of process capability
- The ability to get things done effectively
- People issues that are affected by the strategic plans of the organization

- Organizational effectiveness
- Human capital requirements
- The management change
- The development of knowledge management.

IMPORTANT FACTORS OF SHRM:



PLANNING AND IMPLEMENTING HR POLICIES:



1. Staffing:

It includes the development of a strategic plan to determine how many

people you might need to hire. Based on strategic plan HRM performs the hiring process to recruit and select the right people for the right job.

2. Basic workplace policies:

Development of policies help to reach the strategic plans goals is the job of SHRM.

3. Compensation & Benefits:

Plans in addition to paychecks, health benefits & other perks, implementing all strategies as per the plans.

4. Retention:

Assessment of employees & strategies on how to retain best employees is a task that HR manager oversee. Others will also provide input.

5. Training & Development:

Helping new employees develop skills needed for their jobs and helping current employees grow their skills are also tasks for that HRM department is responsible.

6. Regulatory issues and worker safety:

Keeping up to date on new regulation relating to employment. Health care and other issues is generally a responsibility that falls on the HRM.

STRATEGIC ROLE OF HRM:

The main aim of SHRM is to gain competitive advantages by using of HRM.

SHRM practice is coupled with business strategy. It includes analysis of business and socio-practical environment. HR professionals must be aware of global business and social trends and should be able to perform environmental scanning. HR professionals must analyze human resources against current and future business strategies and identify the gaps between them. The few important strategic roles played by HR manager given below.

A). STRATEGIC ROLE:

- HR Manager participates in business decisions.
- HR Manager can translate corporate strategy into human resource strategy.
- Create value
- HR helps employees satisfy customer's needs.

B). INFORMATIONAL AND PROBLEM SOLVING ROLE:

- HR managers provides information and expertise on the best practices in other companies.
- They collect, disseminate and otherwise make available important information to aid in strategic planning and daily work activities and decision.
- HR diagnoses and recommends solutions to problems arising in employment relations.

C). STRATEGIC FUNCTIONAL ROLE:

- HR helps select employees to fit both strategy and culture.
- They assists in designing benefits to complement strategy.
- To motivate employees and reward system provide.
- Planning performance and appraisal systems.

D). ADMINISTRATIVE ROLE:

- HR assists in designing and improving personnel administrative systems.
- HR does mush of the necessary administrative work involved in employment, legal compliance and record keeping.

STRATEGY FORMULATION:

A). Corporate level

B). Business unit level

C). Functional level

A). CORPORATE LEVEL:

The corporate level strategy is to continuously innovate in all its businesses with the right technology, relentlessly cut cost and focus on the overseas markets. The major questions that need to be answered at this stage are- what kinds of business should the company be engaged? What are the goals and expectations for each business? How should resources be allocated to reach these goal?

B). BUSINESS UNIT LEVEL:

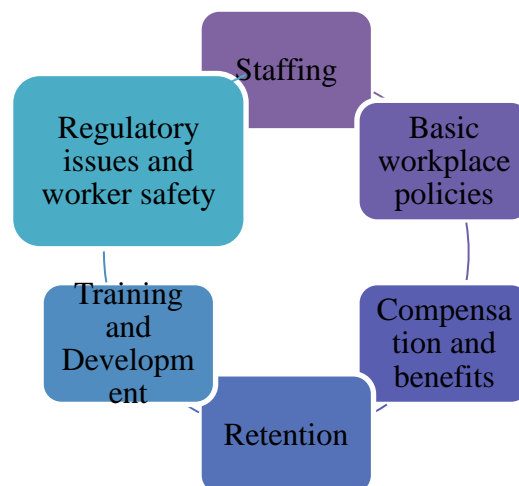
A business unit is an organizational subsystem that has a market, a set of competitors, and a goal distinct from those of the other subsystems in the group.

C). FUNCTIONAL LEVEL:

In formulating functional level strategies, managers must be aware that the different functions are interrelated. A change in one department will invariably affect the way other departments operated. Hence the strategy of one functional area cannot be viewed in isolation. Rather the extent to which all functional strategies are integrated determines the effectiveness of the unit's business strategy.

PLANNING AND IMPLEMENTING STRATEGIC HR POLICIES:

HR strategy is an elaborate and systematic plan of action developed by a human resource department. Here some planning and implementing strategic HR polices are given below.



A). STAFFING:

It includes the development of strategic plan to determine how many people you might need to hire. The main motive of the process is to pick the right candidate for the right jobs.

B). BASIC WORKPLCE POLICIES:

The policies have been developed, communication of these polices on safety , security, scheduling, vacation times, and flextime schedule should be developed by the HR department HR managers closely with supervisors in organizations to develop the policies, workplace policies will be addressed throughout the book.

C). COMPENSATION AND BENEFITS:

The responsibilities of an HR manager is to paychecks, health benefits and other perks are in addition.

D). RETENTION:

The main assessment of HR is to retain the best employees in the organization with using best strategies. HR managers oversee, but other managers in the organization will also provide input.

E). TRAINING AND DEVELOPMENT:

HR Department responsibility is to helping new employee's skills for helping their jobs. Determination of training needs and development and

implementation are important tasks in any organization.

F). REGULATORY ISSUES AND WORKERS SAFETY:

HR keeping up to date on new regulations regulating to employment, health care and other issues generally a responsibility that falls on the HRM department.

THE STRATEGIC HR PLANNING PROCESS:

The strategic HR planning process have four steps that are to be given below.

- 1) Assessing the current HR capacity.
- 2) Forecasting HR recruitment
- 3) Gap analysis
- 4) Developing HR strategies to support organizational strategies

1. ASSESSING THE CURRENT HR CAPACITY:

Based organizations strategic plans the first step in the HR planning process is to assess the current HR capacity of the organization. The knowledge, skills and abilities of your current staff need to be identified. This can be done by developing a skills inventory for each employees.

2. FORECASTING HR REQUIREMENTS:

Realistic forecasting of human resources involves estimating both demand and supply. When forecasting demands for HR we must also assess the

challenges that you will have in meeting your staffing need based on the external environment. How many staff will be required to achieve the strategic goals of the organization? What jobs will need to be filled? What skill sets will people need? And how will the external environment impact on our HR needs?

3. GAP ANALYSIS:

The gap analysis includes identifying the number of staff and the skills and abilities required in the future in comparison to the current situation. One should also look at all your organization's HR management practices to identify practices that could be improved or new practices needed to support the organization's capacity to move forward.

4. DEVELOPING HR STRATEGIES TO SUPPORT ORGANIZATIONAL STRATEGIES:

Here there are five HR strategies for meeting your organizations needs in the future.

- Restructuring
- Training and Development
- Recruitment
- Outsourcing
- Collaboration

HR STRATEGIES TO IMPROVE FIRMS PERFORMANCE:

- a) Make clear goal and expectations
- b) Empower employees to do their best work
- c) Hold team members accountable to goals
- d) Reward high performance
- e) Foster a fun, positive work environment
- f) Increase job satisfaction
- g) Consider remote working options
- h) Use the right technologies

CONCLUSION:

Strategic Human Resource Management (SHRM) is a main process that helps organization achieve their goals and objectives by better effort or managing their workforce. The time taking to develop a SHRM plan companies can ensure that they have the right people in place to achieve their goals and objectives. While developing a SHRM plan can be time- consuming, the benefits of the cost. Not only that it will helps to retain the top talent and keep your employees engaged in their work.

REFERENCES:

1. *Baird L and Meshoulam I (1988)* 'Managing Two Fits of Strategic Human Resource Management. Academic of Management Reviews.
2. *Butler, J.E., Ferris G.R. and Napier N.K (1991)* Strategic and Human Resource Management. Management Journal.

Chapter–XVIII

18

MALDI-TOF MASS SPECTROMETRY AS A RELIABLE SPECTROSCOPIC TOOL TO DIFFERENTIATE *PLUMBAGO* SPECIES

T. Renisheya Joy Jeba Malar

Assistant Professor*, Pg and Research Department of
Nutrition and Dietetics,
Muslim Arts College, Thiruvithancode,
Kanyakumari District, Tamil Nadu, India.

M. Johnson

Assistant Professor, Centre for Plant Biotechnology,
Department of Botany,
St. Xavier's College (Autonomous), Palayamkottai - 627 002,
Tamil Nadu, India

E-mail: renibjoy@gmail.com

Abstract

Matrix-Assisted Laser Desorption/Ionisation (MALDI) mass spectrometry uses the power of high mass resolution time of flight (TOF) mass spectrometry coupled to the raster of lasers shots across the cut surface of tissues to provide new insights into the spatial distribution of bio-molecules within biological tissues. In the present study, Protein biomarker identification from MALDI-TOF MS analysis was used as a efficient spectroscopic and taxonomic tool to differentiate the protein expression of three *Plumbago* species viz., *Plumbago zeylanica* Linn., *Plumbago auriculata* L., *Plumbago rosea* L. collected from Karnataka. Following a simple protein isolation procedure, plant proteins were fingerprinted by analysing biomarker cellular proteins ranged from 0 - 1, 00, 000 kDa or m/z values using Matrix Assisted Laser Desorption/Ionization Time of Flight (MALDI-TOF) mass spectrometry. Totally 31 spectral peak values / m/z values were selected. The obtained spectral profiles were further screened for the presence of recurring peaks or biomarker ions specific for all the species. Based on the unique spectral values the cladogram was constructed. Database MASCOT search provides a assumption of the related protein in the particular kDa. These ionic unique spectral peaks obtained from the three different *Plumbago* species offer a strong proof in differentiating the selected *Plumbago* species and paved a way to study the similarity and variation among the species

using MALDI-TOF MS analysis. The mass spectral values are higher in *P. zeylanica* species compared to other two species. This is the first report on protein identification and variation among *Plumbago* species.

Keywords: *Plumbago* species, MALDI-TOF MS, proteins, mass spectral values, cladogram

Introduction

Proteomics has become an important research tool to study complex biological systems in the post-genomics era, and the large-scale, systematic analysis of tissue and organelle specific proteins provides a more direct view of cellular processes not available through the measurement of DNA. Proteomics can provide insight on the specialized biochemistry of distinct tissues, protein localization, protein-protein interactions, enzymatic complexes, protein-metabolite complexes, post-translational modifications, and cellular signaling (B. Kersten *et al.*, 2002; S. Baginsky, 2009). MALDI is fast and efficient and has a high tolerance to non-volatile buffers and impurities (F. Hillenkamp *et al.*, 1991; J. Hardouin, 2007). The samples for MALDI are typically applied to solid supports and used off-line from liquid or gel separations (K.L. Walker *et al.*, 1995, T. Rejtar *et al.*, 2002). The MALDI-TOF MS technique analyzes peptides and represents a rough equivalent to sequencing, making this method a useful adjunct for determination of species limits. It also allows simple, reliable, and

quick species identification, thus representing a valid alternative to gene sequencing for species diagnosis of bacterial and plant taxa (Sophie De Respinis *et al.*, 2010). Using this technology it has been estimated that up to 99% of species tested are correctly identified when comparing with commercial phenotypic identification panels or gene sequencing (C.A. Chen *et al.*, 2009, A. Bizzini *et al.*, 2010, A. Cherkaoui *et al.*, 2010). Chuntaratin, (2006) studied the plumbagin protein conjugated glutaraldehyde reaction in *P. indica* using MALDI-TOF MS analysis. The plant species *Plumbago zeylanica* (Plumbaginaceae), known vernacularly as Chitraka and popularly as Ceylon Leadwort, is distributed as a weed throughout the tropical and subtropical countries of the world. The genus *Plumbago* includes 3 species viz., *Plumbago indica* L. (*P. rosea* L.), *P. auriculata* L., and *P. zeylanica* L., which are distributed in several parts of India (K.M. Chetty *et al.*, 2006). The roots of the *Plumbago* species contain an alkaloid called plumbagin, a natural naphthaquinone (5-hydroxy-2-methyl-1, 4-naphthoquinone), possessing various pharmacological activities such as anti-malarial (N. Didry *et al.*, 1994), antioxidant activity (G. Nahak and Sahu R.K. 2011) anticancer, cardiogenic, antifertility action, antibiotic and antineoplastic (K.R. Kiritkar and B.D. Basu, 1975, M. Krishnaswamy and K.K. Purushottamam, 1980, N.G.K. Pillai *et al.*, 1981). Its other constituents in roots are chitranone, zeylanone, dihydrosterone, 2- methyl naphthaquin, plumbazeylanone and

terpenoids, lupeol and teraxesterol. The plant also contains alkaloids, glycosides, tannin, saponins and steroids (R.R. Chakraborty and A.T. Patil, 1997). The roots are used extensively in China and other Asian countries for the treatment of cancer, rheumatoid arthritis, dysmenorrhoea, and contusion of extremities (Atta-ur-Rahman, 1988). Extract of the root is given internally or applied to the *Ostium uteri*, causes abortion (P. Premakumari et al., 1977, S.K. Bharghava, 1984). Matrix-assisted laser desorption/ionization TOF mass spectrometry (MALDI-TOF MS) is an important proteomic technology. The protein biomarkers of the selected *Plumbago* species have been indicated by using MALDI-TOF MS to analyze the variation and similarity among them. The goal of this study was to screen for protein biomarkers in the selected *Plumbago* species using MALDI-TOF MS combined with magnetic beads and pattern recognition software.

MATERIALS AND METHODS

Collection of plant materials

The aerial parts of *P. zeylanica*, *P. auriculata* and *P. rosea* were collected from different parts of Tamil Nadu, South India. *P. zeylanica* were collected from Papanasam (Tamil Nadu), *P. auriculata* were collected from Tenkasi (Tamil Nadu) and *P. rosea* were collected from Dana (Tamil Nadu) respectively. The collected species of *Plumbago* were identified by taxonomist from St. Xavier's college, Palayamkottai and the Herbarium specimens were deposited in the St.

Xavier's College Herbarium (XCH), Palayamkottai (*P. zeylanica* – XCH 28089; *P. auriculata* – XCH 28093 and *P. rosea* – XCH 28101).

MALDI -TOF MS Analysis

MALDI spectrum of *Plumbago* species were recorded using Applied Biosystems MALDI-TOF Voyager De-Pro spectrometer. The MALDI sample was prepared by mixing 1 μ L of protein sample solution and sinapic acid matrix solution (5 mg/mL sinapic acid in 50% ACN/0.1% TFA). 0.75 μ L of the resulting mixture was spotted onto a freshly cleaned stain less steel MALDI target plate. After air drying, the crystallized spots were processed with a MALDI-TOF mass spectrometer (Voyager DE PRO) (Applied Biosystem). MS was recorded in the positive and negative mode within a mass range from 0 - 1, 00, 000 kDa, using a nitrogen laser (337 nm). The acceleration voltages applied for MS was 25 kV.

Result

MALDI-TOF MS characterization of *Plumbago* species collected from Karnataka showed a proximate spectra of varied ion peaks m/z ranged from 0 - 1,00,000 kDa. The results of MALDI-TOF MS analysis showed both positive and negative peaks; to reveal the inter-specific similarity and variation between the *Plumbago* species, the positive peaks were selected. The obtained spectral profiles were further screened for the presence of recurring peaks or biomarker ions specific for all the species. Based on the unique spectral values the cladogram was

constructed. Totally 31 spectral peak values / m/z values were selected and summarized in Table-1. Among the three *Plumbago* species, *Plumbago zeylanica* represented maximum number (21) of m/z peaks ranged from 1242 to 39429 m/z values; of which sixteen specific peaks were observed only in the *P. zeylanica*. Next to that, the *Plumbago auriculata* demonstrated nine m/z peaks ranged from 1422 - 92970 respectively. Out of nine peaks, only five unique peaks were observed in *P. auriculata*. Similarly, *Plumbago rosea* depicted two distinct spectral values 822 and 4058 respectively. These ionic unique spectral peaks of the *Plumbago* species collected from various accessions offer a strong proof in differentiating the selected accession and paved a way to study the similarity and variation among the accession using MALDI-TOF MS analysis [Fig.1].

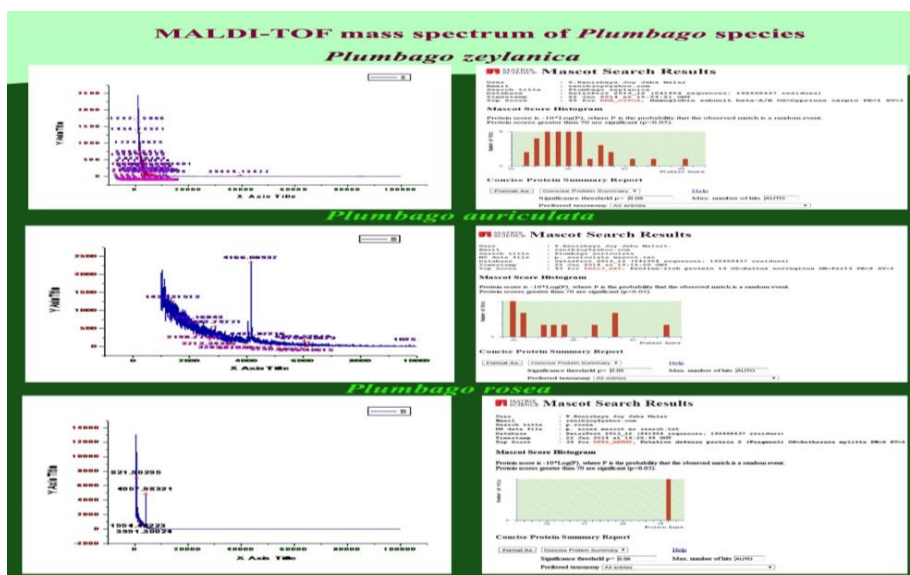


Fig.1 MALDITOF- MS of *Plumbago* species

Table - 1: Mass spectral (m/z) values of *Plumbago* species

<i>Plumbago</i> species m/z peak values		
<i>P. zeylanica</i>	<i>P. auriculata</i>	<i>P. rosea</i>
1242		822
1454	1422	
1724		
2047		
2446	2246	
2829	2883	
3111		
3367		
3602		
4124	4167	4058
4365		
4785		
5293		
5708		
6254	6198	
6821		
7479	10254	
9062	56644	
10441	82260	
39429	92970	

The cladogram constructed based on the MALDI TOF-MS analysis and the results revealed the inter-specific variations and similarities among the *Plumbago* species collected from South India viz., *Plumbago zeylanica*, *Plumbago auriculata* and *Plumbago rosea*. The cladogram distinguished two clades viz., C₁ and C₂ based on the m/z peak values. Clade 1 (C₁) was shared by *P. zeylanica* and *P. auriculata*. Clade 2 (C₂) showed the individual presence of the *P. rosea*. The exclusive presence of the *P. rosea* in a separate clade₂ represented the presence

of some unique m/z peaks compared to other accessions [Fig. 2]. These MALDI-TOF MS spectroscopic profile can act as a biological spectroscopic tool to study the inter-specific variation and similarity of selected *Plumbago* species collected from South India.

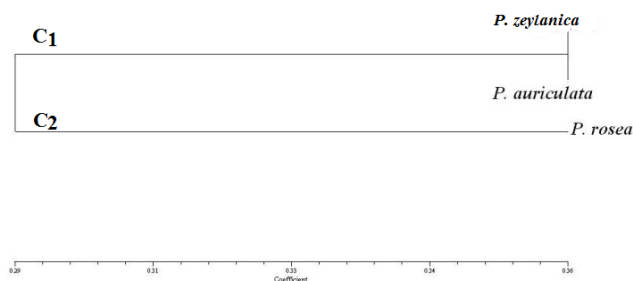


Fig. 2: Cladogram based on MALDI-TOF MS m/z values of *Plumbago* species

Protein Identification

In the MALDI-TOF MS analysis, the protein was identified with significant hits [$p < 0.05$] in MASCOT probability analysis. The MASCOT peptide mass fingerprint search represented varied proteins related to the m/z values among these the top score value was selected for the protein identification. The MASCOT peptide mass fingerprint search for *P. zeylanica* shows the mass value as 16251 kDa with the top score sequence coverage as 45% revealed the Hemoglobin subunit beta-A/B protein. The MASCOT peptide mass fingerprint search for *P. auriculata* shows the mass value as 14325 kDa with the top score sequence coverage as 43% revealed the Proline-rich protein. The MASCOT peptide mass fingerprint search for *P. rosea* shows the mass value as 17273 kDa with the top score

sequence coverage as 39 % revealed the Putative defense protein 2. The MASCOT results were displayed in Fig.1.

Discussion

MALDI-TOF MS analysis accurately reflected the phylogenetic classification, in most cases, species identified by DNA sequence analysis clustered together by MALDI-TOF MS. The resolution of MALDI-TOF MS was performed roughly equivalent to ITS rDNA. The MALDI-TOF MS technique analyzes peptides and represents a rough equivalent to sequencing, thus representing a valid alternative for taxonomic identification of plants (Respinis *et al.*, (2010). Chuntaratin, (2006) studied the plumbagin protein conjugation by glutaraldehyde reaction using MALDI-TOF MS. By means of MALDI-TOF MS analysis it was confirmed that the molecular weight of the proteins of plumbagin-protein conjugate band was higher than the normal protein showing the molecular weight of 72817.704 and 66564.232. The present research showed a proximate spectra of varied ion peaks (m/z) ranged from 0 - 1, 00, 000 in correspondence to varied intensities were recorded in the peptide mass finger printing profile of individual *Plumbago* species.

Respinis *et al.*, (2010) investigated the peptide mass finger printing profile of 129 morphologically similar strains of *Hypocrea* and *Trichoderma* species using MALDI-TOF MS analysis and the single linkage cluster analysis was used to study

the phylogenetic variation. The results were compared using ITS and tef1 sequences. Dominating peaks were observed in two different mass ranges. The most important one was situated between m/z 6,000 and 8,000. In the present study, MALDI-TOF MS analysis was carried out among the selected *Plumbago* species collected from different accessions of South India. The resulting peak lists of individual samples were submitted to NTSYs software to produce a taxonomic tree to reveal the inter-specific and intra-specific variation. Among the three *Plumbago* species, *Plumbago zeylanica* represented maximum number (21) of m/z peaks ranged from 1242 to 39429 m/z values. Next to that, the *Plumbago auriculata* demonstrated nine m/z peaks ranged from 1422 – 92970. Similarly, *Plumbago rosea* depicted two distinct spectral values 822 and 4058 respectively. From the research it was reinforced that, MALDI-TOF MS analysis was used as a taxonomic tool to study the similarity among the selected species and is a quick and reliable tool for species identification which can be a valid alternative to gene sequencing for species diagnosis. The primary advantage of MALDI-TOF MS is the speed by which identification can be made. The MALDI-TOF MS analysis can be completed in a few minutes as opposed to two or more days required for DNA sequence analysis (I.S. Druzhinina *et al.*, 2008, M.R. Hermosa *et al.*, 2004, G.J. Samuels and A. Ismaiel, 2006). Neuhof *et al.*, (2007) proposed the hypothesis that these proteins could be optimal biomarkers at the

inter-specific and intra-specific level. The hypothesis of (C.A. Rebuffo *et al.*, 2006) correlated with the present study demonstrating the MALDI-TOF MS analysis as a biomarker to differentiate the *Plumbago* species collected from various accessions of South India.

Conclusion

MALDI-TOF MS are an effective strategy for determining the protein domains. The similarity and variation among the selected *Plumbago* species were observed through MALDI-TOF MS analysis and Swiss prot database. While comparing the sequence coverage in MASCOT search value the lowest average sequence coverage was identified in the protein samples of *P. rosea* 39% compared to other two *Plumbago* species, the peptides detected are confined to a specific region of the protein, such as the protein N- or C-terminal. This information could easily be incorporated into protein identification tables. Regional coverage information is not readily available from either MS analysis. Some of the protein fragments correspond to chains produced by known cellular processing and activation pathways were detected and compared. Others have been detected as functional and structural domains (Fig.1). By using tools that allow both protein identification and measurement of molecular weight, we can assess the abundance and distribution of protein fragments. Correlation of these results with targeted functional studies on specific proteins will elucidate the

biological function of protein fragments. Thus, the present m/z values of MALDI-TOF MS analysis acted as a spectroscopic tool to recognise the inter-specific variation among the selected *Plumbago* species.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

Financial Support: The author (Renisheya Joy Jeba Malar Tharmaraj) is thankful to Department of Science and Technology, Govt. of India for providing financial assistance (Ref. No. IF110640) through DST-INSPIRE Fellowship.

References

- [1] B. Kersten, L. Bürkle, E.J. Kuhn, P. Giavalisco, Z. Konthur and A. Lueking, "Large-scale plant proteomics", *Plant Molecular Biology*, vol. 48, pp.133–141, 2002.
- [2] S. Baginsky, "Plant proteomics: concepts, applications, and novel strategies for data interpretation", *Mass Spectrometry*, vol. 28, pp. 93–120, 2009.
- [3] F. Hillenkamp, M. Karas, R.C. Beavis, and B.T. Chait, "Matrix- assisted laser desorption/ionization mass spectrometry of biopolymers", *Analytical Chemistry*, vol. 63, pp. 1193–1203, 1991.
- [4] J. Hardouin, "Protein sequence information by matrix assisted laser desorption/ionization in-source decay mass spectrometry". *Mass Spectrometry*,

vol. 26, pp. 672–682, 2007.

[5] K.L. Walker, R.W. Chiu, C. A. Monnig and C.A. Wilkins, “Off-line coupling of capillary electrophoresis and matrix-assisted laser desorption/ ionization time-of-flight mass spectrometry”. *Analytical Chemistry*, vol. 67, pp. 4197–4204, 1995.

[6] T. Rejtar, P. Hu, P. Juhasz, J.M. Campbell, M.L. Vestal and Preisler. J, “Off-line coupling of high- resolution capillary electrophoresis to MALDI-TOF and TOF/TOFMS”, *Journal of Proteomic Research*, vol. 1, pp. 171–179, 2002.

[7] Sophie De Respinis, Guido Vogel, Cinzia Benagli, Mauro Tonolla, Orlando Petrini and G.J. Samuels, “MALDI-TOF MS of *Trichoderma*: a model system for the identification of micro fungi”, *Mycol Progress*, vol. 9, pp. 79-100, 2010.

[8] C.A. Chen, H.H. Chang, C.Y. Kao, T.H. Tsai and Y.J. Chen, “Plumbagin, isolated from *Plumbago zeylanica*, induces cell death through apoptosis in human pancreatic cancer cells”, *Pancreatology*, vol. 9 no.6, 797-809, 2009.

[9] A. Bizzini, C. Durussel, J. Bille, G. Greuba and G. Prodhom, “Performance of matrix-assisted laser desorption/ionization time-of-flight mass spectrometry for the identification of bacterial strains routinely isolated in a clinical microbiology laboratory”, *Journal of Clinical Microbiology*, vol. 48, pp.1549–1554, 2010.

[10] A. Cherkaoui, J. Hibbs, S. Emonet, M. Tangomo and M. Girard, “Comparison of two matrix-assisted laser desorption ionization-time of flight mass

spectrometry methods with conventional phenotypic identification for routine identification of bacteria to the species level”, *Journal of Clinical Microbiology*, vol. 48, pp. 1169–1175, 2010.

[11] R. Giebel, C. Worden, S.M. Rust, G.T. Kleinheinz and M. Robbins, “Microbial fingerprinting using matrix-assisted laser desorption ionization time of- flight mass spectrometry (MALDI-TOF MS) Applications and Challenges”, *Advances in applied microbiology*, vol. 71, pp. 149–184, 2010.

[12] Petcharut Chuntaratin, “Production of plumbagin by hairy root, callus and cell suspension cultures of *Plumbago indica* L”, Ph. D. Thesis, Graduate school, Kasetsart University, 2006.

[13] K.M. Chetty, K. Sivaji, G. Sudarsanam and P. Hindusekar, “Pharmaceutical studies and therapeutic uses of *Plumbago zeylanica* Linn roots (Chitraka, Chitramulamu)”, *Ethnobotanical Leaflets*, vol. 10, pp. 294-304, 2006.

[14] N. Didry, L. Dubrevil and M. Pinkas, “Activity of anthraquinonic and naphthoquinonic compounds on oral bacteria”, *Die Pharmazie*, vol. 49, pp. 681-683, 1994.

[15] G. Nahak and R.K. Sahu, “Antioxidant activity of *Plumbago zeylanica* and *Plumbago rosea* belonging to family plumbaginaceae”, *Natural Product: An Indian Journal*, vol. 7 no. 2, pp. 51-56, 2011.

[16] K.R. Kiritkar and B.D. Basu, “Indian Medicinal Plants”, Indo logical and

Oriental Publishers, Delhi, India 1975.

[17] M. Krishnaswamy and K.K. Purushottamam, "Plumbagin, a study of its anticancer, antibacterial and antifungal properties", *Indian Journal of Experimental Biology*, vol. 18, pp. 876-877, 1980.

[18] N.G.K. Pillai, T.V. Menon, G.B. Pillai, S. Rajasekharan and C.R.R. Nair, "Effect of plumbagin in *Charmakeela* (common warts) a case report", *Journal of Research Ayurvedic Sidha*, vol. 2, pp. 12-126, 1981.

[19] R.R. Chakraborty and A.T. Patil, "Preliminary phytochemical and antimicrobial studies of *Plumbago zeylanica*", *Indian Journal of Natural Product*, vol. 13 no.2, pp. 3-6, 1997.

[20] Atta-ur-Rahman, "Studies in Natural Products Chemistry "Stereoselective Synthesis", Vol. 1, Part A, Ed., The Netherlands 1988.

[21] P. Premakumari, K. Rathinam and G. Santhakumari, "Antifertility activity of plumbagin, *Indian Journal of Medicinal Research*, vol. 65, pp. 829-838, 1977.

[22] S.K. Bharghava, "Effects of plumbagin on reproductive function of male dog", *Indian Journal of Experimental Biology*, vol. 22, pp. 153-156, 1984.

[23] I.S. Druzhinina, M. Komon-Zelazowska, L. Kredics, L. Hatvani, Z. Antal, T. Belayneh and C.P. Kubicek, "Alternative reproductive strategies of *Hypocrea orientalis* and genetically close but clonal *Trichoderma longibrachiatum*, both capable of causing invasive mycoses of humans", *Microbiology*; vol. 154, pp.

3447–3459, 2008.

[24] M.R. Hermosa, E. Keck, I. Chamorro, B. Rubio, L. Sanz, J.A. Vizcaino, I. Grondona, E. Monte, “Genetic diversity shown in *Trichoderma* biocontrol isolates”, *Mycol Research*, vol. 108, pp. 897–906, 2004.

[25] G.J. Samuels and A. Ismaiel, “*Trichoderma evansii* and *T. lieckfeldtia*: two new *T. hamatum*-like species”, *Mycologia*, vol. 101, pp. 142–156, 2009.

[26] C.A. Rebuffo, J. Schmitt, M. Wenning, F. von Stetten and S. Scherer, “Reliable and rapid identification of *Listeria monocytogenes* and *Listeria* species by artificial neural network-based Fourier transform infrared spectroscopy”, *Applied and Environmental Microbiology*, vol.72, pp. 994-1000, 2006.

19

REGENERATIVE STEM CELL THERAPY

Inbavalli. K

**Assistant Professor
Acharya Institutes of Allied Health Sciences,
Bangalore, Karnataka.**

Introduction:

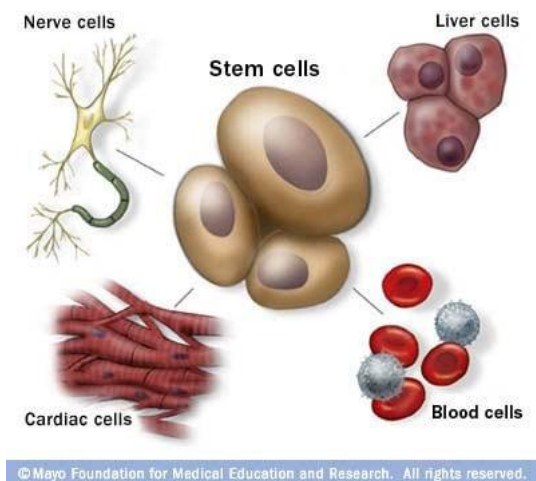
Recently regenerative medicine is the most emerging branch of medical science and it is dealing with the specific tissue and organ functional restoration of aged and various diseased patients suffering from serious conditions, injuries, and chronic disease conditions, and state where the diseased body's own regenerative responses do not suffice. Nowadays donated tissues and organs are unable to meet the transplantation demands of commonly aged and various diseased populations that have navigated the push search for alternatives. In recent times, stem cells have appeared as frontline regenerative medicine sources, and approved with indefinite cell division potential and they can transdifferentiate into other types of cells for the reparation of tissues and organs. abnormalities occurring due to congenital defects, disease, and age-associated effects, and these can be used for the physiological restoration of damaged tissue and organs. For successful regenerative outcomes, transplanted stem cells must survive, proliferate, and differentiate in a site-specific manner and integrate into the host circulatory system. The current stem cell regenerative medicine approaches are founded on tissue engineering technologies that combine the principles of cell transplantation,

material science, and microengineering for the development of organoids; and it can be used for the physiological restoration of damaged tissues and organs. In current biodegradable 3D scaffolds technology is used to generate the nascent tissue.

STEM CELLS:

Stem cells are generated by some cells having the specialized function and it is called the body's raw materials. Stem cells have been divided to form more cells and that are called daughter cells.

The divided daughter cells are to form new stem cells or specialized cells (differentiation) having more specific functions, for example, blood cells, brain cells, heart muscle cells, or bone cells. Apart from those cells, there were no other cells in the body has the natural ability to generate new cell types.



Stem cell therapy:

Stem cell therapy is a hopeful procedure for the regeneration of various damaged tissues as well as organs or the transplantation of stem cells through their functions and it regulates the immune system and reduces inflammation.

Stem cell therapy uses: -

Used to treat various autoimmune diseases, inflammatory disorders, neurological disorders, orthopedic disease conditions, and also treat traumatic injuries. These studies were focused on the use of Crohn's disease, Multiple Sclerosis, Lupus, Chronic Obstructive Pulmonary disease, Parkinson's disease, Amyotrophic lateral Sclerosis (ALS), Stroke recovery, etc.

Stem cell Treatments: -

There are several types of stem cell treatments available, including amniotic fluid and umbilical cord-derived stem cell therapy treatments and hematopoietic stem cell transplantation which is approved by the FDA, and its treats blood cancers like leukemia. A regenerative form of stem cell therapy is used for the treatment of acute skin burns and also damaged corneas.

Details of Diseases Treated by Stem Cells: -

Recently Stem cell therapy is one of the rapidly developing fields

within regenerative medicine. It's shown hopeful results in treating a different variety of diseases and also serious medical conditions. It has different types of stem cells, such as hematopoietic stem cells, mesenchymal stem cells, and induced pluripotent stem cells, and these have been utilized in clinical trials and treatments.

Here the list of diseases treated with stem cells is based on peer-reviewed data sources from the National Library of Medicine.

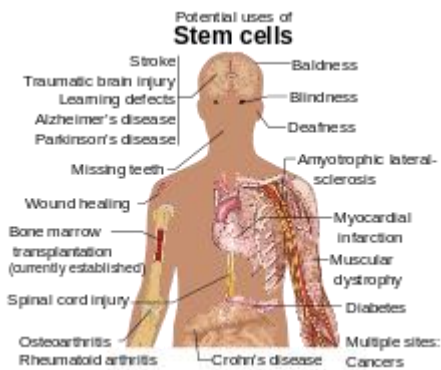
This provides an overview of diseases and conditions which is treated with stem cell therapies:

S.NO	Conditions	Conditions
1	Hematologic malice	<ul style="list-style-type: none"> ❖ Acute myeloid leukemia (AML) ❖ Acute lymphoblastic leukemia (ALL) ❖ Habitual myeloid leukemia (CML) ❖ Habitual lymphocytic leukemia (CLL) ❖ Multiple myeloma ❖ Myelodysplastic runs (MDS)
2	Tubercles	<ul style="list-style-type: none"> ❖ Hodgkin's carcinoma ❖ Non-Hodgkin's carcinoma
3	Bone gist failure runs	<ul style="list-style-type: none"> ❖ Aplastic anemia ❖ Ferocious nightly

		<p>hemoglobinuria (PNH)</p> <ul style="list-style-type: none"> ❖ Fanconi anemia ❖ Pure red cell aplasia
4	Inherited metabolic diseases	<ul style="list-style-type: none"> ❖ Hurler pattern ❖ Adrenoleukodystrophy ❖ Metachromatic leukodystrophy ❖ Gaucher complaint
5	Inherited vulnerable system diseases	<ul style="list-style-type: none"> ❖ Severe combined immunodeficiency (SCID) ❖ Wescott-Aldrich pattern ❖ Habitual granulomatous complaint
6	Autoimmune disease	<ul style="list-style-type: none"> ❖ Systemic lupus erythematosus (SLE) ❖ Multiple sclerosis (MS) ❖ Rheumatoid arthritis (RA) ❖ Sjogren’s pattern ❖ Systemic sclerosis
7	Neurological disease	<ul style="list-style-type: none"> ❖ Parkinson's complaint ❖ Alzheimer's complaint ❖ Amyotrophic side sclerosis (ALS) ❖ Spinal muscular atrophy (SMA) ❖ Stroke ❖ Traumatic brain injury (TBI)

		<ul style="list-style-type: none"> ❖ Spinal cord injury
8	Cardiovascular conditions	<ul style="list-style-type: none"> ❖ Ischemic heart complaint (myocardial infarction) ❖ Dilated cardiomyopathy ❖ Congestive heart failure ❖ Supplemental arterial complaint
9	Diabetes	<ul style="list-style-type: none"> ❖ Type 1 diabetes mellitus ❖ Type 2 diabetes mellitus
10	Liver conditions	<ul style="list-style-type: none"> ❖ Liver cirrhosis ❖ Acute liver failure
11	Order complaint	<ul style="list-style-type: none"> ❖ Habitual order complaint ❖ Acute order injury
12	Lung conditions	<ul style="list-style-type: none"> ❖ Habitual obstructive pulmonary complaint (COPD) ❖ Idiopathic pulmonary fibrosis ❖ Cystic fibrosis
13	Musculoskeletal and connective towel diseases	<ul style="list-style-type: none"> • Osteoarthritis • Cartilage defects • Osteogenesis imperfecta • Bone fractures and non-union
14	Gastrointestinal diseases	<ul style="list-style-type: none"> • Crohn's complaint • Ulcerative colitis

		<ul style="list-style-type: none"> Graft-versus-host complaint (GVHD)
15	Skin diseases	<ul style="list-style-type: none"> Severe beck Epidermolysis bullosa
16	Optical conditions	<ul style="list-style-type: none"> Age-related macular degeneration (AMD) Retinitis pigmentosa Corneal conditions



Diseases and conditions where stem cell treatment is promising or emerging

Stem Cell Exploration:

❖ Enhanced understanding of how conditions do:

By observing stem cells develop into cells in bones, heart muscle, jitters, and other organs and towel, exploration scientists may more understand how conditions do and state develop.

❖ Develop healthy cells to replace complaint-affected cells (regenerative drug): Stem cells can be supported in enhancing specific cells that can be used in common people to regenerate and repair apkins that have been damaged or affected by the complaint. Common people who might profit from stem cell curatives include those with spinal cord injuries, type 1 diabetes, Parkinson's complaint, amyotrophic side sclerosis, Alzheimer's complaint, heart complaint, stroke, becks, cancer, and osteoarthritis.

Stem cells may have the possibility to be grown to come a new towel for use in transplant and regenerative drugs. Experimenters continue to advance the knowledge of stem cells and their operations in transplant and regenerative drugs.

❖ Safety and effectiveness of new medicines test:

Before using investigational medicines on common people, exploration scientists can use some types of stem cells to test the medicines some types of stems cell for safety and quality. This type of testing is most likely first have a direct impact on medicine development for

cardiac toxin testing.

And there

are new areas of study including the effectiveness of using mortal stem cells that have been programmed into towel-specific cells to test new medicines. New medicines to be accurate for the testing, the cells should be programmed to capture the parcels of the type of cells targeted by the medicine. The rearmost ways to program cells into specific cells are under study. For illustration, whim-whams cells could be brought into actuality to test new medicine for a whim-whams complaint. These tests are suitable to show whether the new medicine had any effect on the cells and whether the cells were harmed.

Sources of stem cells

- Embryonic stem cells. These kinds of stem cells are coming from embryos that are 3 to 5 days old. At this stage, an embryo is called a blastocyst and has about 150 cells. These are named pluripotent (plo-uh-tunt) stem cells, the meaning of pluripotent is that can be divided into further stem cells or can come from any type of cell in the body. This rigidity allows embryonic stem cells to be used to regenerate or repair diseased towels and org

ans.

- Adult stem cells. This kind of stem cell is set up in small figures in utmost adult apkins including bone gist or fat. In comparisons of embryonic

stem cells and adult stem cells have a more limited capability to give rise to colorful cells of the body.

Lately, exploration scientists allowed adult stem cells could produce only analogous types of cells. For illustration, exploration scientists allowed that stem cells abiding in the bone gist could give rise only to blood cells.

Though, arising substantiation suggests that adult stem cells may be suitable to produce colorful types of cells. For case, bone gist stem cells may be suitable to produce bone or heart muscle cells.

This type of exploration has led to early-

stage clinical trials to test utility and safety in common people.

For illustration, adult stem cells are presently being tested in people with neurological or heart complaints.

- Parcels of Adult cells altered to have embryonic stem cells.

Research Scientists have successfully converted

regular adult cells into stem cells by using inheritable reprogramming. By altering the genes in the adult cells, experimenters can reprogram the cells to act also to embryonic stem cells.

This new fashion may allow the use of reprogrammed cells rather than embryonic stem cells and help vulnerable system rejection of the new stem cells. At the same time, scientists still do not yet know whether using altered adult cells will beget adverse goods on humans. Research scientists can suitable to take regular connective towel cells and reprogram them to come functional heart cells. In their studies, creatures with heart failure that were fitted with new heart cells endured bettered heart function and survival time.

- Perinatal stem cells. Research scientists also discovered stem cells in amniotic fluid as well as umbilical cord blood. These kinds of stem cells have the capability to change into technical cells.

Amniotic fluid fills the sac that surrounds and protects a developing fetus in the uterus. So, Research scientists can fluently

identify stem cells in samples of amniotic fluid drawn from pregnant women for testing or treatment and this kind of procedure is called amniocentesis.

Stem cell expansion:

Exploration or treatment operations need large figures of high-quality stem cells. This

is necessary to develop culture systems that produce pure populations of tissue-specific stem cells in vitro without the loss of stem-cell eventuality

There are two main approaches are taken for this purpose

1. Two-dimensional

2. Three-dimensional cell culture.

1. Two-dimensional

Thousands of laboratories worldwide for the once four decades have been routinely two confines cell culture.

In two-dimensional platforms, cells are generally exposed to a solid, rigid flat face on the rudimentary side and to liquid at the apical face.

Inhabiting such a two-dimensional rigid substrate requires a dramatic adaptation for the surviving cells because they warrant

the extracellular matrix that's unique to each cell type and which may alter cell metabolism and reduce its functionality.

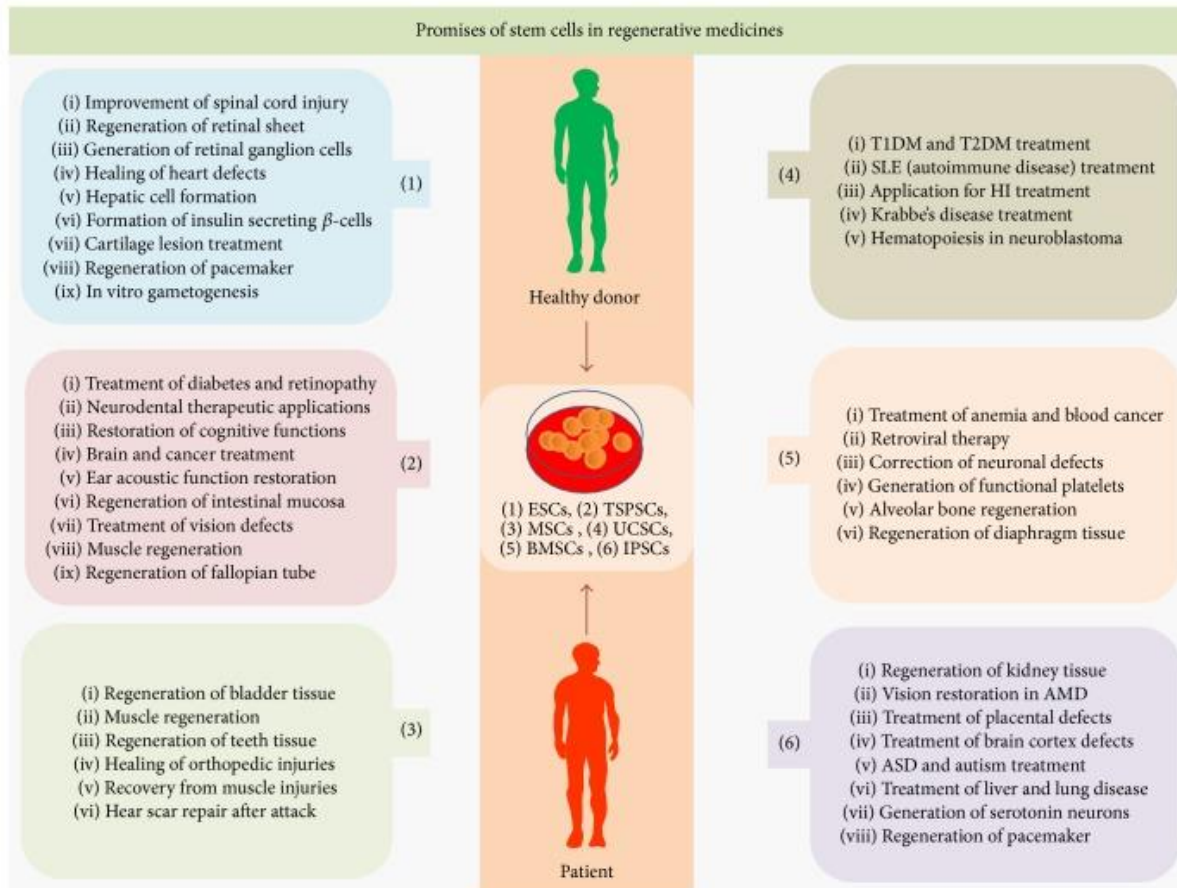
2. Three-dimensional cell culture.

Three-dimensional cell culture systems may produce a biomimicking medium for stem cells, suggesting their native three-dimensional extracellular matrix (ECM).

Advanced biomaterials have significantly contributed to three-dimensional cell culture systems in recent decades, and more unique and complex biomaterials have been proposed for perfecting stem-cell proliferation and controlled isolation.

Among them, nanostructured biomaterials are of particular interest because they have the advantage of a high face-to-volume rate, and they mimic the physical and natural features of natural ECM at the nanoscale.





Conclusion:

Stem cell remedy is getting a palpable reality by the day, thanks to the mounting exploration conducted over the once decade and also faced numerous challenges. Lately, progress in the field of stem cell remedy is veritably promising with reports of clinical success in treating colorful conditions bandied over. In the near future, stem cell-grounded curatives will significantly impact common people's health.

References:

1. Lovell-Badge R, et al (2021). ISSCR guidelines for stem cell research and clinical translation.05.012.
2. Townsend CM Jr, et al (2022). Regenerative medicine. In: Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice. 21st ed. Elsevier.
3. Simeon M, et al (2022). Application of the pluripotent stem cells and genomics in cardiovascular research — What we have learnt and not learnt until now. Cells.
4. Kumar D, et al (2021). Stem cell based preclinical drug development and toxicity prediction. Current Pharmaceutical Design.
5. De la Torre P, et al (2020). Current status and future prospects of perinatal stem cells.
6. Yen Ling Wang A (2021). Human induced pluripotent stem cell-derived exosomes as a new therapeutic strategy for various diseases. International Journal of Molecular Sciences.
7. Alessandrini M, et al (2019). Stem cell therapy for neurological disorders. South African Medical Journal.
8. Goldenberg D, et al (2021). Regenerative engineering: Current applications and future perspectives.

9. Brown MA, et al (2020). Update on stem cell technologies in congenital heart disease. Journal of Cardiac Surgery.
10. Li M, et al (2021). Brachyury engineers cardiac repair competent stem cells. Stem Cells Translational Medicine.
11. Augustine R, et al (2021). Stem cell-based approached in cardiac tissue engineering: Controlling the microenvironment for autologous cells. Biomedical Pharmacotherapy.

20

A REVIEW ON ENVIRONMENTAL BIOTECHNOLOGY AND ITS APPLICATIONS

K. Prabu

**Assistant Professor, PG and Research Department of
Biochemistry, Sacred Heart College (Autonomous),
Tirupattur, Tirupattur District, Tamil Nadu.**

E mail: kprabu.cas@gmail.com

Abstract

Environmental biotechnology is the application of microorganisms to enhance environmental quality, and it has thus far concentrated on the creation of tools for environmental clean-up in the aquatic, terrestrial, and aerial domains. An overview of biotechnology's environmental applications is provided in this article. One of the perspectives for the development of biotechnology is the remediation of the environment, pollution prevention, detection, and monitoring of the results. The primary fields of environmental biotechnology are wastewater treatment, soil treatment, and treatment of gaseous pollutants utilizing microbiological processes have each been shown with a variety of pertinent issues. Environmental biotechnology's unique contribution to the repair of polluted ecosystems, reduction of future waste release, and development of pollution prevention alternatives will be its distinctive roles in the future.

Keywords: Environmental biotechnology, bioremediation and pollution.

Introduction

Environmental biotechnology is the study and management of the

natural environment using the concepts and methods of biotechnology. It entails utilizing microbes and other biological agents to carry out a variety of environmentally friendly tasks, such as cleaning up contaminated sites, improving soil health, and lowering greenhouse gas emissions. Applications of environmental biotechnology include using bacteria to break down contaminants in water and soil, algae to absorb surplus nutrients from wastewater, and fungi to break down organic waste in landfills. Environmental biotechnology is a growing field of study and development with the potential to help find long-term solutions to environmental issues. Environmental biotechnology refers to the application of biology to preserve ecosystems and address environmental issues [1].

It is utilized to research the environment and habitat of living things in their natural settings. Environmental biotechnology is described as the creation, application, and control of biological systems, such as cells, cell compartments, and enzymes, for the remediation of contaminated environments (land, water, air, and sediments), as well as for environmentally friendly processes (green manufacturing technologies and sustainable environments), by the International Society for Environment Biotechnology (ISEB). To find, halt, and remedy

hazardous emissions into the environment, environmental biotechnology can be used in a number of ways. Solid, liquid, and gaseous wastes can be transformed into new products through recycling, or they can be purified to create an end product that is less harmful to the environment. By switching to biological technology instead of chemical ones, environmental harm can be reduced. This is one important way that environmental biotechnology might support sustainable development. Environmental biotechnology is one of the scientific fields that is now advancing most quickly and offering the most practical value. Through studies of the genetics, biochemistry, and physiology of exploitable microbes, technologies for reversing and preventing further environmental deterioration are being created swiftly [2-3].



Figure 1: Environmental Biotechnology

Bioremediation

The term "bioremediation" refers to the beneficial employment of microorganisms in the removal or detoxification of pollutants, typically as contaminants of soils, water, or sediments that would otherwise be dangerous to human health. The alternative names for bioremediation are biotreatment, bioreclamation, and biorestitution. The use of bioremediation is not new. For a very long time, harmful substances and organic debris have been removed from home and industrial waste disposal by microorganisms. However, bioremediation is the main focus in environmental biotechnology to combat various contaminants. In the great majority of bioremediation applications, toxic waste is identified and filtered before it is released into the environment or existing pollution problems are cleaned up using naturally occurring microorganisms. In order to eliminate contaminants that are difficult to decompose, more sophisticated systems involving genetically engineered microorganisms are being tried in waste treatment and pollution management. Both in situ and ex situ bioremediation methods are available. Microorganisms used in bioremediation require a suitable habitat in order to clean up a polluted location. For the microbial activity in the polluted site, it might be necessary to add

nutrients, terminal electron acceptors (O_2/NO_2), temperature, and moisture to encourage the growth of a specific organism. Operations for bioremediation might be carried out in situ or ex situ, on or off-site. Water and soil contaminated by a range of dangerous chemicals, household wastes, radioactive wastes, etc. can potentially be cleaned up via bioremediation [4-6].

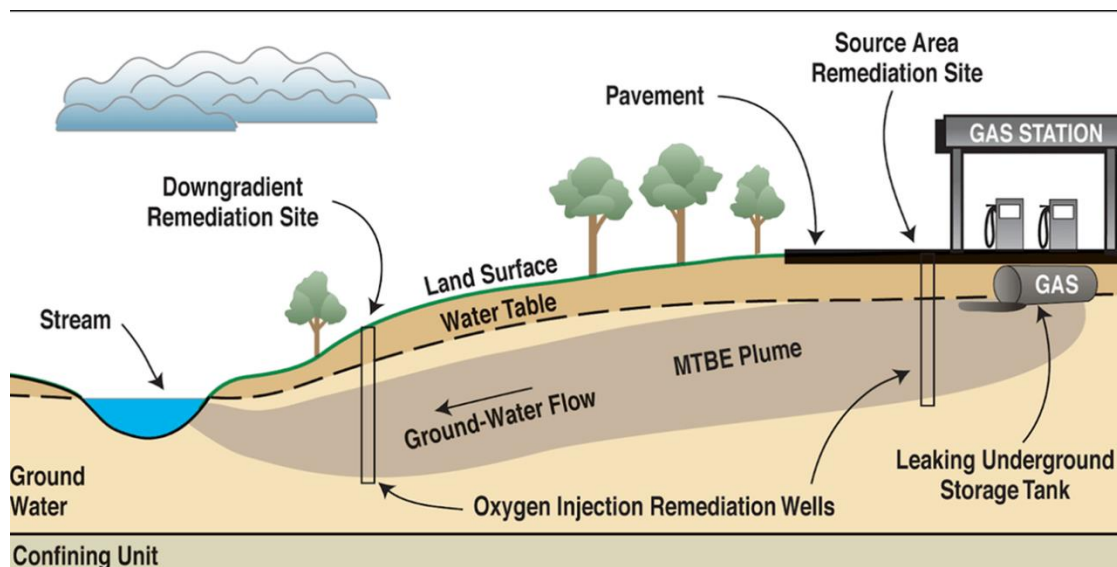


Figure 2: Bioremediation

Waste Water and Industrial Effluents

In many nations around the world, water contamination is a severe issue. Large amounts of waste water were produced as a result of rapid industrialization and urbanization, which caused both surface water supplies and groundwater reserves to deteriorate. Water bodies are

contaminated by biological, organic, and inorganic pollution. These sources have frequently become unfit for use in consuming by people as well as for other purposes including irrigation and industrial requirements. This demonstrates how poor water quality can actually increase water scarcity by reducing its availability for both human use and environmental needs. Around the world, there is a pressing need to treat waste water before disposal. Before sewage is released into rivers or the ocean, the more common pollutants are removed from it in sewage treatment plants using microorganisms. Processes that remove specific pollutants including nitrogen and phosphorus compounds, heavy metals, and chlorinated compounds are now more necessary than ever due to rising industrial and agricultural pollution [7-9].

Aerobic Biological Treatment

The inert substance (rocks, ash, wood, or metal) on which the microorganisms grow as a complex biofilm is typically used in trickling filters, rotating biological contactors, or contact beds. For the treatment of sewage and waste water, these have been in operation for more than 70 years. In these procedures, the microbes oxidize the biodegradable organic material into CO₂ that can be released into the atmosphere.

Activated Sludge Process:

This method is used to treat and remove dissolved and biodegradable pollutants such organic compounds, textile wastes, and sewage from municipal sources. In general, the microorganisms in activated sludge are made up of 70–90% organic and 10–30% inorganic materials. Typically, bacteria, fungus, protozoa, and rotifers are the microorganisms present in this sludge. Acinetobacter, Mycobacteria, Pseudomonas, and other types of bacteria, yeasts, Cladosporium, and Scolecobasidium all break down petroleum hydrocarbons. The fungus Xylaria xylestrix detoxifies pesticides (aldrin, dieldrin, parathion, and malathion). Pseudomonas, a common soil microorganism, is capable of detoxifying organic substances such polychlorinated biphenyls, phenols, organophosphates, and hydrocarbons.

Garbisu et al. (2003) described the use of immobilized Phormidium laminosum cyanobacterium in batch and continuous flow bioreactors for the removal of nitrate, nitrite, and phosphate from water. Phormidium laminosum immobilized in microporous polymeric matrices was shown by Blanco et al. (2003) to biosorb heavy metals. In order to produce high-value products (such beta-carotene and gamma-linoleic acid), create effective effluent treatment systems, and develop novel energy sources, algae and cyanobacteria are currently grown in

photo-bioreactors under tightly controlled environmental conditions. By turning trash into usable goods, wastewater treatment expenses can be decreased. Heavy metals and sulphur compounds can be removed by sulphur metabolizing bacteria from waste streams produced by the galvanization industry and then recycled. Biogas is produced by the majority of anaerobic wastewater treatment systems. In other situations, the pollution-fighting microbes' byproducts can be valuable in and of themselves. Methane, for instance, can be produced by a type of bacteria that breaks down sulphur liquor, a waste product of the paper industry [10].

Soil and Land Treatment

Soil conservation is essential because as the human population expands, so does the demand for food produced by crops. A few effects of human activity and irresponsibility include deforestation, excessive development, and chemical contamination. The growing concern over soil contamination is a result of the increasing amounts of fertilizers and other agricultural chemicals that are applied to soils, as well as industrial and home waste-disposal methods. Persistent poisonous compounds, chemicals, salts, radioactive elements, or disease-causing agents are some of the factors that contribute to soil pollution and have

a negative impact on plant and animal health. For soil bioremediation, a wide variety of fungal species can be employed. Paraquat can be broken down by *Lipomyces* species. Benzaldehyde can become benzyl alcohol thanks to *Rhodotorula* sp. Formaldehyde in the soil is broken down by *Candida* sp. Utilizing the fungi *Aspergillus niger* and *Chaetomium cupreum*, tannins (found in tannery effluents) are broken down in the soil to aid in plant growth.

Phanerochaete chrysosporium has been employed in bioremediation of soils contaminated with various chemical substances, typically recalcitrant and considered environmental contaminants. In the presence of *Phanerochaete chrysosporium*, PCP (Pentachlorophenol) levels decreased by 88–91% over the course of six weeks. The degradation of various pollutants has been done via bioremediation of polluted soil, which is a safe, dependable, economical, and environmentally beneficial process. This may be impacted in situ or by mechanically removing the soil for treatment somewhere else. In situ therapies include ventilation, the addition of nutritional solutions, and the introduction of microorganisms. Ex situ treatment entails removing the soil from its natural environment and treating it above ground, either in the form of compost, soil banks, or specialized slurry

bioreactors. When compared to physical approaches, bioremediation of land is frequently less expensive, and the results are generally safe [11-13].

Soil microorganisms transform organic contaminants into CO₂, water, and biomass during biological treatment. Both anaerobic and aerobic environments are capable of causing degradation. Bioreactors can be used to help with soil bioremediation as well. Both anaerobic and aerobic environments are capable of causing degradation. Bioreactors can be used to help with soil bioremediation as well. A reactor is used to treat liquids, vapors, or solids that are part of a slurry phase. Microbes can be created through genetic engineering, cultivation, or simply by nature. It is now possible to treat soil that has been contaminated with mineral oils thanks to environmental biotechnology research. Petroleum-contaminated soils that have been dug up and placed in a containment system where water and nutrients can percolate are treated using solid-phase methods. On both large and small sizes, in situ and ex situ, biological degradation of oils has proven commercially feasible. In situ soil bioremediation entails activating local microbial populations (for example, by introducing nutrients or aeration). To the greatest extent possible, this method optimizes the

ambient conditions for the biological breakdown of organic contaminants. It is necessary to add electron acceptors like nitrates or oxygen-releasing chemicals, or artificially aerate the environment to provide oxygen. Sometimes utilized to destroy the organic pollutants are water-dissolved ozone and H_2O_2 [14-16].

Air and Waste Gases

One of the first and most polluted elements of the atmosphere since the dawn of human civilisation is the air. Burning fossil fuels, such as gas, coal, and oil, to power machinery and automobiles, is the human activity that contributes to the majority of air pollution. Volatile organic compounds (VOCs), a group of different chemicals, are released into the air when fuels are burned inefficiently. There are many sources of pollution. For instance, methane gas is released by rubbish that is decaying in landfills and other solid waste disposal facilities, and many household goods release VOCs. More pollutants are now in the air as a result of expanding industrial operations. Biological air purification once thought to be an impossibility. This issue is resolved by biological waste gas purification technology that uses bioreactors, such as membrane bioreactors, trickling filters, biofilters, and bioscrubbers. All of these reactors have a similar operating mode.

Volatile substances are transported from the gas phase into the liquid phase in the bioreactors by the passage of air carrying such substances. In this liquid phase, a microbial community—a collection of various bacteria, fungus, and protozoa—grows and consumes the substances ingested from the air. In the bio filters, the air is routed over a bed of organic materials that provides the microorganisms with the nutrients they need to develop. By preserving the air's humidity upon entry, this medium is kept wet. The main principle of biological off-gas treatment is the direct oxidation of a broad variety of voracious bacteria, such as *Nocardia* sp. and *Xanthomonas* sp., by the VOC in the waste gases after they have been absorbed into the aqueous phase.

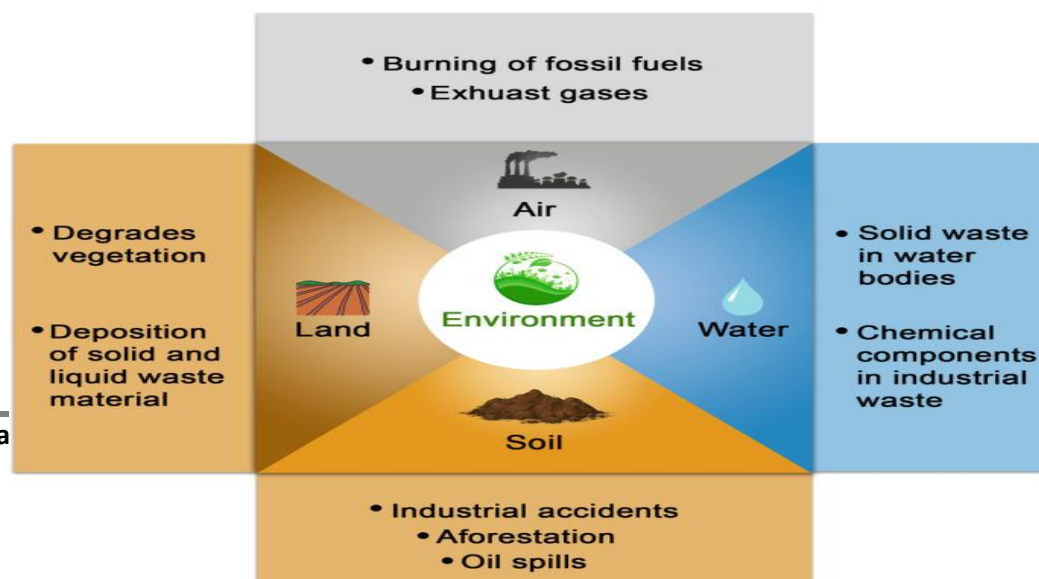


Figure 3: Significance of Environmental Biotechnology

Enzyme Application

For many years, industries have used enzymes extensively. In comparison to non-biological catalysts, enzymes are very effective biological catalysts that are non-toxic and biodegradable. For thousands of years, man has used enzymes both directly and indirectly. Enzymes have become crucial components in the recent synthesis of pharmaceuticals, fine compounds, amino acids, antibiotics, and steroids. Enzymes can be used to create environmentally friendly industrial processes. The use of enzymes in the textile, leather, food, pulp and paper, and food industries helps to significantly reduce or completely eliminate the use of harmful chemicals while also being more energy and resource efficient.

Biotechnological processes can provide food products with increased nutritional content, functional qualities, and shelf durability. It is not necessary to extract the chemicals from vanilla beans because plant cells grown in fermenters can create flavors like vanilla. The

manufacturing of biotechnologically created chymosin, which is used to make cheese, alpha-amylase, which is used to make high-fructose corn syrup and dry beer, and lactase, which is added to milk to reduce the lactose content for people who are lactose intolerant, have all helped food processing. Because they do not produce by-products or off-flavours in food, genetically modified enzymes are preferred over chemically manufactured molecules because they are simpler to produce than enzymes extracted from natural sources.

Environmental Detection and Monitoring:

For the detection of pollution and ongoing monitoring of pollutants, a variety of biological techniques are used. In order to help people become more aware of their surroundings, biotechnology techniques have developed new ways to diagnose environmental issues and evaluate typical environmental circumstances. Applications of these techniques are portable, quicker, and less expensive. Scientists can assess the degree of pollution on the spot and know the results right away, as opposed to collecting soil samples and sending them to a lab for analysis. Biosensors and immunoassays have been developed and are now being used in biological detection methods. In biosensors that

detect contamination of metals or contaminants, microbes are used. For the detection of heavy metals, *Selenastrum capricornatum* (green algae) is employed, whereas *Saccharomyces cerevisiae* (yeast) is used to detect cyanide in river water. Immunoassays detect pollutant levels by labeling enzymes and complex proteins produced in a biological reaction to certain substances. If a pollutant is present, the antibody binds to it and causes a color change, fluorescence, or radioactivity that makes the pollutant visible [17-19].

Biosensors

An analytical tool known as a biosensor transforms a biological response into a physical, chemical, or electrical signal. In order to create biosensors, it is necessary to combine highly sensitive biologically generated sensing components (such as immobilized cells, enzymes, or antibodies) with physico-chemical transducers (either electrochemical or optical). They are immobilized on a substrate, and when an environmental change occurs, their characteristics alter in a way that can be electrically or optically detected.

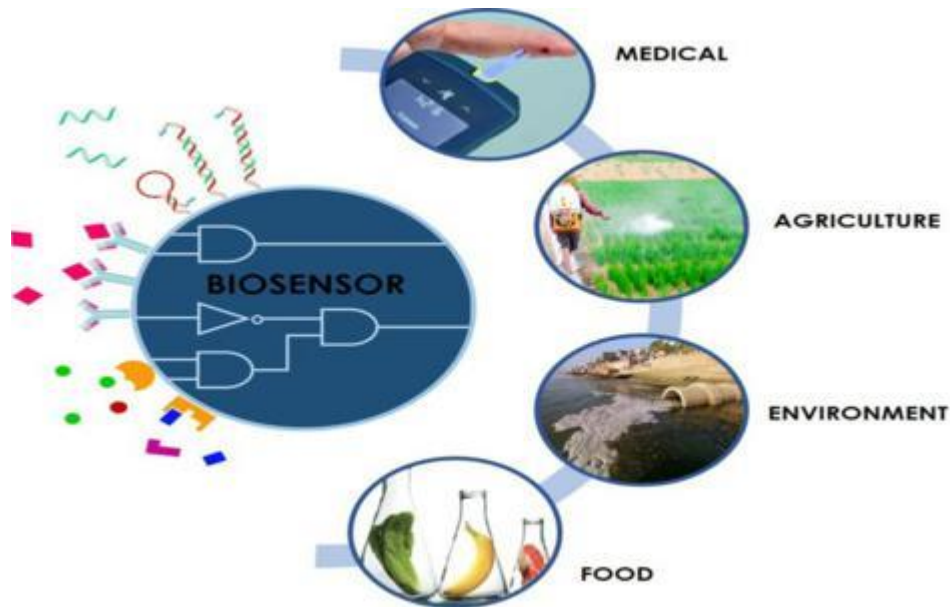


Figure 4: Biosensor

Then, it is possible to quantify contaminants with a high degree of sensitivity or with exceptional precision. The bio catalytic membrane, which accomplishes the transformation of reactant to product, controls the biological response of the biosensor. Enzymes that have been immobilized are particularly suitable for usage in these systems because they have a variety of beneficial characteristics. They are reusable, which guarantees that the same catalytic activity will be present throughout a number of tests. A wide number of businesses, including those in manufacturing, engineering, chemical, water, food, and beverage production, have benefited from the use of biosensors,

which are strong tools that rely on biochemical reactions to identify specific compounds. They are rapid, simple, and accurate at detecting even minute quantities of the specific target compounds.

They have been fervently embraced for this characteristic of biosensors for a range of process monitoring applications, mostly in regard to pollution assessment and control. Biosensors for the detection of pathogenic bacteria, organic acids, glucosinolates, pesticides, and other substances have already been created. The biosensors can be made to be extremely sensitive to a small number of molecules or extremely selective. Algal-based biosensors, for instance, can be used to identify a variety of herbicides in river water by measuring changes in the chlorophyll's optical characteristics as a result of pressures placed on the organisms. Different types of biosensors exist, including calorimetric, immuno, optical, BOD, and gas biosensors.

Microbes' extraordinary capacity for chemical breakdown is becoming effective not only in pollutant cleanup but also in pollutant detection. At the Los Alamos National Laboratory, a team of researchers uses microorganisms that break down phenols, a family of organic compounds. Phenolic substances that are consumed by bacteria bind to a receptor. Following this, the phenol-receptor complex attaches to

DNA and activates the genes responsible for phenol degradation. The Los Alamos researchers included a reporter gene that, when activated by a phenol-receptor complex, generates a readily recognizable protein, signaling the presence of phenolic chemicals in the surrounding environment. Organophosphorus chemicals in water can be found using cholinergic esterase-based biosensors [20-21].

Genetic Engineering

Biotechnology is an important technology that has to be developed continuously since it is predicted to have a significant positive impact on human wellbeing. Among the various forms of biotechnology, DNA technology application has the potential to produce novel gene combinations that have never before occurred in nature. Genetic engineering has long claimed to be able to create specially suited microbes with enhanced toxin-degrading abilities. Stability of plasmids is highly desired given the advancement of GEM (genetically engineered microorganisms) and their potential use in the remediation of contaminated soil and water. Circular DNA strands known as plasmids can multiply on their own without the help of the host chromosome. Plasmids come in a variety of sizes, carrying anywhere from a few genes to hundreds or even thousands. There might be many

copies of small plasmids. Conjugation is the mechanism used to exchange genetic material via plasmids.



Figure 5: Genetic engineering

Specific DNA segments that can be passed on to an organism lacking the same by using restriction enzymes have been isolated. Often, but not always, plasmids contain the genes that regulate the metabolism of xenobiotic chemicals, such as PCBs, and other environmental contaminants. A new outlook on waste biotreatment has been provided by the possibility of genetic transmission in non-biodegradable bacteria. Recombinant DNA is capable of replication and may also confer a unique derivative capacity to detoxify environmental pollutants. The derivative capacity in vitro has been enhanced via gene transfer among microbiological populations. *Pseudomonas putida*, a

bacterium with the capacity to break down hydrocarbons, was the subject of the first genetically modified organism (GMO) or GEM patent application made in the United States by Professor A. M. Chakrabarty. The role of plasmids in the breakdown of alkanes, naphthalene, toluene, and m- and p-xylenes has been observed in later investigations.

Genetic engineering has the potential to be a very powerful tool for developing environmentally friendly substitutes for current products and processes that pollute the environment or use up all of the planet's non-renewable resources. This is because of the enormous diversity of species, biomolecules, and metabolic pathways on this planet. In the modern day, if naturally occurring organisms are unable to biodegrade a given pollution properly or quickly enough, extra genetic traits can be added to the organisms. Blockages in environmental remediation may be avoided by mixing diverse metabolic capabilities in the same microbe.

Although some genetically engineered bacteria have received US approval for bioremediation, there have been no reports of their widespread use. Only carefully supervised field testing are permitted in Europe. Biotechnology uses naturally occurring, live bacteria to carry

out a similar purpose more quickly than other means of material degradation like light, heat, and moisture. Some bacteria naturally consume pollutants such as chemicals and some potentially harmful substances. These are the things they eat, digest, and excrete harmless stuff in their place. To degrade toxic and dangerous compounds already present in the environment, bioremediation employs both naturally occurring and recombinant microbes. Instead of detoxifying waste streams at the point of disposal, bio treatment can be employed to do so before they contaminate the environment. This strategy entails the selective use of organisms called biocatalysts, which are enzymes that speed up the decomposition of particular chemicals.

However, using GMOs or GEMs in the environment for bioremediation may have negative effects on the ecosystem. These specifically created organisms don't have the opportunity to go through the many changing environmental conditions that naturally existing species go through during their evolutionary processes, which take millions of years. The latter are therefore well adapted to the shifting environmental circumstances, such as variations in temperature, substrate, or waste concentrations. GMOs, however, exhibit more survivability than normally occurring bacteria when exposed to contaminated sites

because of their specially designed enzymatic machinery. There are worries that these GMOs would harm the intricate and delicate microbial communities in the soils they are sprayed to through genetic material exchange or competition. They may have an impact outside of the treatment area, which is much more concerning. Recombinant strains could seem safe in the lab, but determining their effects in the field is incredibly difficult [22-23].

Conclusion

It is clear from the explanation above that biotechnology has a huge impact on environmental issues. The use of biotechnology contributes to reducing or resolving environmental issues, which helps to maintain a healthy ecosystem for living things. Reputable institutions, like ISEB, do research on various microorganisms in an effort to develop eco-friendly ways to clean the environment and locate sources of renewable energy. The International Society for Environmental Biotechnology's principal objective is to safeguard the natural environment, which includes the soil, water, air, and sediments. Environmental concerns including the depletion of natural resources, pollution of natural bodies of water, and other challenges are brought on by industrialization, urbanization, and anthropogenic activities;

these issues can be successfully and efficiently treated by implementing biotechnology applications.

References

1. Banerjee D, Rao MA and Wattal PK. 2013. Separation and Recovery of Cs from High Active Waste Simulant using Resorcinol Formaldehyde Polycondensate Resin: Batch and Column Studies. *Separation Science and Technology* 48, 133-139.
2. Mesjasz-Prybylowicz J, Nakonieczny M and Migula P. 2004. Uptake of cadmium, lead, nickel and zinc from soil and water solutions by the nickel hyper accumulator Berkley code. *Acts biol. Cracoviensia Ser. Bot.* 46, 75-85.
3. Nixdorf B, Fyson A and Krumbeck H. 2001. Review: plant life in extremely acidic waters. *Environ. Exp. Bot.* 46, 203-211.
4. Barrows G, Sexton S and Zilberman D. 2014. *The Journal of Economic Perspectives*, Volume 28, Number 1, Winter 21, 99-119.
5. Bidar G, Garçon G, Pruvot C, Dewaele D, Cazier F, Douay F, Shirali P. 2007. Behaviour of *Trifolium repens* and *Lolium perenne* growing in a heavy metal contaminated field: Plant metal concentration and phytotoxicity. *Environmental Pollution* 147, 546-553.

6. Costea T, Istudor V, Fierascu RC, Fierascu I and Botez A. 2013. Researches upon indigenous herbal products for therapeutic valorification in metabolic diseases Note I. *Betulae folium* and *Rubi idaei folium*, sources of micro- and microelements. *Pharmacia* 6, 56-61.
7. Cunningham SD and Berti WR. 1993. Remediation of contaminated soil with green plants, *Vitro Cell. Dev. Biol.* 29, 207-212.
8. Daugulis Andrew J and Boudreau Neal G. 2003. Removal and destruction of high concentrations of gaseous toluene in a two-phase partitioning bioreactor by *Alcaligenes xylooxidans*. *Biotechnology Letters* 25, 1421-1424.
9. Delplanque M, Collet S, Del Gratta F, Schnuriger B, Gaucher R and Robinson B. 2013. Bert Combustion of *Salix* used for phytoextraction: The fate of metals and viability of the processes. *Biomass and Bioenergy* 49,160-170.
10. Arundel A and Rose A.1999. The diffusion of environmental biotechnology in Canada: adaption strategies cost offset. *Tec novation*.19, 551-560.
11. Fierascu RC and Fierascu I. 2013. Archaeometallurgical investigation of historical coins. *Metallurgies International* 18, 277-278.

12. Annette C, Dietz and Jerald L. 2001. Advances in Phytoremediation. Environ Health Perspect 109, 163-168.
13. Garvillesco M. 2010. Environmental Biotechnology: Achievement, Opportunities and Challenges. Global Science Books 1-36.
14. Ghosh M and Singh SP. 2005. A review on phytoremediation of heavy metals and utilization of its byproducts. Applied Ecology and Environmental Research 3; 1-18.
15. Stoltz E. 2004. Phytostabilisation use of wetland plants to treat mine tailings, Department of Botany, Stockholm, and Doctoral Thesis.91, 7265- 7972.
16. Tan Z and Lagerkvist A. 2011. Phosphorus recovery from the biomass ash: A review. Renewable and Sustainable Energy Reviews 15, 3588- 3602.
17. Guo F, Nishihama S and Yoshizuka K. 2012. Selective Recovery of Copper, Cobalt, and Nickel from Aqueous Chloride Media using Solvent Impregnated Resins. Solvent Extraction and Ion Exchange 30, 579-592.
18. Diebel W, Vivekanandhan S, Zarrinbakhsh N, Misra M and Mohanty A. 2012. Material property characterization of co-products from biofuel industries: Potential uses in value-added biocomposites. biomass and bioenergy 37, 88-96.

19. Hassen A, Saidi N, Cherif M and Boudabous A. 1998. Resistance of environmental bacteria to heavy metals. *Bio resource Technology* 64, 7-15.
20. Hoque MdE, Philip OJ. 2011.. *Materials Science and Engineering* 31, 57-66.
21. Grommen R and Verstraete. 2002. Environmental biotechnology: the ongoing quest. *Journal of Biotechnology* 98, 113-123.
22. Arienzo M, Adamo P, Cozzolino V. 2004. The potential of *Lolium preened* *The Science of the Total Environment* 319, 13-25.
23. Min X, Yuan C, Liang Y, Chai L and Ke Y. 2012. Metal recovery from sludge through the combination of hydrothermal suffixation and flotation. *Procardia Environmental Sciences* 16, 401-408.

Chapter-XXI

21

MECHANISM OF OXIDATION OF HYDROQUINONE, BY N- CHLOROPIPERAZINE-2,5- DIONE- A KINETIC STUDY

K. Rajalakshmi

Assistant Professor, Department of Chemistry,

Shrimati Indira Gandhi College,

Tiruchirappalli, Tamil Nadu.

E.Mail:chemraji8021@gmail.com

ABSTRACT

The kinetics and mechanism of oxidation of Hydroquinone was studied by N-Chloropiperazine-2, 5-dione in acetic acid-water medium. The reaction was found in Hydroquinone to be one with respect to [oxidant] and fractional order with respect to [substrate]. The reactions are studied at five different temperatures. The enthalpy of activation and entropy of activation are calculated. Based on the above kinetic facts, a suitable mechanism was proposed for each substrate.

KEYWORDS: Substrate, Oxidation, Hydrogenation Concentration, enthalpy of activation and entropy of activation.

INTRODUCTION

When a reaction occurs in steps, intermediate species are probably formed and they may not be detectable, because they may be promptly used up in a subsequent step¹. However by investigating the influence that various factors on the rate at which the net change occurs, it is sometimes possible to elucidate what the intermediates are and how they are involved in the mechanism of the reaction².

Among oxidation and reduction reactions, oxidation is the most commonly studied reaction. A large amount of kinetic study is concentrated on oxidation reactions. An interesting fact is that many oxidations are

accompanied by the release of energy. Such released energy is the source of work in biological systems including the human system and also in man-made machines. Hence the knowledge of oxidative pathways may be very useful in understanding processes in nature and synthetic situations. N-chloropiperazine-2, 5-dione (NCDP) was introduced in the series of N-halo compounds. NCDP is proved to be a mild oxidizing agent. It liberates iodine from acidified potassium iodide solution. A survey of literature provides much information on the mechanism of reactions involving N-halo compounds.³⁻⁸

EXPERIMENTAL METHODS

100g (1.33mol) of glycine and 500ml of ethylene glycol were placed in a one liter three necked flask, fitted with an air-cooled reflux condenser and a sealed mechanical stirrer. A thermometer was fitted so that the bulb was inside the liquid. The mixture was heated in the fume cupboard to 175° C and that level was maintained with continuous stirring for one hour. The dark brown reaction product was cooled to room temperature and left overnight in refrigerator. The resulting suspension was centrifuged and the mother liquor was decanted. The solid was transferred to a Buckner funnel with the aid of cold methanol and the solid was washed with more methanol, using about 200ml in all. The product was crystallized from

300ml of boiling water but no attempt was made to filter the hot solution at the stage. The light brown crystals were collected which separated on cooling in ice. The crude material was dissolved in 350 ml of water; 4g of decolorizing carbon was added and boiled for three minutes. The hot suspension was filtered through a preheated Buckner funnel and the filtrates were cooled in ice. The colorless crystals of pure piperazine-2, 5-dione was collected, washed with ice water and dried in the oven at 50° C. piperazine-2, 5-dione has melting point of 310 – 312° C.

Preparation of N-chloropiperazine-2, 5-Dione

1g of piperazine-2, 5-dione was taken in a 50ml conical flask and 10 ml of water was added to it. Then chlorine gas passed for about 15-20 minutes. Then 0.8g of sodium bicarbonate was also added to it. The resulting white precipitate was filtered and dried.

KINETIC AND MEASUREMENT FOR THE OXIDATION OF HYDROQUINONE BY NCDP

Measurement were made at 40°C and the temperature was controlled using a thermostat to an accuracy of $\pm 0.1^\circ\text{C}$. the following solutions of the desired concentrations were prepared and used.⁹

1. Hydroquinone in acetic acid
2. NCDP in acetic acid

3. Other reagents in doubly distilled water

Known volumes of substrate, water, perchloric acid and acetic acid were mixed to bring the percentage of acetic acid to the desired value and thermostated. The reaction was started by adding the oxidant to the mixture. A stop watch was started when half of the oxidant solution had been delivered. Aliquots (2ml) were removed at definite intervals and the unreacted NCDP was estimated iodometrically by draining 10ml of 3N sulphuric acid and 10ml of 5% potassium iodide solution and the liberated iodine was titrated against standard sodium thiosulphate solution using starch as indicator.

Reactions were generally followed to 60-75% completion. The kinetic investigations were carried out under pseudo-first order conditions, keeping the substrate concentrations always in excess. The pseudo-first order rate constants (k_1) were calculated from the slope of linear plots of \log (titre) against time by the method of least squares¹¹⁻¹³.

Throughout the kinetic studies hydroquinone concentration was kept ten times greater than that of the N-chloro compound.

Evaluation of rate constants¹⁰

The pseudo-first order rate constant of each kinetic run was evaluated from the slope of the linear plot of $\log (a-x)$ Vs time, according to the first

order rate equation by the method of least squares.

The linearity of each fit is given in terms of the correlation coefficient (r)

$$k_1 = \frac{2.303}{t} \log \frac{a}{a-x}$$

$$t = \frac{2.303}{k_1} \log \frac{a}{a-x}$$

where k_1 is the pseudo-first order rate constants 't' is the time in second and 'a' and (a-x) denote the initial concentration and concentration at time 't' respectively of N-chloropiperazine-2,5-dione. the specific reaction rate is evaluated by dividing the k_1 by substrate raise to the power of its order.

Activation parameters

The activation parameters were calculated by the least square analysis of linear plot of $\ln(k_2/T)$ Vs $1/T$ of Eyring's equation. H^\ddagger and S^\ddagger were calculated from the slope and the intercept of the plot respectively as per the following equation.

$$K = \frac{k_B T}{h} \cdot e^{-\Delta H^\ddagger / RT} \cdot e^{\Delta S^\ddagger / R}$$

Where,

K = Rate constant

k_B = Boltzman constant

h = Planck's constant

T = Temperature in Kelvin

The logarithmic form of Eyring's equation can be rearranged in the form of a linear equation as shown below.

$$\ln k_1 = \ln k_B + \frac{\Delta S^\ddagger}{R} - \frac{\Delta H^\ddagger}{RT}$$

ΔS^\ddagger , ΔH^\ddagger and ΔG^\ddagger were calculated using the following relationships

$$\Delta H^\ddagger = (-\text{slope}) * 0.008318 \text{ kJ mol}^{-1}$$

$$\Delta S^\ddagger = (\text{intercept} - 23.7604) * 8.318 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta G^\ddagger = \Delta H^\ddagger - T \Delta S^\ddagger \text{ kJ mol}^{-1}$$

all the calculations, graphs and correlation coefficients were computed

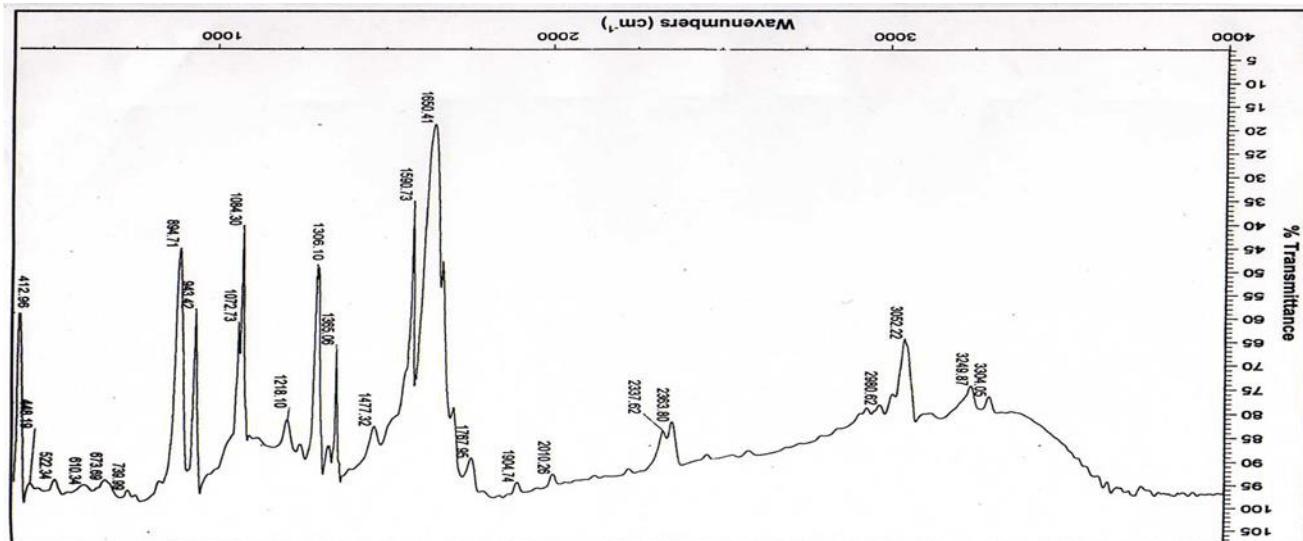
Stoichiometry

Reaction mixture containing an excess of oxidant (NCDP) 0.01M over hydroquinone (0.01M) in the presence of perchloric acid were kept at room temperature for a sufficient length of time under the conditions employed for the kinetic runs. Estimation of unchanged oxidant showed

that one mole of hydroquinone consumed one mole of N-chloropiperazine-2, 5-dione. Thus the stoichiometry of the reaction was found to be 1:1 mole ratio of the substrate and oxidant respectively.

Product analysis

Hydroquinone (0.1M) and NCDP (0.1M) were mixed in 80% acetic acid water medium and kept at room temperature for two days under the conditions employed for the kinetic runs. Then the product was extracted with chloroform. The extract was dried over anhydrous sodium sulphate and chloroform layer was evaporated. The product obtained was p-benzoquinone (pic. 1).



(pic-1) FT-IR Spectra of p-benzoquinone.-1)

RESULTS AND DISCUSSION

KINETICS AND MECHANISM OF OXIDATION OF HYDROQUINONE, 8-HYDROXYQUINOLINE

Effect of varying the [oxidant]

The oxidation of hydroquinone by NCPD was investigated at several initial concentrations of the oxidant [NCPD] (table-1). At constant temperature and the [substrate] in excess, the plot of log (titre) Vs time was linear indicating first order dependence of the reaction of [NCPD]. The values of the pseudo-first order rate constants (k_1) were evaluated from the plots, according to the first order equation by the methods of least square.

Table-1

[Hydroquinone] = $3.0 \times 10^{-2} \text{ mol dm}^{-3}$

[HClO₄] = 1.5 mol dm^{-3}

Solvent = 80%(v\v) acetic acid-water

Temperature = 40°C

[NCPD] x 10 ³	k_1 x 10 ⁴ s ⁻¹
0.5	4.2913
1.0	4.3304
1.5	4.5774

2.0	4.6235
2.5	4.4569

Effect of varying the [substrate]

The reactions were carried out at 40°C with varying concentrations of hydroquinone while keeping the concentration of all other factors constant. The rate constants were found to slightly increase in substrate concentration (table-2). A plot of log [substrate] Vs log k_1 was linear with a slope of 0.285 ($r = 0.997$) for hydroquinone.

[Hydroquinone] x 10^2 mol dm^{-3}	k_1 x 10^4 s^{-1}
2.0	3.9080
2.5	4.1213
3.0	4.3304
3.5	4.5578
4.0	4.7648

Table-2

$$[\text{NCPD}] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$$

$$[\text{HClO}_4] = 1.5 \text{ mol dm}^{-3}$$

Solvent = 80%(v\v) acetic acid-water

Temperature = 40°C

Effect of varying the ionic strength

The reactions were carried out at various concentrations of sodium perchlorate while keeping all other variables constant. The results indicate that there was no appreciable change in the rate of the reaction (table-3).

Table-3

$$[\text{Hydroquinone}] = 3.0 \times 10^{-2} \text{ mol dm}^{-3}$$

$$[\text{NCPD}] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$$

$$[\text{HClO}_4] = 1.5 \text{ mol dm}^{-3}$$

Solvent = 80%(v\v) acetic acid-water, Temperature = 40°C

[NaClO₄] x 10² mol dm⁻³	k₁ x 10⁴s⁻¹
0.25	4.4799
0.50	4.1420
1.00	4.1559
1.50	4.2879
2.00	4.1829

Effect of varying the $[H^+]$ ion

The reactions were carried out at five different pH while keeping the other factors constant. The pH of the medium was measured using I.T.L. Digital pH meter. The rate constant was found to increase as the pH was increased (table-4). For hydroquinone the plot of $\log k_1$ Vs $\log[H^+]$ was linear with a negative slope indicating the inverse order of dependence in $[H^+]$.

Table-4

$$[\text{Hydroquinone}] = 3.0 \times 10^{-2} \text{ mol dm}^{-3}$$

$$[\text{NCPD}] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$$

Solvent = 80%(v\ v) acetic acid-water

Temperature = 40°C

pH	$[H^+] \times 10^{-3} \text{ mol dm}^{-3}$	$k_1 \times 10^4 \text{ s}^{-1}$
1.95	11.220	0.60
2.17	6.761	69
2.39	4.074	1.66
2.64	2.291	97

2.80	1.585	4.33
		04
		8.52
		11
		12.5
		361

Effect of varying the dielectric constant

The reaction were carried out at different percentage acetic acid – water (v/v) mixture containing 65,70,75,80 and 85% and the rate constants were found to increase with increase in the percentage of acetic acid (Table-5).

Table-5

[Hydroquinone] = $3.0 \times 10^{-2} \text{ mol dm}^{-3}$

[NCPD] = $1.0 \times 10^{-3} \text{ mol dm}^{-3}$

[HClO₄] = 1.5 mol dm^{-3}

Temperature = 40°C

Acetic acid %(v\v)	$k_1 \times 10^4 \text{ s}^{-1}$
65	0.3153
70	0.4581
75	1.1687
80	4.3304
85	7.8498

Effect of varying the temperature

The reactions have been studied at five different temperatures keeping the other factors constant. The following thermodynamic parameters have been computed from the linear plot of $(\ln k_2/T)$ Vs $(1/T)$ of Eyring's equation (Table-6).

Table-6

$$\Delta H^\# = 71.06 \text{ kJ mol}^{-1}$$

$$\Delta S^\# = -75.37 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta G^\# = 94.65 \text{ kJ mol}^{-1}$$

$$[\text{Hydroquinone}] = 3.0 \times 10^{-2} \text{ mol dm}^{-3}$$

$$[\text{NCPD}] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$$

$$[\text{HClO}_4] = 1.5 \text{ mol dm}^{-3}$$

Temperature = 40°C

The specific reaction rate k_2 was calculated using $k_1/[\text{S}]^{0.285}$

MECHANISM OF HYDROQUINONE

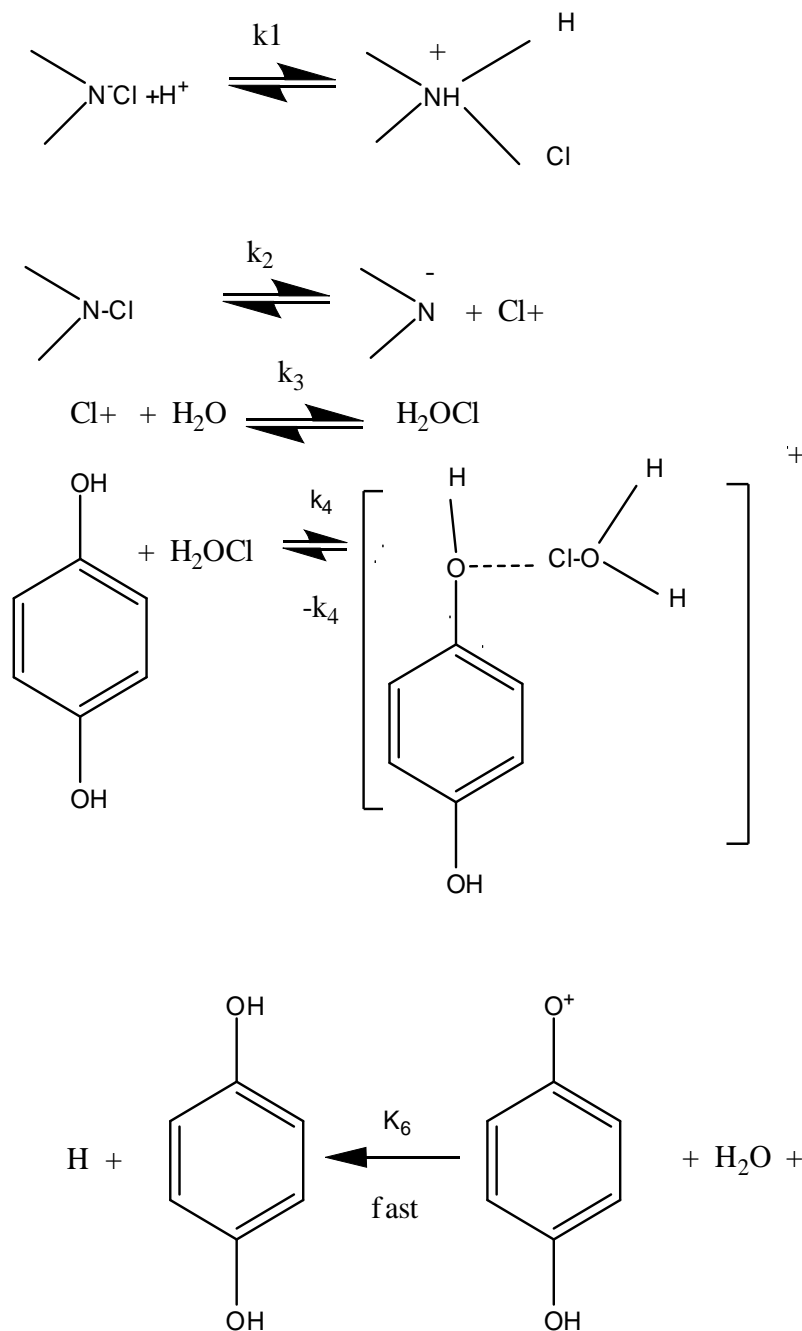
From the above observations it is clear that the reaction is showing first order dependence with respect to [oxidant] and fractional order with respect to [substrate]. The rate is showing inverse order of dependence with respect to the $[\text{H}^+]$ ions.

The rate shows no appreciable change on changing the ionic strength of the medium. But the rate increase with increase of percentage of acetic acid. The N-Cl bond in N-chloropiperazine-2,5-dione is partially polar similar to N-Br bond in N-bromosuccinimide. Various possible oxidizing species in acidified solution are the molecular NCPD, protonated NCPD i.e. NCPDH^+ , solvated chlorocation $[\text{H}_2\text{OC1}]$ and HOCl .

As the reaction rate is not inhibited by acetonitrile, the chlorine is not the reacting species. As the protonation and deprotonation are said to be fast, at this higher acidic solution both NCPD and NCPDH^+ are less likely to be the reactive species. Moreover, as the reaction rate increase with the decrease of acidity, NCPDH^+ is not considered as the reactive species. At low pH, among HOCl and $\text{H}_2\text{O}+\text{Cl}$, the

protonated form is predominating, also this is a strong electrophile and a more potent reactive species.

Moreover, as the reaction rate increase with the decrease of acidity, NCPDH^+ is not considered as the reactive species. At low pH, among HOCl and $\text{H}_2\text{O}+\text{Cl}$, the protonated form is predominating, also this is a strong electrophile and a more potent reactive species.



$$\text{Rate of the reaction} = k_s[\text{complex}]$$

Applying the steady state approximation for the complex formed we will get,

$$k_4[S][H_2O+Cl] - k_{-4}[C_1] - k_5[C_1] = 0$$

$$[\text{Complex}] = \frac{k_4[S][H_2O+Cl]}{k_{-4} - k_5 + [S]}$$

But

$$\begin{aligned}
 \text{H}_2\text{O} + \text{Cl} &= k_3 k_2 [\text{NCPD}]_f [\text{H}_2\text{O}] \\
 [\text{NCPD}]_f &= [\text{NCPD}]_t \\
 &\text{-----} \\
 &1+k_1[\text{H}^+] \\
 \text{Rate} &= k_5 k_4 [\text{S}] [\text{NCPD}]_t \\
 &\left\{ \frac{k_{-4}+k_5}{k_1} + [\text{S}] \right\} \left\{ 1+k_1[\text{H}^+] \right\}
 \end{aligned}$$

This rate law is in accordance with the proposed mechanism.

CONCLUSION

The kinetics of oxidation of hydroxyquinone by N-chloropiperazine-2,5-dione was studied in 80% and 75%(v/v) acetic acid-water medium. The order of the reaction was found to be one with respect to the [oxidant], fractional order with respect to the [substrate]. The reaction showed inverse order of dependence with respect to hydrogen ion concentration. Variation in the ionic strength of the medium has no appreciable change in the rate of the reaction. As the percentage of the acetic acid increases, the rate of the reaction increases. The reactions were studied at five different temperatures. The enthalpy of activation and entropy of activation are computed as 71.06KJmol⁻¹ and -75.37JK⁻¹mol⁻¹ for hydroquinone.

REFERENCES

1. Subramaniyan S P, Indian J.Chem.,1987,20:429
2. Ganapathy K and Vijayan B, J.Indian Chem.Soc.,1974,55:957
3. Palaniappan A N, J.Indian Chem. Soc.,1986,56:1102
4. Iyanar K J, Indian Chem.Soc.,1986,67:1108
5. Saradamani P N and Jaganadhan V, Indian Chem.,1990,29A:700
6. Rajalakshmi K, International Journal of Scientific Research,2019,8(2):27
7. Ahadevappa D S and .Naidu H M K, Aust.J.Chem,1974,27:1203
8. Kalyan K.Banerji, Indian J.Chem.,1997,15A:615
9. Rajalakshmi K, and T.Ramachandramoorthy,Research Journal of Chemistry and Environment,2012,16(4),87
10. Natarajan M M and Thiagarani V Ibid Perkin II,1975,1590
11. Rajalakshmi R, J.Indian Chem.Soc.,2002,70:1071
12. Morris D F C and Ritter T J, J.Less-common Met.,1979,65(2):49
13. Rajalakshmi K and T.Ramachandramoorthy, Journal of Chemistry,2013.

Chapter – XXII

22

MYCOTOXINS BIOLOGICAL DETOXIFICATION OF MYCOTOXINS BY LAB (LACTIC ACID BACTERIA)

Sowmya K L

Research Scholar, Department of Studies in
Microbiology, Davangere University, Davangere-
577007, Karnataka, India. E-mail:
swomyakl456@gmail.com

Ramalingappa B

Professor, Department of Studies in Microbiology,
Davangere University, Davangere-577007, Karnataka,
India. E-mail: ramalingappa.88@gmail.com

Abstract

Mycotoxins are poisonous by-products of fungi that can appear in bakery foods including bread, cake, and biscuits, among others. Mycotoxins produced by filamentous fungus (moulds) have a severe impact on the sustainability of food supply and cause significant economic loss. High levels of mycotoxins in bakery food products pose a serious health risk to consumers and are essentially unavoidable. Mycotoxins can enter our food chain directly through plant-based dietary ingredients that are contaminated with them, or indirectly through the growth of toxic fungi on food. To solve this issue, biological detoxification has demonstrated a significant potential for mass-scale, cost-effective food detoxification. Mycotoxins can be biologically degraded, and because it operates in a benign environment, it has showed potential. The most economically relevant mycotoxins are thought to be aflatoxin (AF), zearalenone (ZEA), patulin (PAT), and deoxynivalenol (DON), due to their great occurrence and considerable adverse effects on animals and human health. The ability of lactic acid bacteria to remove mycotoxins was well demonstrated.

Key words: Fungi, Mycotoxins, Analysis, Lactic acid bacteria, Enzymes and biological decontamination.

Introduction:

Mycotoxins, named from the coupling of the ancient Greek words mykes and toxon, meaning “mold” and “poisonous arrow” respectively, are products of the secondary metabolism of filamentous fungi (Kizis *et al.*, 2021). Mycotoxins are toxic metabolites produced by fungi (Guan *et al.*, 2011; Wu *et al.*, 2013). They are mostly found to be natural contaminants of food products sold by supermarket chains and grocery markets and are detrimental to human health. They induce negative effects on human health by making food unsafe for consumption (Chen *et al.*, 2016). Molds of the genus *Aspergillus*, *Fusarium* and *Penicillium* are the most important in producing mycotoxins. Aflatoxins, produced mainly by *Aspergillus flavus* and *Aspergillus parasiticus* (Wogan and Pong, 1970), are recognized as the most hazardous mycotoxins. While the most common mycotoxins found in bakery food products are aflatoxins B1, B2, G1 and G2, Ochratoxin A, Fumonisin B1, B2 and B3, Zearalenone, Deoxynivalenol and Patulin (Streit *et al.*, 2013) (**Table 1**). Mycotoxin contamination is one of the most relevant and worrisome problems concerning food safety, since they cause a variety of toxic effects in humans and animals, due to their different chemical structures. Decontamination is the most suitable method to reduce

mycotoxin levels in foods, in which these toxins are removed from the raw material before it is consumed. There are many physical, chemical, and biological methods being used for food and feed decontamination (Yang *et al.*,2017) **(Figure 1)**.

However, the biological decontamination of mycotoxins was proposed as a very promising alternative with the possibility of using hundreds of microorganisms including fungi, yeast, and bacteria (Wu *et al.*, 2009). Biological detoxification is defined as the application of microorganism enzymes and their metabolites for mycotoxin degradation. Biological detoxification, which has the potential to use hundreds or even thousands of suitable microorganisms, lactic acid bacteria is the major microorganisms for the degradation of mycotoxins and metabolites, or detoxification is identified as the biotransformation of mycotoxins into less or nontoxic compounds.

Table 1: Major mycotoxins in bakery food products and their effects.

MYCOTOXINS	FUNGAL SPECIES	BAKERY FOOD PRODUCTS	EFFECTS
Aflatoxins B1, B2, G1, G2	<i>Aspergillus flavus</i> <i>Aspergillus parasiticus</i>	Biscuits, Bread, Peda, Ladoo etc	Cancerogenic, teratogenic, Mutagenic
Aflatoxin M1	Metabolite of aflatoxin B1	Peda, Burfi etc	Cancerogenic
Ochratoxin A	<i>Aspergillus ochraceus</i> <i>Penicillium verrucosum</i> <i>Aspergillus carbonarius</i>	Chips, Peda, Cake, Burfi etc	Nephrotoxic and neurotoxic effects, affects mammary functions
Fumonisin B1, B2 and B3	<i>Fusarium verticillioides</i> <i>Fusarium proliferatum</i>	Bun, Bread, Peda, etc	Neurotoxicity, Hepatotoxicity
Zearalenone	<i>Fusarium graminearum</i> <i>Fusarium culmorum</i>	Rasgolla, Cream Bun, Peda, Biscuits etc	Cytogenetic toxicity, decreases fertility, embryotoxicity, immunotoxicity, estrogenic, anti-androgenic activities
Deoxynivalenol	<i>Fusarium graminearum</i> <i>Fusarium culmorum</i>	Bakery products	Intestinal damage, emetic immune toxic
Patulin	<i>Penicillium expansum</i>	Apple cake, fruit cake etc	Genotoxicity, mutagenicity, gastrointestinal disorders

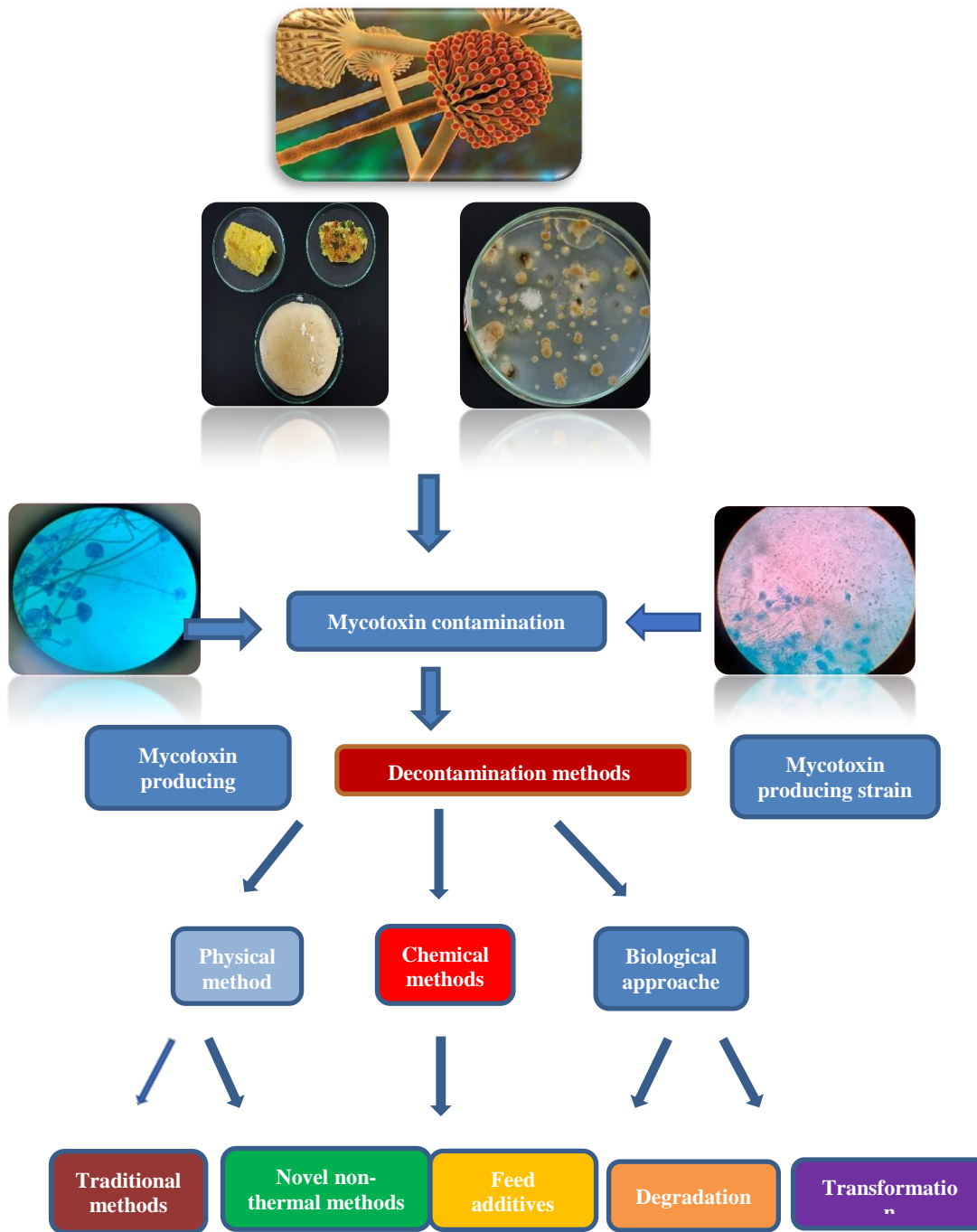


Figure 1: Schematic representation of mycotoxin detoxification methods.

Occurrence of major mycotoxin contamination:

A set of harmful, structurally similar secondary metabolites known as **aflatoxins (Figure 2)** are mostly produced by *Aspergillus* species found in foods, such as *A.flavus* and *A.parasiticus*. Aflatoxin comes in a variety of types, including B1, B2, G1, G2, M1, and M2 (Sato *et al.*, 2012). The most prevalent of these mycotoxins in foods is type B1. *A.flavus* strains can create AFB1 and AFB2, while *A.parasiticus* strains can produce AFB1, AFB2, AFG1 and AFG2 (Bennett *et al.*, 2003).

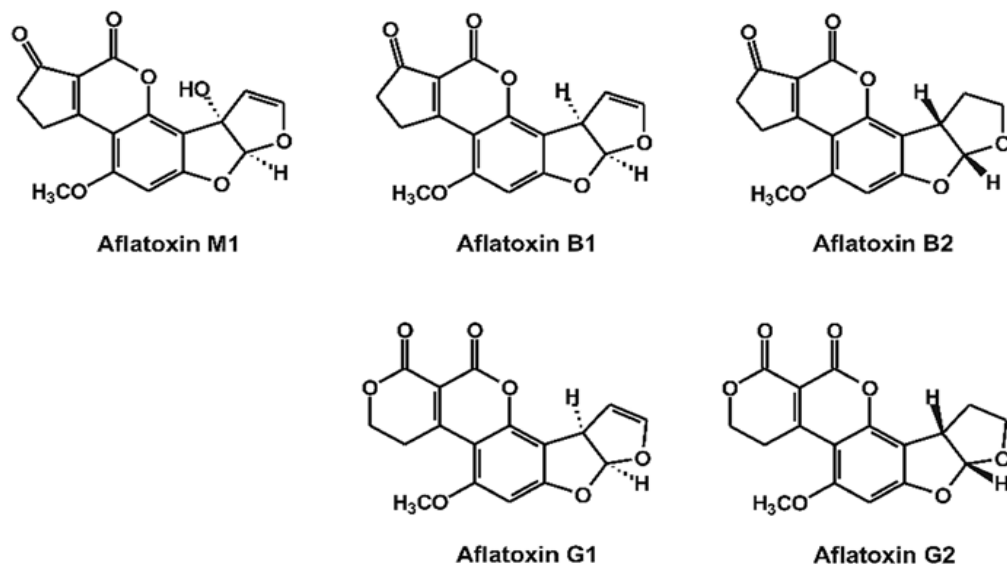


Figure 2: Chemical structure of Aflatoxins

(www.chemspider.com).

Aspergillus and *Penicillium* species of fungi produces **ochratoxins**, which are mycotoxins that can cause tumours in both humans and animals (Hussein *et al.*, 2001). The most harmful toxin in this group, ochratoxin A, has been linked to several medical issues, including nephrotoxic, hepatotoxic, teratogenic, and carcinogenic disorders (Wahhab *et al.*, 2005). Ochratoxins A can be found in pork products, dried vine fruit, beer, wine, cocoa, cereals, and other beverages (Wanigasuriya *et al.*, 2008). Ochratoxin A is typically found in solid meals, making biological detoxification particularly challenging. In numerous foods, LAB strains and their metabolites demonstrated antagonistic and synergetic degrading activity.

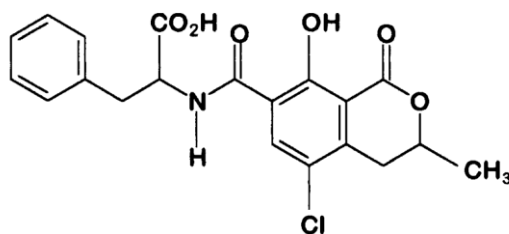


Figure 3: Chemical structure of Ochratoxin A

(www.chemspider.com)

Fumonisins, a kind of non-fluorescent mycotoxin, were identified in 1988. In contrast to most other mycotoxins, fumonisins are hydrophilic mycotoxins that can disintegrate completely in organic solvents (Bennett *et*

al.,2003). *F. proliferatum* also produces fumonisins. The majority of the fumonisins family, or fumonisin B1 (FB1), are found in plants. Frequently contaminates maize kernels with FB1 (Reddy *et al.*, 2010). Sorghum, wheat, barley, soybeans, asparagus spears, figs, black tea, and medicinal herbs can also contain fumonisins (Sweeney *et al.*,1998).

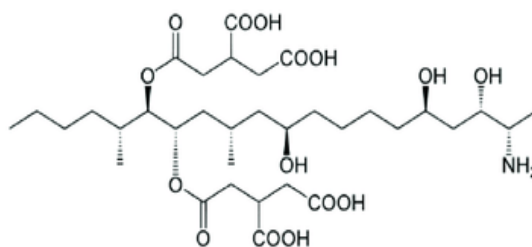


Figure 4: Chemical structure of Fumonisin (www.chemspider.com).

Fusarium fungi, such as *Fusarium graminearum*, *Fusarium culmorum*, *Fusarium cerealis*, *Fusarium equiseti*, and *Fusarium crookwellense*, produce the estrogenic mycotoxin **zearalenone (Figure 5)**, formerly known as F2 toxin. Contamination occurs primarily in maize, wheat, and barley fields and is frequently found in corn, sorghum (Hussein *et al.*, 2001).

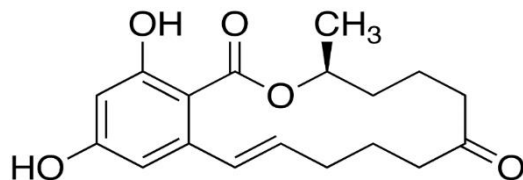


Figure 5: Chemical structure of Zearalenone (www.chemspider.com).

A polyketide mycotoxin, **patulin (Figure 6)** is a water-soluble mycotoxin that was first identified in 1943. It is created by specific *Penicillium* and *Aspergillus* species that grow on fruits and vegetables, with *P.expansum* being the fungus that produces the most of it (Bennett *et al.*,2003). Patulin contamination may also affect other fruits like pears, peaches, and grapes even though it mostly affects apples, apple juice, and apple goods (Harrison *et al.*, 1989).

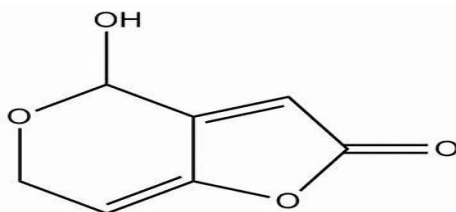


Figure 6: Chemical structure of Patulin (www.chemspider.com).

Biological detoxification is a promising alternative, with the possibility of using hundreds or thousands of suitable microorganisms and metabolites (Wang & Xie, 2020). For detoxification, microorganisms to be used should meet a certain such as being safe to use, non-pathogenic (Deshpande.,2002). Several microorganisms have been suggested to serve as detoxification agents in food. Fungi, yeast, and bacteria are the most common microorganisms used for the detoxification of food (Varga *et al.*, 2005). Karlovsky,1999, the potential of using several microorganisms for detoxification including *Rhizopus* sp., *Corynebacterium rubrum*, *Candida*

lipolytica, *Aspergillus niger*, *Trichoderma viride*, *Mucor ambiguous*, *Neurospora* sp and lactic acid bacteria. Nichea *et al.*, reviewed several fungi belonging to the genus *Aspergillus* sp, were reported to have the ability to degrade and convert aflatoxins B1 to B2 and B3 from foodstuffs due to their enzymes.

In contrast, several studies reported the possibility of using certain bacteria for detoxification of mycotoxins in foodstuffs (Sato *et al.*, 2012). *Flavobacterium aurantiacum* was one of the first used bacteria to degrade aflatoxin B1 in feed and it was observed that the activity is related to the bacterial enzymes (Smiley *et al.*, 2000). Sangare *et al.*, demonstrated the detoxification activity of *Pseudomonas aeruginosa* N17-1, which was able to highly degrade several aflatoxins including aflatoxin B1, B2, and M1 in nutrient broth. In addition, some microorganisms were reported to utilize mycotoxins as their source of carbon. The bacteria belonging to the *Agrobacterium -Rhizobium* group isolated from soil was able to convert deoxynivalenol to a less toxic metabolite named 3-keto-4-deoxynivalenol (Shima *et al.*, 1997). Bondy *et al.*, the bacterium *Devosia mutans* 17-2-E-8 degraded deoxynivalenol and the major metabolite was 3-keto-deoxynivalenol, and both showed a toxicity lower than that of the mycotoxin.

Detoxification of mycotoxins by LAB (Lactic Acid Bacteria):

Lactic acid bacteria (LAB) are one of the major microorganisms used for the degradation of mycotoxins this is because they are very safe for use in food and naturally grow in the human gut and makes them function well for the removal of mycotoxins (Nichea *et al.*,2015). LAB produces numerous proteolytic enzymes that can hydrolyze proteins that includes cell wall bound proteinase that hydrolyzes the protein into polypeptides and peptide transporters that transfers the peptides into the cell, and the intracellular peptidases that degrade the transferred peptides to amino acids (Wu *et al.*,2009). In food stuffs, the proteolytic enzymes of LAB play an important in the detoxification process (Abrunhosa *et al.*, 2010). Lactic acid bacteria have two important mechanisms for mycotoxin detoxification from foods. The use of viable LAB or by using enzymes produced by LAB. Several bioactive metabolites produced from LAB, and these can be able to inhibit the growth of fungi and also prevent the food contamination or toxins production from fungi (mycotoxins) (Nichea *et al.*,2015). Several studies reported (El-Nezami *et al.*,1998, Peltonen *et al.*,2001, Sezer *et al.*,2013, Mendoza *et al.*,2009, Slizewska *et al.*,2011, Huang *et al.*, 2017, Fuchs *et al.*, 2008, Luz *et al.*, 2018, Franco *et al.*, 2011, Rogowska *et al.*,2019) mycotoxins in foods can be degraded (detoxification) up to 80-90% by using

LAB(Figure 7 and Figure 8).

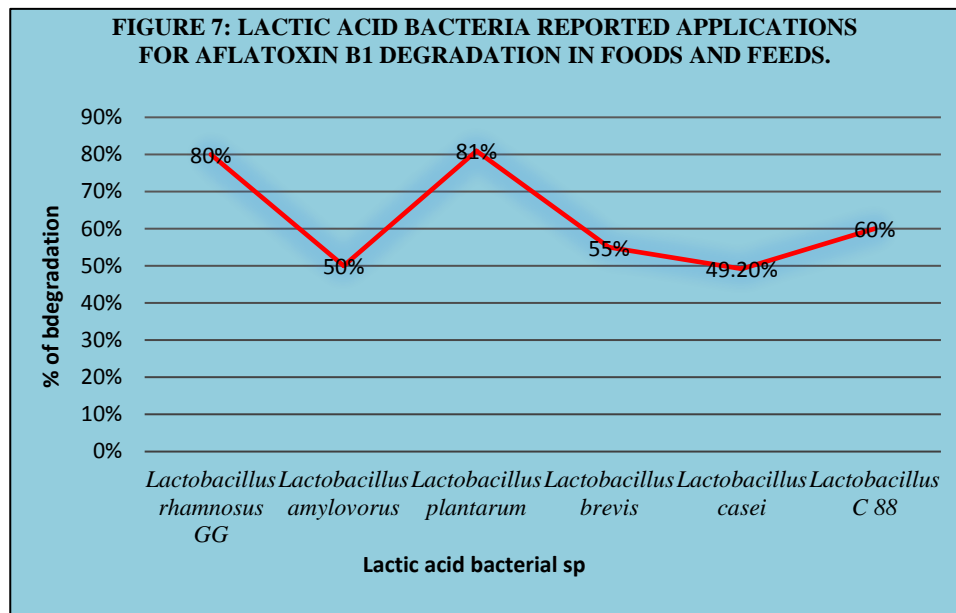


Figure 7: Lactic acid bacteria reported Aflatoxin B1 degradation in food and feeds.

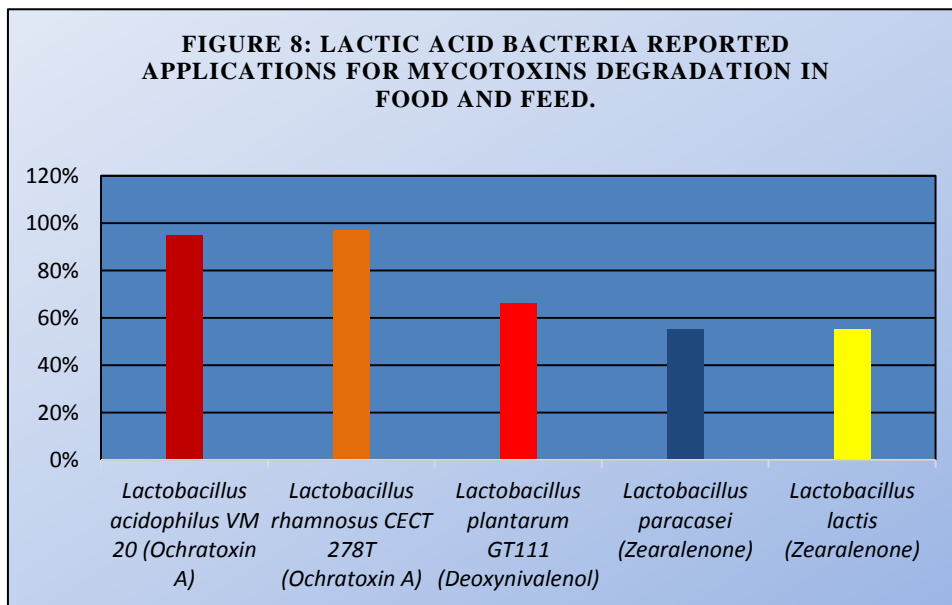


Figure 8: Lactic acid bacteria reported different mycotoxins degradation

in food and feeds.

Degradation of Aflatoxin by LAB:

According to reports, the interaction with the targeted fungi, gene expression is the process by which aflatoxin B1 is degraded. A correlation was shown between the decrease in the Omt-A gene (60–70%), which is necessary for the conversion of sterigmatocystin to O-methylsterigmatocystin for aflatoxin B1 biosynthesis, and the reduction in aflatoxin B1 generated by *Aspergillus flavus* and *Aspergillus parasiticus* (Gomaa *et al.*, 2018). The results of this investigation showed that the high cell density needed for detoxification limited the use of that strain for food applications. The capacity of the bacterial cell to attach to aflatoxin B1 allowed the strains *L. amylovorus* and *L. rhamnosus* to destroy more than 50% of it (Slizewska *et al.*, 2011). In a different investigation, a single strain (*L. plantrium*) combined with the yoghurt strains (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) produced yoghurt with a high level of aflatoxin M1 breakdown. Several LAB isolates can decrease the aflatoxin content in a variety of liquid, semiliquid, and solid food systems, according to prior investigations on aflatoxins. Therefore, a viable approach for a variety of food applications is the biological detoxifying activity of LAB (Elsanhoty *et al.*, 2014).

Degradation of Ochratoxin by LAB:

In numerous foods, LAB strains and their metabolites demonstrated antagonistic and synergetic degrading activity. Due to its antagonistic activity, the strain *L. acidophilus* VM 20 significantly reduced the concentration of ochratoxin A in a liquid media (by 95%). Hepatoma cell line (HepG2) was used to further demonstrate the detoxifying activities, with the new strain digesting more than 50% of ochratoxin A (Fuchs *et al.*, 2008). The researchers found that the ochratoxin A concentration, LAB cell density, pH level, and LAB cell viability all affect the LAB binding activity. When examined in liquid media, *L. rhamnosus* GG, *L. acidophilus* CH-5, *L. plantarum* BS, *L. sanfranciscensis*, and *L. brevis* displayed a 50% reduction in ochratoxin A; however, the binding of ochratoxin A with LAB cells was found to be reversible (Piotrowska & Zakowska, 2005). A 30-minute incubation in 1 M phosphate buffer (sodium acetate 0.615%, EDTA 0.1%, MgCl₂ 0.254%, raffinose 29.72%, pH 6.2) showed a 50% reduction in ochratoxin A, according to an in vitro study of the detoxifying activities of the LAB strains *L. plantarum*, *L. brevis*, and *L. sanfranciscensis*. The increase in hydrophobicity, according to the researchers, is what caused the thermally inactivated LAB cells to absorb ochratoxin A to such a degree (Piotrowska *et al.*, 2014). The detoxifying activity of *Pediococcus parvulus*

towards ochratoxin A in a liquid environment was identified by Abrunhosa *et al.*, 90% of ochratoxin A was broken down in 19 hours under ideal circumstances (incubation at 30 °C for 7 days). This was accomplished by the conversion of OTA into OT α . The inoculum size and incubation temperature had a significant impact on the degradation activity. To increase the activity of ochratoxin A breakdown, a recent study showed the benefit of combining various LAB strains with *Saccharomyces cerevisiae* in a symbiotic system (Markowiak *et al.*, 2019).

Degradation of Patulin by LAB:

Studies on patulin biodegradation by LAB strains are quite few. 80% of patulin is degraded by *Bifidobacterium animalis* VM, and the activity was found to be correlated with both the media patulin content and LAB cell density. Using the human hepatoma cell line (HepG2), which demonstrated an enhanced division rate in the presence of the chosen LAB, the detoxifying activity was further validated (Abrunhosa *et al.*, 2014 & Fuchs *et al.*, 2008). In a liquid medium, the heat-inactivated *L. brevis* 20,023 demonstrated a strong ability to bind patulin to the cell walls of the chosen LAB. The adsorption of patulin into the LAB cells was found to be greatly enhanced by the presence of functional groups, such as polysaccharides and proteins (Wang & Xie, 2020). The proportion of patulin degraded by the

LAB strains *Bifidobacterium bifidum* 6071 and *L. rhamnosus* 6149 in a liquid system at pH 4 and incubation temperature of 37 °C was 52.9% for viable cells (Hatab *et al.*,2012). Patulin can be greatly degraded at low pH levels, and this may be the main factor in the LAB degradation activity. In a very recent study, chemical degradation of patulin in the presence of ascorbic acid apple juice was evaluated. The patulin was reduced by 60% in the apple juice mixed with 0.25% (*w/v*) ascorbic acid, and the biodegradation led to the production of less-toxic metabolites (Assaf *et al.*, 2019).

Conclusions and Future study:

Mycotoxins are unpredictable and unavoidable contaminants in food stuffs worldwide. Various fungi produce several mycotoxins in food stuffs, and these are the main source of a serious health threat to consumers. Decontamination is the most suitable method to reduce mycotoxin levels in foods, in which these toxins are removed from the raw material before it is consumed. There are many physical, chemical, and biological methods being used for food and feed decontamination. Biological detoxification is a very promising alternative, with the possibility of using hundreds and/or thousands of suitable microorganisms, LAB is the major microorganisms for the degradation of mycotoxins and metabolites, or detoxification is identified as the biotransformation of mycotoxins into less or nontoxic

compounds. Certain LAB strains were found to be able to remove different mycotoxins from food stuffs by binding to their cell wall or by degrading with their enzymes. However, more effort is needed to determine the mechanisms of mycotoxin degradation. Future study should be focus on combining LAB strains that have different detoxification mechanisms to improve the efficiency of mycotoxin degradation. In addition, it is important to identify and choose the best enzymes and microbes for efficient detoxification as well as to examine the enzymatic characteristics and their catalytic functions in food.

References:

1. Abdel-Wahhab M.A., Abdel-Galil M.M., El-Lithey M. (2005). Melatonin counteracts oxidative stress in rats fed an ochratoxin A contaminated diet. *J. Pineal Res.* 38:130–135.
2. Abrunhosa L., Ines A., Rodrigues A.I., Guimaraes A., Pereira V.L., Parpot P., Venancio A. (2014). Biodegradation of ochratoxin A by *Pediococcus parvulus* isolated from Douro wines. *Int. J. Food Microbio.* 188: 45–52.
3. Abrunhosa L., Paterson R.R., Venâncio A. (2010). Biodegradation of ochratoxin A for food and feed decontamination. *Toxins.* 2:1078–1099.
4. Alberts J.F., Gelderblom WCA, Botha A., van Zyl W.H. (2009). Degradation of aflatoxin B1 by fungal laccase enzymes. *Int J Food*

*Microbiol.*135:47–52.

5. Ananthi V., Subramanian R.S., Arun A. (2016). Detoxification of Aflatoxin B1 using Lactic acid bacteria. *Int. J. Biosci. Technol.*9:40.

6. Assaf J C., Nahle S., Chokr A., Louka N., Atoui A., El Khoury A. (2019). Assorted methods for decontamination of aflatoxin M1 in Milk using microbial adsorbents. *Toxins.*11:304

7. Ashiq S. (2015). Natural occurrence of mycotoxins in food and feed: Pakistan perspective. *Compr. Rev. Food Sci. Food Saf.*14:159–175.

8. Assaf C.E.H., De Clercq N., Van Poucke C., Vlaemynck G., Van Coillie E., Van Pamel E. (2019). Effects of ascorbic acid on patulin in aqueous solution and in cloudy apple juice. *Mycotoxin Res.*35:341–351.

9. Belal J., Muhialdin., Nazamid saari., Anis Shobirin Meor Hussin. (2020). Review on the Biological Detoxification of Mycotoxins Using Lactic Acid Bacteria to Enhance the Sustainability of Foods Supply. *Molecules*, 25:1-12.

10. Ben Taheur F., Kouidhi B., Al Qurashi YMA., Ben Salah-Abbès J., Chaieb K. (2019). Review: biotechnology of mycotoxins detoxification using microorganisms and enzymes. *Toxicon.*160:12–22.

11. Bennett J.W., Klich M. (2003). Mycotoxins. *Clin. Microbiol. Rev.* 16:497–516.

12. Boevre M., Mavungu J.D., Landshchoot S., Audenaert K., Eeckhout

M., Maene P. (2012). Natural occurrence of mycotoxins and their masked forms in food and feed products. *World Mycotoxin J.* 5:207–219.

13. Corassin C H., Bovo F., Rosim R E., Oliveira CAFF. (2013). Efficiency of *Saccharomyces cerevisiae* and lactic acid bacteria strains to bind aflatoxin M1 in UHT skim milk. *Food Control.* 31:80–83.

14. Chang X., Wu Z., Wu S., Dai Y., Sun C. (2015). Degradation of ochratoxin A by *Bacillus amyloliquefaciens* ASAG1. *Food Addit Contam - Part A Chem Anal Control Expo Risk Assess.* 32:564–571.

15. Chapot-Chartier M.P., Kulakauskas S. (2014). Cell wall structure and function in lactic acid bacteria. *Microb. Cell Fact.* 13:S9.

16. Deshpande S.S. (2002). Toxic metals, radionuclides, and food packaging contaminants. *Hand Book of Food Toxicology.* pp. 783–810.

17. Dimosthenis Kizis., Aikaterini-Eleni Vichou and Pantelis I., Natskoulis. (2021). Recent Advances in Mycotoxin Analysis and Detection of Mycotoxigenic Fungi in Grapes and Derived Products. *Sustainability,* 13:1-26.

18. El-Nezami H., Kankaanpaa P., Salminen S., Ahokas J. (1998). Ability of dairy strains of lactic acid bacteria to bind a common food carcinogen, aflatoxin B1. *Food Chem. Toxicol.* 36:321–326.

19. Elsanhoty R.M., Salam S.A., Ramadan M.F., Badr F.H. (2014).

Detoxification of aflatoxin M1 in yoghurt using probiotics and lactic acid bacteria. *Food Control*.43:129–134.

20. Fandohan P., Zoumenou D., Hounhouigan D J, Marasas W F O., Wingfeld M J., Hell K. (2005) Fate of aflatoxins and fumonisins during the processing of maize into food products in Benin. *Int J Food Microbiol*.98:249– 259.

21. Franco T.S., Garcia S., Hirooka E.Y.,Ono Y.S., Dos Santos J.S. (2011). Lactic acid bacteria in the inhibition of *Fusarium graminearum* and deoxynivalenol detoxification. *J. Appl. Microbiol*. 111:739–748.

22. Fuchs S., Sontag G., Stidl R., Ehrlich V., Kundi M., Knasmüller S. (2008). Detoxification of patulin and ochratoxin A, two abundant mycotoxins, by lactic acid bacteria. *Food Chem. Toxicol*. 46:1398–1407.

23. Gomaa E.Z., Abdelall M.F., El-Mahdy O.M. (2018). Detoxification of aflatoxin B1 by antifungal compounds from *Lactobacillus brevis* and *Lactobacillus paracasei*, isolated from dairy products. *Probiotics Antimicrob. Proteins*.10:201–209.

24. Gruber-Dorninger C., Faas J., Doupovec B., Aleschko M., Stoiber C., Höbartner-Gußl A. (2021). Metabolism of Zearalenone in the rumen of dairy cows with and without application of a Zearalenone-degrading enzyme. *Toxins*.13:1–18.

25. Guan S., Yin Y., Zhou T., Xie M., Ruan Z., Young J C. (2011). Microbial strategies to control aflatoxins in food and feed. *World Mycotoxin J.* 4:413-24.
26. Guan Y., Chen J., Nepovimova E., Long M., Wu W., Kuca K. (2021) Aflatoxin detoxification using microorganisms and enzymes. *Toxins.* 13:1–17.
27. Hahn I., Kunz-Vekiru E., Twaruzek M., Grajewski J., Krska R., Berthiller F. (2015) Aerobic and anaerobic in vitro testing of feed additives claiming to detoxify deoxynivalenol and zearalenone. *Food Addit Contam - Part A Chem Anal Control Expo Risk Assess.* 32:922–933.
28. Harrison M A., (1989). Presence and stability of patulin in apple products: A review. *J. Food Saf.* 9: 147–153.
29. Hatab S., Yue T., Mohamad O. (2012). Removal of patulin from apple juice using inactivated lactic acid bacteria. *J. Appl. Microbiol.* 112:892–899.
30. Hathout A S., Aly S E. (2014) Biological detoxification of mycotoxins: A review. *Ann Microbiol.* 64:905–919.
31. He J W., Bondy G S., Zhou T., Caldwell D., Boland G J., Scott P M. (2015). Toxicology of 3-epi-deoxynivalenol, a deoxynivalenol-transformation product by *Devosia mutans* 17–2-E-8. *Food Chem. Toxicol.*

84:250–259.

32. Heintl S., Hartinger D., Thamhesl M., Schatzmayr G., Moll W D., Grabherr R. (2011). An aminotransferase from bacterium ATCC 55552 deaminates hydrolyzed fumonisin B1. *Biodegradation* 22:25–30.

33. Hernandez-Mendoza A., Garcia H S., Steele J L. (2009). Screening of *Lactobacillus casei* strains for their ability to bind aflatoxin B1. *Food Chem Toxicol.* 47:1064–1068.

34. Huang L., Duan C., Zhao Y., Gao L., Niu C., Xu J., Li S. (2017). Reduction of aflatoxin B1 toxicity by *Lactobacillus plantarum* C88: A potential probiotic strain isolated from Chinese traditional fermented food “tofu”. *PLOS ONE.* 12:1-6.

35. Hummel W and Groger H. (2014). Strategies for regeneration of nicotinamide coenzymes emphasizing self-sufficient closed-loop recycling systems. *J. Biotechnol.* 191:22–31.

36. Hussein H S., Brasel J M. (2001). Toxicity, metabolism, and impact of mycotoxins on humans and animals. *Toxicology.* 167:101–134.

37. Juodeikiene G., Bartkiene E., Cernauskas D., Cizeikiene D., Zadeike D., Lele V., Bartkevics V. (2018). Antifungal activity of lactic acid bacteria and their application for *Fusarium* mycotoxin reduction in malting wheat grains. *LWT.* 89:307–314.

38. Karlovsky P., Suman M., Berthiller F., De M J., Eisenbrand G., Perrin I., Oswald I P, Speijers G. (2016). Impact of food processing and detoxification treatments on mycotoxin contamination. *Mycotoxin Res.*32:179–205.
39. Kensler T W., Roebuck B D., Wogan G N., Groopman J D. (2011). Aflatoxin: A 50-year odyssey of mechanistic and translational toxicology. *Toxicol. Sci.* 120: S28–S48.
40. Khan G I. 2020. Eco-friendly bacterial biodegradation of mycotoxins. *Pure Appl. Biol.* 9:1708–1717.
41. Khaneghah A M., Chaves R D., Akbarirad H. (2017). Detoxification of aflatoxin M1 (AFM1) in dairy base beverages (acidophilus milk) by using different types of lactic acid bacteria-mini review. *Curr. Nutr. Food Sci.*13:78–81.
42. Khaneghah A M., Farhadi A., Nematollahi A., Vasseghian Y., Fakhri Y. (2020). A systematic review and meta-analysis to investigate the concentration and prevalence of trichothecenes in the cereal-based food. *Trends Food Sci. Technol.*102:193–202.
43. Kim S H., Vujanovic V. (2017). Biodegradation and biodetoxification of *Fusarium* mycotoxins by *Sphaerodes mycoparasitica*. *AMB Express* 7:1–9.

44. Lee W H., Kim M D., Jin Y S., Seo J H. (2013). Engineering of NADPH regenerators in *Escherichia coli* for enhanced biotransformation. *Appl. Microbiol. Biotechnol.* 97:2761–2772.
45. Loi M., Fanelli F., Cimmarusti M T., Mirabelli V., Haidukowski M., Logrieco A F., Caliandro R., Mule G. (2018). In vitro single and combined mycotoxins degradation by Ery4 laccase from *Pleurotus eryngii* and redox mediators. *Food Control.* 90:401–406.
46. Luz C., Ferrer J., Manes J., Meca G. (2018). Toxicity reduction of ochratoxin A by lactic acid bacteria. *Food Chem. Toxicol.* 112:60–66.
47. Lyagin I., Efremenko E. (2019). Enzymes for detoxification of various Mycotoxins: origins and mechanisms of catalytic action. *Molecules.* 24:2363.
48. Markowiak P., Slizewska K., Nowak A., Chlebicz A., Zbikowski A., Pawlowski K., Szeleszczuk P. (2019). Probiotic microorganisms detoxify ochratoxin A in both a chicken liver cell line and chickens. *J. Sci. Food Agric.* 99:4309–4318.
49. Mazzoni E., Scandolara A., Giorni P., Pietri A., Battilani P. (2011). Field control of *Fusarium* ear rot, *Ostrinia nubilalis* (Hübner), and fumonisins in maize kernels. *Pest Manag. Sci.* 67:458–465.
50. Ming-Tzai Chen., Yuan-Hsin Hsu., Tzu-Sui Wang., Shi-Wern

Chien. (2016). Mycotoxin Monitoring for commercial foodstuffs in Taiwan. *Journal of Food and Drug Administration*. 24:147-156.

51. Moretti A., Logrieco A F., Susca A. (2017). Mycotoxins: An underhand food problem. *Methods Mol. Biol.* 1542:3–12.

52. Nichea M., Palacios S., Chiacchiera S., Sulyok M., Krska R., Chulze S., Ramirez M. (2015). Presence of multiple mycotoxins and other fungal metabolites in native grasses from a wetland ecosystem in Argentina intended for grazing cattle. *Toxins*. 7:3309–3329.

53. Ostry V., Malir F., Toman J., Grosse Y. (2017). Mycotoxins as human carcinogens-the IARC Monographs classification. *Mycotoxin Res.* 33:65–73.

54. Oueslati S., Romero-Gonzalez R., Lasram S., Frenich A G. Vidal JLM. (2012). Multi-mycotoxin determination in cereals and derived products marketed in Tunisia using ultra-high performance liquid chromatography coupled to triple quadrupole mass spectrometry. *Food Chem Toxicol.* 50(7):2376-81.

55. Paris M P K., Schweiger W., Hametner C., Stückler R., Muehlbauer G J., Varga E. (2014). Zearalenone-16-o-glucoside: a new masked mycotoxin. *J. Agric. Food Chem.* 62:1181–1189.

56. Peltonen K., El-Nezami H., Haskard C., Ahokas J., Salminen S.

(2001). Aflatoxin B1 binding by dairy strains of lactic acid bacteria and *bifidobacteria*. *J. Dairy Sci.* 84:2152–2156.

57. Piotrowska M., Zakowska Z. (2005). The elimination of ochratoxin A by lactic acid bacteria strains. *Pol. J. Microbiol.* 54:279–286.

58. Piotrowska.(2014). The adsorption of ochratoxin A by *Lactobacillus* species. *Toxins.* 6:2826–2839.

59. Puel O., Galtier P., Oswald I P., (2010). Biosynthesis and toxicological effects of patulin. *Toxins.* 2:613–631.

60. Reddy K R N., Nurdijati S B., Salleh B. (2010). An overview of plant-derived products on control of mycotoxigenic fungi and mycotoxins. *Asian J. Plant Sci.* 9:126–133.

61. Rheeder J P., Marasas W F., Vismer H F. (2002). Production of fumonisin analogs by *Fusarium* species. *Appl. Environ. Microbiol.* 68:2101–2105.

62. Rogowska A., Pomastowski P., Walczak J., Railean-Plugaru V., Rudnicka J., Buszewski B. (2019). Investigation of Zearalenone Adsorption and Biotransformation by Microorganisms Cultured under Cellular Stress Conditions. *Toxins.* 11 :463-465.

63. Saladino F., Luz C., Manyes L., Fernandez-Franzon M., Meca G. (2016). In vitro antifungal activity of lactic acid bacteria against

mycotoxigenic fungi and their application in loaf bread shelf-life improvement. *Food Control*. 67:273–277.

64. Sangi F., Abbas M., Miman. (2018). Identification of new aflatoxin B1-degrading Bacteria from Iran. *Iran J Toxicol*.12:39–44.

65. Sato I., Ito M., Ishizaka M., Ikunaga Y., Sato Y., Yoshida S., Tsushima S. (2012). Thirteen novel deoxynivalenol-degrading bacteria are classified within two genera with distinct degradation mechanisms. *FEMS Microbiol*. 327:110–117.

66. Sezer C., Guven A., Oral N B., Vatansever L. (2013). Detoxification of aflatoxin B1 by bacteriocins and bacteriocinogenic lactic acid bacteria. *Turk. J. Vet. Anim. Sci*. 37:594–601.

67. Shima J., Takase S., Takahashi Y., Iwai Y., Fujimoto H., Yamazaki M., Ochi K. (1997). Novel detoxification of the trichothecene mycotoxin deoxynivalenol by a soil bacterium isolated by enrichment culture. *Appl. Environ. Microbiol*. 63:3825–3830.

68. Shu X., Wang Y., Zhou Q., Li M., Hu H., Ma Y., Chen X., Ni J., Zhao W., Huang S., Wu L. (2018). Biological degradation of aflatoxin B 1 by cell-free extracts of *Bacillus velezensis* DY3108 with broad PH stability and excellent thermostability. *Toxins*.10:1–15.

69. Slizewska K., Smulikowska S. (2011). Detoxification of aflatoxin

B1 and change in microflora pattern by probiotic in vitro fermentation of broiler feed. *J. Anim. Feed Sci.* 20:300–309.

70. Smiley R D., Draughon F A. (2000). Preliminary evidence that degradation of aflatoxin B1 by *Flavobacterium aurantiacum* is enzymatic. *J. Food Prot.* 63:415–418.

71. Stefano Sforza., Chiara Dall’asta., Rosangela Marchell. (2006). Recent Advances in Mycotoxin Determination in Food and Feed by Hyphenated Chromatographic Techniques/ Mass Spectrometry. *Mass Spectrometry Reviews*, 25:54-76.

72. Streit E., Naehrer K., Rodrigues I., Schatzmayr G. (2013). Mycotoxin occurrence in feed and feed raw materials worldwide: long-term analysis with special focus on Europe and Asia. *J Sci Food Agric.* 93(12):2892-99.

73. Sweeney M J., Dobson D W., (1998). Mycotoxin production by *Aspergillus*, *Fusarium* and *Penicillium* species. *Int. J. Food Microbiol.* 43:141–158.

74. Taheur F B., Fedhila K., Chaieb K., Kouidhi B., Bakhrouf A., Abrunhosa L. (2017). Adsorption of aflatoxin B1, zearalenone and ochratoxin A by microorganisms isolated from kefir grains. *Int J Food Microbiol.* 251:1–7.

75. Tang Y., Xiao J., Chen Y., Yu Y., Xiao X., Yu Y., Wu H. (2013). Secretory expression and characterization of a novel peroxiredoxin for zearalenone detoxification in *Saccharomyces cerevisiae*. *Microbiol Res.*168:6–11.
76. Varga J., Toth B. (2005). Novel strategies to control mycotoxins in feeds: A review. *Acta Vet. Hung*, 53:189–203.
77. Wang J., Ogata M., Hirai H., Kawagishi H. (2011). Detoxification of aflatoxin B1 by manganese peroxidase from the white-rot fungus *Phanerochaete sordida* YK-624. *FEMS Microbiol Lett.* 314:164–169.
78. Wang L., Wang Z., Yuan Y., Cai R., Niu C., Yue T. (2015). Identification of key factors involved in the biosorption of patulin by inactivated lactic acid bacteria (LAB) cells. *PloS ONE.* 10:0143431.
79. Wang G., Yu M., Dong F., Shi J., Xu J. (2017). Esterase activity inspired selection and characterization of zearalenone degrading bacteria *Bacillus pumilus* ES-21. *Food Control.*77:57–64.
80. Wang J Q., Yang F., Yang P L., Liu J., Lv Z H. (2018). Microbial reduction of zearalenone by a new isolated *Lysinibacillus* sp. ZJ-2016-1. *World Mycotoxin J.* 11:571–578.
81. Wang L., Wu J., Liu Z., Shi Y., Liu J., Xu X., Hao S., Mu P., Deng F., Deng Y. (2019). Aflatoxin B1 degradation and detoxification by *Escherichia*

coli CG1061 isolated from chicken cecum. *Front Pharmacol.* 9:1–9.

82. Wang J., Xie Y. (2020). Review on microbial degradation of zearalenone and aflatoxins. *Grain Oil Sci. Technol.*3:117–125.

83. Wanigasuriya K P., Peiris H., Ileperuma N., Peiris-John R J., Wickremasinghe R. (2008). Could ochratoxin A in food commodities be the cause of chronic kidney disease in Sri Lanka? *Trans. R. Soc. Trop. Med. Hyg.* 102:726–728.

84. Wogan G N., Pong RS. (1970). Aflatoxins. *Ann N Y Acad Sci.*174(2):623-35.

85. Wu L., Wang W., Yao K. (2013). Effects of dietary arginine and glutamine on alleviating the impairment induced by deoxynivalenol stress and immune relevant cytokines in growing pigs. *Plos One.* 8:69502.

86. Wu Q., Jezkova A., Yuan Z., Pavlikova L., Dohnal V., Kuca K. (2009). Biological degradation of aflatoxins. *Drug Metab. Rev.*41:1–7.

87. Yang X., Zhang Q., Chen Z Y., Liu H., Li P. (2017). Investigation of *Pseudomonas fluorescens* strain 3JW1 on preventing and reducing aflatoxin contaminations in peanuts. *PLoS ONE.* 12: e0178810.

88. Yazar S., Omurtag G Z., (2008). Fumonisin, trichothecenes and zearalenone in cereals. *Int. J. Mol. Sci.* 9:2062–2090.

89. Zhang Z., Xu W., Wu H., Zhang W., Mu W. (2020). Identification of

a potent enzyme for the detoxification of Zearalenone. *J Agric Food Chem.*68:376–383.

90. Zeinvand-Lorestania H., Sabzevari O., Setayesh N., Amini M., Faramarzib A., Ahmadabadi A N., Faramarzi A M. (2015). Comparative study of in vitro prooxidative properties and genotoxicity induced by aflatoxin B1 and its laccase-mediated detoxification products. *Chemosphere.* 135:1–6.

91. Zhang W., Xue B., Li M., Mu Y., Chen Z, Li J, Shan A. (2014). Screening a strain of *Aspergillus niger* and optimization of fermentation conditions for degradation of aflatoxin B1. *Toxins.* 6: 3157–3172.

Chapter - XXIII

23

DISCUSING DIFFERENT LEVEL OF A WOMAN'S ACQUAINTANCE IN MANJU KAPUR'S *A MARRIED WOMAN*

M.USHA BHARATHI
ASSISTANT PROFESSOR
SHRIMATI INDIRA GANDHI COLLEGE
TRICHY
ushabharathi@sigc.edu

ABSTRACT

Manju Kapur is a feminist writer who speaks out against women's difficulty in a patriarchal ethos where societal, artistic, and partisan factors stand in the way of a new woman. *A Married Woman* explores the inner torment of an ordinary middle class woman who experiences many challenges in her life after marriage but eventually endeavours for her elementary rights of equality, identity, and self-satisfaction. Astha, the protagonist of the novel talks about the different phases in the life of a woman, pre and post marriage. The writer has documented a comparison between Hindu-Muslim religious tension in India and Astha and Pipeelika's sensual tension. Pipeelika, a much younger lady who is a social activist, begins a romance that confronts all expectations that society and the family have executed on her.

Manju Kapur is one of the most efficient Indian women authors in English. Her remarkable works have developed the Indian English fictional dominion. Her compositions, with a gentle entreaty, portray the meticulous challenges in the lives of Indian women. She is a feminist writer who speaks out against women's difficulty in a patriarchal ethos where societal, artistic, and partisan factors stand in the way of a new woman. Manju Kapur's *A*

Married Woman, published in 2003 and it is set in 1992, the year the Hindutva fanatics demolished the Babri Masjid in Ayodhya. It also realistically depicts the stoic existence of a married woman amid communal conflict in India over the land of Ayodhya.

A Married Woman explores the inner torment of an ordinary middle class woman who experiences many challenges in her life after marriage but eventually endeavours for her elementary rights of equality, identity, and self-satisfaction. Kapur's characters are naturally educated which shows that they are conscious of their surroundings. In her debut work, *Difficult Daughters*, she presented the story of a haughty young lady who falls in love with a professor who is not only her mentor but also married, established in pre-independence India. On the other hand, *A Married Woman*, discusses the various stages of a woman's life, both before and after marriage. Astha, the protagonist of the novel talks about the different phases in the life of a woman, pre and post marriage. The novel deals into interrogation to the essential ethics of the institution of marriage and illustrates the awful certainties of a homosexual relationship in India against a backdrop of communal struggles through the journey of a married woman. Astha's life has always been governed by her mother, who has always forced her decisions on her daughter. As a typical mother, she bestows her entire

exertions to formative Astha into an idyllic wife, daughter-in-law, and mother. All these are discussed in the opening pages giving a transitory about her pre-marital life. After two brief encounters, Astha's parents arranging her marriage with Hemant, an MBA from the United States.

Aijaz in the novel, is a road play artist who invites her to write the script for a play about the Babri Masjid disputation. Astha meets a man for the first time and he who recognizes her talent and is so strained to him. Aijaz is oppressively killed while presenting a play about the Babri Masjid- Ram Janambhoomi disputation. This part depicts cooperative violence and Manju Kapur explores how it has affected the central character's life in multitudinous ways. Talking about the position of women in the traditional society with a story plot in the 70s through a wedded woman as the protagonist, Kapur's notation has a tone which says she's alive of hurdles the women in the early period went through, where they are simply subservient and tractable, and this constant state of their lives becomes the source of their psychiatric and neurotic problems. They never say anything negative about the male-domination. These women are regarded as ideal Indian wives. More over, in the present era, a woman opposes the old social structure of society. She protests against overbearing rules and traditions, rejecting the ultimate image of the woman. The description of the book is of

a married woman's journey where despite having all a woman could want from her marriage like a responsible husband, kind in-laws, and two children, Astha nonetheless feels incomplete as a person. Her spouse constantly dismisses her thoughts and opinions, and her needs as a person are often trampled by her commitments to her family.

Manju Kapoor's perfect interpretation of Astha and Peeplika's love is the heart of the novel. The writer has a motive why both the ladies need each other, as well as their primary reluctance, have been thoroughly explored without any shyness. As many themes put forward, the end of the over takes a different level as the two characters take two different tracks of lives. When she becomes involved in communal protests and meets Pipeelika Khan, a Muslim widow, they both fall in love with one another, and the writer has written flexibly about their powerful love affair.

The writer has documented a comparison between Hindu-Muslim religious tension in India and Astha and Pipeelika's sensual tension. Peeplika, a much younger lady who is a social activist, begins a romance that confronts all expectations that society and the family have executed on her.

"Manju Kapur present in her novel the changing image of women moving away from traditional portrayals of enduring, self sacrificing women towards self assured assertive and ambitious women making society aware

of their demands and in this way providing a medium for self expression". (<https://mkuniversity.ac.in> › notification_2020).

In India, it is not a shared and not admittable one. But the author handles this theme very boldly. Astha's craving for a scope in her life other than being a wife, mother and a daughter-in-law against a strongly intellect in context of Indian sectional politics. It extant an interesting amalgamation of problems, insecure and conflict faced by an ordinary middle class woman and country both at the power of transition.

In spite of her excellent education and intelligent level, a woman has no place in a family or community, and her beliefs or interpretations are not appreciated. She gets depressed and ultimately agrees to track her aim for pleasure or fulfilment. Beholding her marriage that is falling apart due to inherent divergences, she forsakes her nuptial life and falls for Pipeelika without any inhibitions. This is the distinguishing feature of a woman who is willing to acquire any risk to attain equivalence with male in society. Her ideas may express very rare to some, but they are the inner voice of a new woman strongminded to live her life to the occupied, which is described by the author through the entire novel. The end of her novel shows the incapability of Indian women to break family bonds. Astha have a chances to meet at different stages through different relationships in her search for

individuality and expects her complete independence in life.

Manju Kapur registers her apprehension for Indian Women in this novel. She lodges on various feministic issues in this novel alike female education and their empowerment, financial independence and so on. She recounts important issues of class and patriotism and connects them to the developing sense of female uniqueness in post-colonial India. Her novel A Married Woman empowers the woman to get an idea of the feminist struggle against partialities and search for different appeal.

REFERENCES:

1. Kapur Manju-A Married Woman, India Ink, 2002.
2. (<https://mkuniversity.ac.in> › notification_2020).
3. Scientific Research Publishing
4. <https://media.neliti.com> › media › publications
5. <https://media.neliti.com> › media › publications

Chapter - XXIV

24

A STUDY ON BRAND PREFERENCE AND BRAND LOYALTY OF CUSTOMERS ON ONLINE SHOPPING APPS IN TENKASI DISTRICT

T.S.SUBBULAKSHMI

Assistant professor

Department of commerce

Sri paramakalyani college

Alwarkurichi.

Tenkasi district. Tamilnadu

Mail.id : r.a.subbu123@gmail.com

Abstract

Investigating brand loyalty among internet shoppers is the goal of this study. There are 85 survey participants overall who are over the age of 15. Using a simple random sampling procedure, the respondent's responses to a questionnaire are used to collect the main data for this study. Percentage analysis, the weighted average mean index approach, and the chi square test are all employed as sample techniques. This study examines the connection between e-quality, e-trust, e-satisfaction, and e-loyalty. The weighted method's primary findings include the elements of brand preference and loyalty and the lack of a statistically significant relationship between brand preference and loyalty and gender. According to the report, among the respondents, Flipkart is their top choice for online shopping.

Keywords: Brand loyalty, online shopping, brand preference, consumer.

INTRODUCTION

Online shopping is a type of electronic commerce that enables customers to make direct purchases from sellers using a computer browser and the internet. The consumer can find a product of interest by

going directly to the retailer's website or by browsing across many online retailers. Using a shopping search engine that shows the same goods and its price at many online retailers. The phrase refers to both looking for something online and purchasing them. Online sales have been available for roughly 25 years. Its popularity has considerably increased. Nowadays, we can buy almost everything online. In fact, according to retail experts, internet shopping will soon surpass traditional shopping in terms of revenue. For locating information, search engines and online price comparison services

A consumer's overall assessment and judgment of the excellence and quality of an e-service being offered in a virtual marketplace can be used to establish the concept of service quality. E-Service Quality is the difference between what customers anticipate from the service after they receive it and what they anticipate from the service before it is offered. According to Santos (Santos, 2003), e-service quality may be summed up as the consumer's overall assessment and judgment of the excellence and quality of e-service offers in the online market. To provide and uphold service quality, a business must first determine what quality means to the customers it serves (Gronross, 1984).

OBJECTIVES OF THE STUDY

- ❖ To study and analyze the social economic profile of the customers of online shopping apps
- ❖ To analyze about the behavior of customers towards online shopping apps
- ❖ To examine about various apps available in online shopping
- ❖ To study and analyze the brand preference of customers on online shopping apps
- ❖ To analyze the brand loyalty of customers on online shopping apps
- ❖ To examine overall opinion on the preference of the customers of online shopping apps,
- ❖ To give suggestions and recommendations, in the background of the findings of the study.

SCOPE OF THE STUDY

The current study will define consumer attitudes regarding online shopping apps among various social strata in Indian society, particularly in Tenkasi Taluk, Tamil Nadu. The division of the population into various strata according to location, gender, age, wealth, etc. Future research by academics and researchers will greatly benefit from an analysis of the customer attitude toward the many aspects that were identified during

focus group discussions.

SAMPLE TECHNIQUE AND SIZE

In this study a simple random sampling method is used to collect data and the data were analysed by using tools like Percentage, weighted average mean index, chi square test. The sample size for this paper is 85 customers in Tenkasi district.

REVIEW OF LITERATURE

Boshoff & Du Plessis, (2009) suggested that due to intense competition in the market place, businesses have increased efforts to implement the customer retention strategy in order to maximize the lifetime value of customers.

Deng, Lu, Wei, Zhang (2010) customer loyalty refers to Commitment by customers to make consistent repeat purchases of a preferred brands or services in spite of situational and marketing efforts to influence switching behavior.

Cheng et al. (2011), it is more cost-effective to keep existing consumers than to acquire new ones. The writers then stated that the expense of developing a new client is 5 to 9 times the cost of sustaining existing customers. This highlights the importance of merchants retaining loyal customers since cost effectiveness increases the likelihood of survival

and future expansion.

Anderson and Srinivasan (2003) argue that Customer service is an additional important thing for companies doing e business. To avoid some difficulties in designing websites, they need to have an attentive customer service system.

ANALYSIS AND INTERPRETATION

Category	Particulars	No of Respondents	Percentage
Gender	Male	33	34
	Female	52	66
Age	15-20 Years	41	48
	21-30 Years	38	45
	31-40 Years	04	5
	41-50 Years	02	2
Marital status	Married	21	25
	Unmarried	64	75
Monthly	Below 20000	49	58

Income			
	20000-30000	22	26
	40000-60000	09	10
	More than 70000	05	06
Occupation	Govt. employees	15	18
	Private employees	15	18
	Business	13	15
	Home Makers	17	20
	Students	16	18
	Others	09	11

SOCIO ECONOMIC PROFILE OF THE RESPONDENTS

Source: primary data

In the above table it shows that out of 85 respondents, 66% of the

respondents were Female, 48% of the respondents were the age group of 15 to 20 years, 75% of the respondents were unmarried, 58% of the respondents were earned monthly income of below 20,000, 20% of the respondents were home makers.

FACTORS OF BRAND PREFERENCE AND LOYALTY

PARTICULARS	S. A	A	M.S	D.A	S.D.A	TOTAL	WAM	RANK
Availability	27	38	16	02	02	85	22.73	1
Quality	16	30	30	05	04	85	20.33	4
Quantity	12	31	29	07	05	85	19.33	6
Satisfaction	14	27	36	04	04	85	19.87	5
Awareness	18	30	27	05	04	85	20.46	3
Affordability	07	35	29	08	06	85	18.66	7
Image the brand	10	35	28	06	05	85	21.26	2

Source: primary data

From the above table weighted average mean index for the basis of factors of brand preference and loyalty in that Availability got 1st rank, Image brand got 2nd rank, Awareness got 3rd rank, Quality got 4th rank, Satisfaction got 5th rank, Quantity got 6th rank, Affordability 7th rank.

TEST OF INDEPENDENTS BETWEEN GENDER AND BRAND PREFERENCE & LOYALTY

H_0 : There is no significant different between age and gender.

H_1 : There is significant different between age and gender.

Age	H.S	M.S	D.S	TOTAL
Female	20	15	15	50
Male	15	15	5	35
Total	35	30	20	85

O	E	O - E	(O-E) ²	(O-E) ² /E
20	21	1	1	0.04
15	18	3	9	0.5
15	12	3	9	0.7
15	14	1	1	0.07
15	12	3	9	0.75
5	8	3	9	0.13

Calculated value: 3.19

Degrees of freedom = 2, Table value= 0.13

Results:

Hence the calculated value is less than the table value so the hypothesis is accepted it is concluded that there is no significant difference between gender and Brand Preference & loyalty.

FINDINGS

- ❖ Regarding gender wise classification of respondents, it is found that maximum number of gender are female (66%)
- ❖ Regarding Age wise classification of respondents, it is found that maximum number of age group are 15-20 years (48%).
- ❖ In Marital status wise classification of respondents, it is extracted that maximum number of users are unmarried persons (75%).
- ❖ Regarding on the basis of annual income it is found that majority of the respondents are below 20000 income group (58%)
- ❖ Regarding on the basis of occupation it is found that majority of the respondents are home maker (20%)
- ❖ In the weighted average mean index method, the basis of factors of brand preference and loyalty in that Availability got 1st rank, Image brand got 2nd rank, Awareness got 3rd rank, Quality got 4th rank, Satisfaction got 5th rank, Quantity got 6th rank, Affordability 7th rank.

- ❖ The calculated value is less than the table value so the hypothesis is accepted it is concluded that there is no significant difference between Gender and Brand Preference & loyalty.

SUGGESTION:

- The product's price might be further reduced to draw in more customers without sacrificing quality; makers could survey customers to learn what they want.
- Discounts and offers are another alluring way to catch people's attention.
- Online advertising appears to be ineffective, therefore the corporation can improve advertising.
- Regular advertising efforts must to be run in order to boost sales.
- The household only makes under 20,000 per year. Due to its low price and the fact that most of its clients are students Thus, emphasis must be placed on other income categories.
- Duplication of products is one of the main issues that users in online shopping applications experience and should be the focus of attention.
- Other types of advertising for sales, such online or digital marketing are to be focused for sales promotion.

CONCLUSION

According to the study, the majority of respondents are aware of

online shopping. The study's findings indicate that there are numerous major aspects that contribute to the purchase of a product via an online shopping app. It could be because the app's offering is reasonably priced. It could be due to the product's quality. Customer retention is influenced by customer satisfaction. This study allows manufacturers to learn about their customers' needs and preferences, which they can use to improve their products.

REFERENCES

1. Bakos, J.Y. and Brynjolfsson, E. (2000), Bundling and Competition on the Internet, *Marketing Science*, Vol.19, No. 1, pp.63-82
2. Cheung.M.K.C & Zhu.L& Kwong.T, *Online Consumer Behavior: A Review and Agenda for Future Research*, Information Systems Department, City University of Hong Kong.
3. Constantinides, E. (2004), *Influencing the online consumer's behavior: the Web experience*, *Internet Research*, Vol.14, No. 2, pp. 111-126
4. Cooper, D.R. and Schindler, P.S. 2001. *Business Research Methods*. 7th ed. Boston:McGraw-Hill/Irwin.
5. Elhance, D.N. (1984), *Fundamentals of Statistics*, Kitab Mahal, New Delhi.

7. Kothari, C.R. (1990), Research Methodology, Second revised – edition, New Age international (P) Limited, Publishers, New Delhi.
8. Kotler, p. (2001), Marketing Management, Prentice-Hall, India.

Chapter - XXV

25

CULTURAL ALTERITY IN MAHESH DATTANI'S TARA

Rochelle Maryann

Assistant Professor

Justice Basheer Ahmed Sayeed College for Women,
Chennai

E mail: rochelle.maryann89@gmail.com

ABSTRACT

Culture and society are closely related. It is very important as it plays a crucial role in shaping and forming an identity and determines the social environment of a nation. Cultures have evolved from time immemorial .In course of time each society is made to think and believe that the practices and beliefs they have carried forth are right and ought to be followed. Though people are educated, they still adhere to the stringent cultural practices. This is because of the environment and the thoughts instilled in them right from the time of their birth.

Cultures have evolved from time immemorial .In course of time each society is made to think and believe that the practices and beliefs they have carried forth are right and ought to be followed. Though people are educated, they still adhere to the stringent cultural practices. This is because of the environment and the thoughts instilled in them right from the time of their birth.

The theory of alterity has become a philosophical concept that is an offshoot of postmodernism. The notion of alterity holds good to understand the formation as individuals and social beings. Alterity has a wide range of approaches to epistemology, psychoanalysis social and cultural theory. In the contemporary world everyone encounters the 'other' which has increased

through globalization and mass media.

There are eight dualisms of alterity (1) the popular other (2) the lower-class other (3) the black other (4) Third World other (5) the female other (6) the national or ethnic other (7) oppressed parts of subjectivity as the other and (8) somewhere else as the other place. In this way the tag leads us to see the colonial other which is never layered without differences and further places him or her in the margins when representing them.

Cultural alterity is that which is associated with different cultures, gender, classes and other social branches and the manner in which society thinks about them and views them. In the contemporary thinking, alterity focuses on 'otherness'. The 'other' in scholarship includes the Jews, homosexuals, insane, sick, women and other heterogeneous groups who have been commonly marginalized. The construction of the otherness can be detected on the basis of suffering and injustice.

This paper examines the play '*Tara*' by Mahesh Dattani on the theory of cultural alterity. This play discusses how the 'girl child' "Tara" who has a twin brother, they are both conjoint by a leg which rightfully belongs to her. She being a girl is denied this limb and is handicapped. No one not even her mother or the doctor tries to stand up for her because a girl child is not considered deserving in an Indian milieu. This is the cultural frame which is

instilled in the minds of people from inception and people think in those terms. This paper shows how Tara is seen and treated as the 'other' by her family and society.

Keywords: Culture,gender,Tara, society, other,patriarchy,discrimination

Culture is a contributing factor and so is the society in shaping the minds and attitudes of people towards gender roles and preferences. Gender disparity is instilled in society through a number of ways and sources. Tradition, religion, legal and economic systems play an important role in determining gender roles. These lay the rules for social norms and behavior and encourage one to fit into the dominant culture. As Wole Soyinka says, "Culture is a matrix of infinite possibilities and choices. From within the same culture matrix we can extract arguments and strategies for the degradation and ennoblement of our species, for its enslavement or liberation, for the suppression of its productive potential or its enhancement."(UNFPA)

The culture of India is among the world's oldest, reaching back to about five centuries. Many Indian traditional sources describe it as "Sa Prathama Sanskrati Vishvavara" — the first and the supreme culture in the world. India is a very diverse country, and different regions have their own distinct cultures. India is a county known for its unity in diversity, with many religions, languages and varied people who follow and have their own cultural

and social identities. India as a nation in the past was exposed to other cultures (Western culture) because of the colonial rule and in the present day world; it is part of the globalization. Many changes have come into effect among the multicultural societies of the nation but at the same time, certain cultural stereotypes have not been overcome. There still exists several cultural taboos that education or globalization have failed to erase from social practices. These collide with changes that societies have otherwise adopted for progress.

Gender discrimination has existed for generations and it particularly affects the lives of the female sex. The world right from the time of creation or inception has always considered the female as the weaker or inferior sex. Women were always subordinate to men. Women were invariably deprived of basic human rights like education for a long time. Society designated the role of a woman as to procreate and nurture families. "The history of men's opposition to women's emancipation is more interesting perhaps than the story of that emancipation itself." (Virginia Woolf, *A Room of One's Own* 26).

This scenario was no different in the Indian society which always treated the female as the 'other.' Women suffered from health problems like malnutrition and intrauterine problems. Most of them were deprived of healthy food in quantity and quality. The boy child was always preferred or

welcomed in an Indian household. This is because a boy was considered an heir to the property while the girl adopted a new home through marriage. When a girl was born, she was always considered a burden because she brought no constant income to her family which also had the responsibility to save for her wedding dowry; a rigid cultural practice that has stayed on in spite of all the progress the country has witnessed. India is culturally diverse but is unified in its oppression of women. Simone de Beauvoir explains that society treats the 'woman as the other' as humanity is male and man defines woman not in herself but as relative to him; she is not regarded as an autonomous being ("Introduction" *The Second Sex* 3). Thus culturally a male was viewed as an asset while the female a liability.

Representations of women in literature and cultural productions were also on the same lines until the nineteenth century. In course of time literature discussed these issues and caught the attention of society to these hitherto suppressed practices. Mahesh Dattani is one among them who emerged in the field of Indian English drama in the twentieth century with plays on contemporary issues and whose "characters have a lot to say" to the world (Preface, *Tara: a Stage Play*).

Mahesh Dattani's *Tara* (1990) is his third play staged in Bangalore the same year and directed by Dattani himself. Dattani foregrounds 'the female other'

and challenges society to break free from primordial stereotypes even as it sensitizes it to the dangers of gender discrimination.

Tara is about a pair of conjoint twins who are born with three legs and the blood supply to the third leg is from the girl's body. Only one of the twins can have two legs and the other would have to survive with one leg. Medically it would have been right for the girl to keep the leg but gender discrimination intervenes and the parents in connivance with the doctor decide to give the male twin the benefit. Culture distinguished the needs of a male and female not based on their common human sensibilities but rather on the basis of its self imposed norms. In an interview when asked about the play, *Tara* Mahesh Dattani said:

I was prepared to take on the gender issue head on, and I think that was a powerful metaphor...It's a metaphor either for being born equal as male and female and sharing so much more and with the surgical separation comes a cultural distinction and prejudices as well, but on another level, it could also deal with the individual having the male and female self and half the female self is, whether your gender is male or female, is definitely given the lower priority (1).

Tara's grandfather is a politician who used his power and bribed the doctor , Dr.Thakkar to give the leg to the boy Chandan. The doctor went ahead

against medical ethics just for his benefit. This issue became a continuous discussion between Tara's grandfather, her mother Bharati and Dr.Thakkar. As time went by the mother showered more love upon Tara just to keep under wraps what she had done. As Tara discovered the truth of her past she is driven to insanity. Tara is devastated when she learned about the role of her mother in discriminating her that she died of shock and her brother Chandan became a recluse.

Tara's grandfather because he was a politician had his way of doing things. This shows the power of patriarchy and its influence in a society. His domineering presence overshadowed the entire family that they seem to have lost their individual power of thinking and decision making. As is the cultural practice he left all his wealth for Chandan and nothing for Tara. He held on to age old norms being brought up in a culture which emphasized that only the boy should inherit the wealth and not the girl. Patel, Tara's father tells them "It was his money. He could do what he wanted with it"(40).

The educated are no exemption to the cultural bias towards the male. Even the doctor who had vowed by his profession to be ethical breaks the code for monetary gain. Perhaps he did not consider it unethical as he was only abiding by the cultural norms which favoured a male over a female as the male was considered more beneficial to a society.

PATEL.[...] The doctor has agreed, I was told. It was only later I came to know of his intention of stacking a large nursing home-the largest in Bangalore. He had acquired three acres of prime land in the heart of the city from the state. Your grandfather's political influence had been used.(58)

Though Patel knew the intention of the doctor why didn't he stop the proceedings? This is because he is from a different caste (an inter-caste marriage) and not all that well off as Bharati. Being raised in a culture that adheres so much to caste he had to stay away from things. Though he too was educated and employed as the General Manager of Indo Swedia Company he clung to ancient cultural norms. He was insistent that Chandan should learn the business and take over the business after him. Patel says "Chandan, I think I must insist that you come"(6). This is a typical patriarchal practice where the sons take over the business of the fathers irrespective of their competence. Chandan is not interested and wants Tara to learn which Patel does not approve. Tara expresses her feelings subtly and with a touch of humour:

TARA.[...]"The men in the house were deciding on whether they were going hunting while the women look after the cave"(6)

Patel made plans for Chandan's higher studies and wanted him to go abroad to study. "Chandan is going to study further and he will go abroad for his studies"(30). In all his plans for the future of his children only the son is

included and Tara is never considered not even for education. As a result Tara is denied of her basic rights only because of her gender.

Patel does not prefer his son to do the household chores. He blames his wife Bharati and makes it clear that he does not believe in equality and thinks it is a slur for a boy to do the 'so called women's job'. He does not give Chandan a chance to express and state his preferences. Even to help is a feminine task and the men are not encouraged to participate in domestic chores by the society.

PATEL. But you can't think of turning him into a sissy-teaching him to knit.

CHANDAN. Daddy that's unfair

BHARATI.Chandan,please go to your room!

CHANDAN. All I'm doing is helping mummy to

PATEL. I am disappointed in you. From now on you are coming to the office with me. I can't see you rotting at home (29).

Patel becomes symbolic of the views that the past generation believed in regarding gender roles within a family. While the girls were trained for the domestic chores the boys were consciously kept away from it.

Even when Bharati was in hospital Patel did not allow Tara to meet her alone and gave instructions to the hospital authorities not to allow Tara inside

Bharati's room alone:

TARA. The hospital staff at the reception they asked me who I wanted to see. I told them. They asked me to wait. One of the nurses passing by recognized me. She drew the receptionist aside and told her in a low voice. She thought I cannot hear what she was saying. But I heard! She told her that she had received strict instructions from our father that I shouldn't on any account be allowed to see mummy on my own.(pause). Now tell me I'm imagining things. Tell me that he doesn't hate me!(53,54)

Tara becomes aware of her family's hatred towards her and keeps all this stifled within her.

Roopa, Nalini and Pooja are the neighbours of Tara who come and make friends with her. They reflect the way society views people who are different. Roopa puts on airs that she is sound in the English language but she is mocked for her malapropism where she confuses between concoction and decoction. She talks badly about her friends Nalini and Prema to Tara and lets them down.

ROOPA.[...] you know these two love to go about. If I were you I would stay away from them. They'll talk behind your back and all that. Real bitches, they'll think of all kinds of names to call you. That bugs bunny and that drumstick. Some people are like that you know(14).

Dattani highlights the hypocrisy in society through Roopa's role. Gossip is culturally accepted and people engaged in it without any sensitivity discussing other's weaknesses. Roopa tells Tara how people spoke about her at the back and she herself talked about her friends Nalini and Roopa in their absence and called them names too.

TARA. That's okay. I can handle them.

ROOPA. That's what you think. Besides they are not really our standard you know. Their English isn't that good. They won't understand your jokes like two peas in pots and all that(18).

When Roopa leaves Tara's place she talks about Tara and her family to Nalini and Prema.

ROOPA(urgently). Prema! Prema!Come quick! Where's NAlini? Never mind, you come now!My God, Oh, my God! Guess what? I went to her house. Yes right inside I met everyone there. She is a real freak of nature all right, but wait till you see her mother! Oh God! I cant tell you she is really- wandah Tara. Oh God! I'll never go there again(20)

Tara is referred to as 'freak' a term that refers to a person who is physically deformed or physically challenged. It points at the outward appearance or behavior of a person. In this instance it is used to show how society marginalizes challenged people like Tara particularly when it is a woman who

is affected. Tara is subjected to oppression as a woman and as a physically challenged individual.

Tara is not only an 'other' to her family but also to the society she belongs to. They see and make her feel that she is odd and abnormal.

TARA[...] When they saw me get off the car, they stopped. They stopped running and they stopped laughing. And they waited. Watching me to get off and walk across the footpath towards them. Embarrassing me, making me go slower than I would when I reached them they grinned. Nalini whispered something to her ugly friend. I knew what was coming.[...]Well. Then I showed it to them. The duckling wouldn't believe her eyes. She stared at my leg. She felt it and knocked on it. Silly as well as ugly, I said we get them in pairs. My twin brother wears the other one(13).

Dattani depicts how Tara is made fun of her handicap. Another important issue is if the leg was not given to Chandan, Tara would have been normal (physically). The leg on Chandan lasted only two days and had to be replaced with an artificial limb because it was not functioning properly on him. The doctor should have rightly given the leg to Tara as it was her body that was supplying blood to the third leg and if done so the leg would have survived on her. Cultural practices deprived her of what is rightfully hers because of her gender.

Bharati, Tara's mother tried to release her share of guilt by doting on her daughter unconditionally. This is because she and her father were instrumental in giving her leg to Chandan. She treated her like a baby.

Bharati.Tara!My beautiful baby!You are my most beautiful baby!I love you so much.

TARA(enjoying the affection).Yes mummy;I know that

BHARATI. I want you to remember that Tara(34).

Bharati did things according to Tara's whims and fancies. She made the cook prepare food and cater only to her preferences and told "Tara I hope you like Chinese for dinner. Ida says chow mein is her speciality" (17).

She also bribes Roopa to be Tara's best friend by showering her with gifts such as lipsticks, cosmetics and allowing her to watch movies in her house.

BHARATI(sharply). You can watch whatever you want? (more subdued) just be my Tara's friend.

ROOPA.Yes, May I go now?

BHARATI.Yes,first promise me that you would be her friend.

ROOPA. I don't know. Can I think about it?

BHARATI. Promise me now! (19, 20)

Bharati did all this for her daughter Tara only to make up for her biased decision. She did this to convince Tara that she loved her the most. As a

mother, having been brought up in a culture that favoured the male child she too followed the same practice. The women of Bharati's generation were praised for their beauty and the women too succumbed to their praises and charms. This situation is unlike the present-day woman where she gives importance to her thoughts and decisions. Though the women of Bharati's time were educated they could not utilize their education to change themselves. They were severely bound to patriarchy.

Similarly she felt that by donating Tara her kidney, she was giving a part of her and thus cleanse herself of her guilt. "Everything will be alright now that I am giving you a part of me. Everything will be alright" (34). But Patel does not allow her to do so and this guilt continues to haunts her.

BHARATI. Why won't you let me do it?

Patel. Because, need I tell you? Because I do not want you to have the satisfaction of doing it"(22).

The guilt kept eating into her and ultimately she became insane and died.

Tara becomes lonely as she had no one to relate to or communicate other than Chandan. Music was her only companion. Tara used people's weaknesses and her knowledge in the English language as her weapon to make it known to society what it was to be treated as an 'other'. She was made to feel foreign in her native land. She narrated an incident to Roopa where she played upon

the weakness of her friend just to make her know what it felt to be hurt by others.

TARA.[...]We sat on her bed, making our model with rubber balls and wires. Her bed felt different somehow. I put my hand under the cover, and guess what?

ROOPA. What?

TARA. There was a rubber sheet underneath! Imagine thirteen year old and she was wetting her bed. I laughed. I laughed out loud. She went red (48).

Tara narrated this incident to Roopa to make her treat others properly and not to make fun of her or of anybody which was the normal behaviour of society.

Tara and Chandan knew that they were physically handicapped but they did not like society pointing out their disability. They liked to be treated as normal human beings without being made to feel that they are not one among the crowd. Chandan too has his share of bad experience with society when a socialite lady called him 'Mobility Impaired' as she pointed to his leg and shrugged her shoulders

Dattani brings out the female infanticide in the Gujarati community where Roopa tells Tara "The Patels in the old days were unhappy with getting girl babies-you know dowry and things like that. So they used to drown them in

milk. So when people ask how the baby dies, they could say that she choked while drinking her milk” (27). This was so common a practice fully aided by cultural codes that even law found it difficult to prevent this practice. The perpetrators, significantly are women themselves.

Tara had the feeling that she and her brother were the ugly creatures of society but did not prefer this to be exposed to them directly. This ugliness was defined solely by external appearances. She could never come in terms with her physical disability. As she and her brother looked different they felt the ‘otherness’ in them and could not overcome its consequences.

CHANDAN. They are not the ugly ones. We are horrible one legged creatures.

TARA (angry). Yes but you don’t have to say it!

CHANDAN (moving to her). I’m sorry. You mustn’t mind very much.

TARA. What?

CHANDAN. Being one legged

TARA. What makes you think I mind?

CHANDAN (softly). I feel your pain

TARA. Yes, I do mind. I mind it very much (50-51)

If Tara was treated properly by society just as another person and in the same way by her family she would have lived long. The shock that her mother was mainly instrumental in her being handicapped was too much of a jolt for her.

Tara had no voice for she was stifled by her family and society. She succumbed to the blind practices of her society. Dattani's explains Tara's emotional frame of mind when she learns the truth about her mother:

She suspected her father for having done something, you know, was in some way, but she had no idea what it was, but her love, her mother's love was unquestioned and she did not question that, so when she comes to know of the truth.. it does sort of break her away like a shooting star from the mother, and I think with that ... she dies. In hind sight you could see where it was coloured or where it was blinkered or where it was being compensated for"(3).

The title 'Tara' is symbolic of a shooting star that is a temporary guest of a small fraction of time as the protagonist is. The idea also brings to mind the concept of the binary star systems that consist of two stars that "are gravitationally bound, and generally move around each other in stable orbits. When two such stars have a relatively close orbit, their gravitational interaction can have a significant impact on their evolution." Just as the Siamese twins in this case have an interwoven identity; and has a great impact on each other, mentally and biologically in their evolution they are spiritually inseparable. Chandan neglects his own personal history to get over his guilt with what happened to Tara. Just as the lowest portion occupies a major

portion of the stage, the memory of guilt haunts and dominates Chandan's personality. It is to deny this that he creates his alter-ego Dan. His identity of the diaspora caught between his native culture and foreign culture as signified by Chandan and Dan where he says "Our culture is so rich with tradition, and that's a great advantage and disadvantage as well." (321)

With the demise of Tara, Chandan experiences a sense of identity crisis. Where in the person of Dan he asks Tara for forgiveness. They metaphorically represent the two sides of the concept of gender in society.

TARA: And me. Maybe we still are. Like we've always been inseparable. The way we started life. Two lives and one body, in one comfortable womb. Till we were forced out... (325)

"DAN'S VOICE. [...] Forgive me Tara. Forgive me for making it my tragedy" (60)

Dan ultimately bears the sin of the family, something for which he was never responsible.

Dattani has skillfully woven the theme of female otherness and also the message to parents, particularly mothers to treat a boy and a girl child equally. Dattani focuses on the cultural issue of gender bias in the Gujarati community. "The play is a comment on the predicament of women in the past, reflects the status of women in the present and dramatizes the complexities of the social setup...and is an exhortation to the society to shed the age old

prejudices against women and have a progressive outlook” (Sharma). By culturally altering the rightful space of the female in society the natural balance of life is altered too. The play delineates the fact that a man and woman should complement each other culturally and socially and that one is incomplete without the other.

The message is for society to think and be more broad minded. They have to accept a girl too and give them a future and a career. Boys are not the only cynosure of the family and society. Women too can reach great heights if opportunities are given to them and are treated equally. Till today there are many instances of female infanticide and gender discrimination, some instances are kept under the wraps. Actually towards the end of the play when Tara hears about the truth of her separation, because she felt that her mother alone loved her and cared for her. How could she do such a thing to me? This hurt and shock kills her. Her mother becomes mad. Chandan who is later known as Dan lives a lonely and desolate life in London. Dattani questions the place of education in altering the status of women in society.

References

1. Dattani, Mahesh. *Collected Plays*. New Delhi: Penguin Books India, 2000. Print.
2. Dattani, Mahesh. *Tara*. New Delhi: Ravi Dayal Publisher, 1995. Print.
3. Secondary Sources

4. Abrams M.H. and Galt Harpham. *A Glossary of Literary Terms*. Boston: Wodsworth,Cengage Learning,2005.Print.
5. Acharya,Nithin.B."Mahesh Dattani's Plays A New Horizon in *IndiaTheatre*.Jaipur,IndiaBook Enclave,2008.Print
6. Asha Kuthari Chaudhuri. *Contemporary Indian Writing in English*. New Delhi: Foundation Books,2005.Print.
7. Ashcoft,Bill.Gareth Griffiths and Helen Tiffin.Post -Colonial Studies: The Key Concepts.London: Routledge,2000.Print.
8. Barry,Peter.Beginning Theory: An Introduction to Literary and Cultural Theory. New Delhi: Viva Books,2010.Print.
9. .Multani,Angeline." A conversation with Mahesh Dattani". *The Journal School of Language,Literature & Cultural Studies*.1Vol:130.New Delhi:JNU,2005.Print.
10. Woolf, Virginia.A Room of One's Own.New York: Harcourt Brace & Co,1989.Print.

Chapter - XXVI

26

THE ROLE OF ARTIFICIAL INTELLIGENCE IN RESEARCH RELATED TO HEALTHCARE

Shaik Asha Begum

Nirmala College of Pharmacy, Atmakur Mangalagiri, Andhra
Pradesh

S. Joshna Rani

IPT, Sri Padmavati Mahila Viswa Vidyalayam, Tirupati

SK. Abdul Rahaman

Nirmala College of Pharmacy, Atmakur Mangalagiri, Andhra
Pradesh

ABSTRACT

The use of Artificial Intelligence (AI) in health care has increased in many areas. Organizations in health care of various sizes, types, and specialties are now more interested in how artificial intelligence has changed and how it helps patient needs and care while reducing costs and increasing efficiency. This chapter describes the implications of AI in health care management and the challenges associated with using AI in health care, as well as a review of several research papers using AI models in various fields of health care such as dermatology, radiology, drug design, and so on. . Recommendations for diagnosis and treatment, patient involvement and adherence, and management activities are the most common types of applications. While there are many situations in which AI can perform health care services and even better than humans, implementation problems will prevent the automation of large health care activities for a long time. Behavioral concerns in the use of AI in health care are also addressed.

KEY WORDS: Artificial Intelligence, Healthcare, Diseases and diagnosis, hospital AI.

INTRODUCTION

Artificial Intelligence (AI) and related technologies are becoming increasingly common in business and in the community, and they are beginning to be used in health care. Many aspects of patient care, as well as management processes within the provider, payer, and medical organizations, have the potential to be transformed by these technologies.

Healthcare systems around the world face significant challenges in achieving the 'quadruple aim' for healthcare: improving population health, improving patient experience of care, improving caregiver experience, and lowering rising healthcare costs. 1–3 Ageing populations, an increasing burden of chronic diseases, and rising healthcare costs globally are putting pressure on governments, payers, regulators, and providers to innovate and transform healthcare delivery models. Precision medicine is the most common application of machine learning in healthcare. Precision medicine is the prediction of which treatment protocols will be successful on a given patient based on previous patient data. This type of determining from prior learning will necessitate training the model with datasets, and this method is known as supervised learning.

A number of research studies have already found that AI can perform as well as or better than humans at key healthcare tasks such as disease diagnosis. Algorithms are already outperforming radiologists in detecting malignant tumours and advising researchers on how to build cohorts for expensive clinical trials. However, we believe that it will be many years before AI replaces humans in broad medical process domains for a variety of reasons[1].

However, developing and deploying AI technology is difficult and expensive. In order for AI to be successful, health organisations must overcome a number of obstacles. Among these difficulties are the following: (1) a lack of understanding about what a specific type of AI technology can or cannot do; (2) a lack of clear strategies for integrating different AI technologies into existing care systems in order to effectively solve the most pressing problems that health organisations are currently facing; (3) a shortage of a well-trained workforce for AI implementation; (4) the incompatibility of AI technologies with legacy infrastructure; and (5) a lack of access to good and diverse medical care.

BACKGROUND

What is Artificial Intelligence?

AI is the science and engineering of creating intelligent machines using algorithms or a set of rules followed by a machine to mimic human cognitive functions such as learning and solving problems. AI systems have the ability to anticipate problems or to deal with them as they arise, and as a result, they operate intentionally, intelligently, and flexibly. The power of AI is its ability to learn and recognize patterns and relationships in large multidimensional and multimodal data sets; for example, AI systems can translate the entire medical patient's record into a single number representing a possible diagnosis. In addition, AI programs are flexible and satisfying, learning and adapting as additional data becomes available.

Artificial intelligence is not a single technology, but rather a group of them. The majority of these technologies are immediately applicable to the field of healthcare, but the specific processes and tasks they support vary greatly. Some important AI technologies for healthcare are defined and described below[2].

The state of AI Technology

In practise, artificial intelligence refers to computer systems that

simulate or exhibit a particular aspect of human intelligence or intelligent behaviour, such as learning, reasoning, and problem solving. As such, AI is a collection of intelligent processes and behaviours generated by computational models and algorithms, rather than a single technology[3]. Refined computational models and algorithms, combined with powerful computers and the availability of massive data, have recently accelerated AI advancements, particularly in ML, Natural Language Processing (NLP), AI voice technology, AI assistants, and robotics. New and powerful solutions for complex real-world problems in image understanding, speech recognition, big data analytics, and healthcare have been developed. In the following sections, we will examine and discuss the AI technologies that are currently available.

Machine learning – neural networks and deep learning

Machine learning is a statistical technique for fitting models to data and teaching models to 'learn' by training them with data. Machine learning is one of the most common types of AI; according to a 2018 Deloitte survey of 1,100 US managers whose organisations were already pursuing AI, 63 percent of companies surveyed were using machine learning in their operations. It is a broad technique at the

heart of many AI approaches, and there are numerous variations on it[4].

The most common application of traditional machine learning in healthcare is precision medicine, which predicts which treatment protocols are likely to be successful on a patient based on various patient attributes and the treatment context. The vast majority of machine learning and precision medicine applications necessitate the use of a training dataset, which the outcome variable (eg onset of disease) is known; this is called supervised learning.

Despite its success in areas such as medical imaging and big data, machine learning is not a one-size-fits-all solution. ML is less applicable for tasks that require common sense reasoning or domain-specific knowledge, or for situations that fall outside of the ML training data set. This is due to the fact that ML relies on computational power and massive amounts of data to identify superficial patterns and correlations. As such, it does not reveal any causal relationships or provide a clear understanding of the phenomenon under investigation. As a result, it is difficult to explain ML results and correct the specific known errors produced by ML algorithms.

Nature language Processing

Natural language processing employs computational methods to analyse and represent human languages, typically in text format. ML methods have recently been applied to NLP, yielding impressive results in speech recognition, machine translation, text classification, question answering, sentiment analysis, information extraction, and search engine[5]. There is a massive amount of unstructured textual data in healthcare in the form of doctors' notes, test results, lab reports, medication orders, and discharge instructions.

Since the 1950s, AI researchers have sought to understand human language. NLP applications include speech recognition, text analysis, translation, and other language-related goals. There are two approaches: statistical NLP and semantic NLP. Statistical NLP is based on machine learning (particularly deep learning neural networks) and has contributed to a recent increase in recognition accuracy. It is necessary to have a large 'corpus' or body of language from which to learn.

The most common applications of NLP in healthcare involve the creation, comprehension, and classification of clinical documentation and published research. NLP systems can analyse unstructured clinical notes on patients, prepare reports (for example, on radiology exams),

transcribe patient interactions, and perform conversational AI.

Physical Robots

Physical robots are well-known at this point, with over 200,000 industrial robots installed globally each year. They carry out predefined tasks such as lifting, repositioning, welding, or assembling objects in settings such as factories and warehouses, as well as delivering supplies in hospitals. Recently, robots have become more collaborative with humans and are easier to train by guiding them through a desired task. They are also becoming smarter as other AI capabilities are integrated into their 'brains' (really their operating systems). It appears likely that the same advances in intelligence seen in other areas of AI will be incorporated into physical robots over time.

Human-machine Partnership in Healthcare

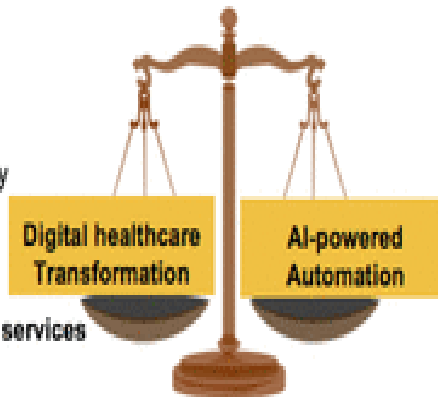


Digital healthcare transformation

- Boosting clinical effectiveness by improving:

- Quality
 - Experience
 - Outcomes
- Safety
 - Ways to ensure patient safety
- Efficiency
 - Productivity
 - Usability

- Extending access and expanding services
- Supporting patient engagement
- Providing affordable care through optimizing workflows



AI-powered automation

- Machine learning/deep learning
 - Supervised learning
 - Unsupervised learning
 - Reinforcement learning
- Natural language processing
 - Statistical vs. rule-based NLP
- AI assistants and voice technology
 - Clinical voice documentation
 - AI nursing assistants
- Medical robotics
 - Surgical robots
 - Rehabilitation robots
 - Social companion robots
 - Assisted-living robotic companions
 - Smart pills...

Voice Technology and Assistants based on AI

Voice is the most intuitive, natural, and universal mode of communication for humans. Artificial intelligence voice technology is transforming human-machine communication, making it much easier for people to obtain, understand, use, and store health information. Voice interface has the potential to improve user experience by assisting them in overcoming barriers such as those found in text-based information exchange or complex system operation[6].

Voice technology has been widely used in a variety of industries, and it is now being incorporated into healthcare to address some of the information challenges that both health professionals and patients face. Because current EHR systems are complex and difficult to use, many EHR vendors and health providers are incorporating voice technology into their EHR systems to simplify clinical documentation. On the consumer front, AI assistants such as Alexa, Siri, Cortana, and Google Assistant have gained the "skills" to perform routine and simple tasks in the healthcare context, such as reminding patients when to take their medication and scheduling appointments.

Diagnosis and Treatment Design

The use of artificial intelligence (AI) in the design of treatment plans for patients is becoming more common in healthcare. AI can provide superior strategies for treating patients and monitoring treatment plans by analysing data from previous patients. AI can recognise signs of disease more accurately and quickly with the help of medical images such as CT scans, MRI, X-rays, and ultrasound[7]. It benefits patients by allowing for faster and more accurate disease identification and treatment selection. IBM's Watson recently gained media attention for its ability to focus on precision medicine, particularly cancer diagnosis

and treatment. Different types of AI techniques, such as neural networks, support vector machines, and decision trees, are used to diagnose various diseases. ANN (Artificial neural network) demonstrated greater accuracy in classifying diabetes and CVD.

Current and future use cases on AI in healthcare

By democratising and standardising a future of connected and AI-augmented care, precision diagnostics, precision therapeutics, and, ultimately, precision medicine, AI can help healthcare systems achieve their "quadruple aim." AI healthcare research is advancing rapidly, with potential use cases being demonstrated across the healthcare sector (both physical and mental health), including drug discovery, virtual clinical consultation, disease diagnosis, prognosis, medication management, and health monitoring[8].

AI today

AI systems are currently not reasoning engines, which means they cannot reason in the same way as human physicians, who can rely on 'common sense' or 'clinical intuition and experience.' AI, on the other hand, resembles a signal translator, converting patterns from datasets[9]. Today, healthcare organisations are beginning to use AI systems to automate time-consuming, high-volume repetitive tasks.

Furthermore, there has been significant progress in demonstrating the use of AI in precision diagnostics (eg diabetic retinopathy and radiotherapy planning).

AI in medium Term

In the medium term, we anticipate significant progress in the development of powerful algorithms that are efficient (e.g., require less data to train), capable of using unlabeled data, and capable of combining disparate structured and unstructured data such as imaging, electronic health data, multi-omic, behavioural, and pharmacological data[11]. Furthermore, healthcare organisations and medical practises will transition from being AI platform adopters to co-innovators with technology partners in the development of novel AI systems for precision therapeutics.

Conclusion

We believe that AI will play an important role in future healthcare offerings. It is the primary capability driving the development of precision medicine, which is widely acknowledged to be a much-needed advance in care. Although early efforts to provide diagnosis and treatment recommendations have been difficult, we anticipate that AI will eventually master that domain as well. Given the rapid

advancements in artificial intelligence for imaging analysis, it appears likely that most radiology and pathology images will be examined by a machine at some point. Speech and text recognition are already used for tasks such as patient communication and clinical note capture, and their use will grow[12].

As much as the last ten years have been about the implementation of digitisation of health records for efficiency (and, in some healthcare systems, billing/reimbursement), the next ten years will be about the insight and value society can gain from these digital assets, and how this can be translated into driving better clinical outcomes with the help of AI, and the subsequent creation of novel data assets and tools[13]. It is clear that we are at a tipping point in terms of the convergence of medical practise and technological application, and while there are numerous opportunities, there are formidable challenges that must be overcome in terms of the real world and the scale of the problem.

References:

1. Hussain A, Malik A, Halim MU, Ali AM. The use of robotics in - surgery: a review. *Int J Clin Pract* 2014;68:1376–82.
2. Bush J. How AI is taking the scut work out of health care. *Harvard*

Business Review 2018. Buchanan BG, Shortliffe EH. *Rule-based expert systems: The MYCIN experiments of the Stanford heuristic programming project*. Reading:

3. Addison Wesley, 1984. Ross C, Swetlitz I. IBM pitched its Watson supercomputer as a revolution in cancer care. It's nowhere close. *Stat* 2017. Davenport TH. *The AI Advantage*. Cambridge: MIT Press, 2018.
4. Right Care Shared Decision Making Programme, Capita. *Measuring shared decision making: A review of research evidence*. NHS, 2012.
5. Loria K. Putting the AI in radiology. *Radiology Today* 2018;19:10
6. Schmidt-Erfurth U, Bogunovic H, Sadeghipour A, et al. Machine learning to analyze the prognostic value of current imaging biomarkers in neovascular age-related macular degeneration. *Ophthalmology Retina* 2018;2:24–30.
7. UserTesting *Healthcare chatbot apps are on the rise but the overall customer experience (cx) falls short according to a UserTesting report*. San Francisco: UserTesting, 2019.
8. 27. Deloitte *From brawn to brains: The impact of technology on jobs in the UK*. Deloitte, 2015.
29. McKinsey Global Institute *A future that works: automation,*

employment, and productivity. McKinsey Global Institute, 2017.

30. Davenport TH, Kirby J. *Only humans need apply: Winners and losers in the age of smart machines*. New York: HarperBusiness, 2016.
31. Davenport TH, Dreyer K. AI will change radiology, but it won't replace radiologists. *Harvard Business Review* 2018.
32. Char DS, Shah NH, Magnus D. Implementing machine learning in health care – addressing ethical challenges. *N Engl J Med* 2018;378:981–3.

Chapter – XXVII

27

BIOPLASTICS

Affrin Jahana R.

B.Sc. Biotechnology

Arcot Sri Mahalakshmi Women's College, Villapakkam, Arcot.

R. Manogari

Arcot Sri Mahalakshmi Women's College, Villapakkam, Arcot.

G. Vijaya

Assistant Professor

A. Parkavi

Assistant Professor

ABSTRACT

INTRODUCTION:

Plastics are the long chain, man-made polymeric molecules. They are inexpensive, lightweight and durable. They are synthetic or semi-synthetic materials, that are polymers of high molecular weight and they are obtained from the petroleum and natural gas (Manali Shah *et al.*, 2021). They are increasingly being used due to their inexpensive cost and superior qualities, such as flexibility, rigidity, brittleness, capacity to be moulded into a variety of shapes, and reduced weight (Stevens, 2002). Petrochemical-based plastics including Poly Ethyl Terephthalate (PET), Poly Butylene Terephthalate (PBT), Polypropylene (PP), Polystyrene (PS), and Polyvinyl Chloride (PVC) are widely utilized in our daily lives because of their adaptability, affordability and great thermal properties (Kumar Y *et al.*, 2014; Chisti Y, 2014; Gadhave RV *et al.*, 2018). They are useful in manufacturing products such as water bottles, coffee cups, forks, knives, plastic bags to carry the groceries etc. They are not environmental-friendly due to their high carbon footprint (Boonniteewanich J *et al.*, 2014). The ecosystem has been severely impacted by the over use of plastics, and it is estimated that humans manufacture roughly 34 million tonnes of plastic annually. Only 7% of that gets recycled, leaving the rest 93% to be disposed of in landfills, oceans, and seas (Sushmitha BS *et al.*, 2016). The burning or incinerating of conventional

plastic releases many toxic emissions such as carbon dioxide and methane, and these greenhouse gases impact the climate worldwide (Barker T, 2010). The petrochemical based products causes various issues such as accumulation of wastes in the land area, in the natural habitats such as oceans, seas, etc.. (Thompson RC et al., 2009). Because of plastic pollution, humans are suffering from the disturbance of thyroid hormone levels (Mathieu-Denoncourt Justine et al., 2015). The organisms living in the ocean, land and its surroundings get affected everyday due to increase in the pollution (Chozhavendhan S *et al.*, 2020). To overcome this problem, bioplastics are produced.

BIOPLASTICS:

Bioplastic is a long chain monomers linked to each other by ester bonding (Chozhavendhan S *et al.*, 2020). According to European bioplastics, a plastic material is said to be bioplastic if it is either bio-based or biodegradable or possess both the properties. According to International Union of Pure and Applied Chemistry (IUPAC), “A bioplastic is derived from biomass or monomers derived from biomass and which, at some stage in its processing into finished products, can be shaped by flow” (Ritu Saharan *et al.*, 2022). They can be broken down by bacteria and fungi that live in the soil without releasing any pollutants. Additionally, using renewable resources in their production is crucial for preserving the environment's health (Rajendran N *et*

al., 2012).

SOURCES OF BIOPLASTICS:

Bioplastics are made from organic materials found in nature such as polysaccharides, lipids and proteins. Different polysaccharides used to produce bioplastics are as follows: cellulose, starch, lignin, chitin, dextrin, pectin, gum etc... Bioplastics are obtained from naturally occurring proteins and lipids such as casein, gelatin and gluten and animal fats and plant oils. They are also made from plant-based renewables waste substances, biomass, microbial and micro algal cells. Not only from these things, but they are also obtained mainly from organic wastes produced from food waste, corn and sugarcane waste, vegetable waste, agricultural waste, household kitchen wastes, and by-products of wood industries etc..(Ritu Saharan *et al.*, 2022).

IMPORTANCE OF BIOPLASTICS:

Some of the importance of bioplastics are their complete biodegradability, Environment- friendly products, sustainability, decreases the carbon footprint, high recyclability, reduces toxicity and low energy production etc..(Ritu Saharan *et al.*, 2022).

TYPES OF BIOPLASTICS:

Bioplastics are classified mainly into two types:

1. Natural bioplastics

2. Synthetic bioplastics

1. Natural bioplastics:

- Natural bioplastics are produced from natural sources such as biomass, microorganisms etc.. They are formed as the result of continuous evolution in the nature.
- Natural bioplastics are further divided into three types based on their sources of production.

They are:

i. Production from biomass

- Bioplastics are produced from biomasses such as starch, cellulose etc..
- E.g.: Polysaccharides, Polypeptides, lipids

ii. Production from microorganisms

- Bioplastics are produced using microorganisms such as *Ralstonia eutropha* (also known as *Cupriavidus necator*), *Alcaligenes spp.*, *Azotobacter spp.*, *Bacillus spp.*, *Nocardia spp.*, *Pseudomonas spp.*, and *Rhizobium spp.*, (McAdam B *et al* , 2020) are used for the production of polyhydroxybutyrate.
- E.g.: i. Polyhydroxyalkanoates

ii. Polyhydroxybutyrate

iii. Production from biotechnological applications

- Bioplastics are produced using Biotechnological products
- E.g.: Polylactides/polylactic acid

2.Synthetic bioplastics:

- Synthetic bioplastics are made by mixing chemicals and biological materials. They are produced through significant research and progress.
- Synthetic bioplastics are further divided into three types.

They are:

i.Aliphatic polyesters

- Aliphatic polyesters are the most widely used polymers for drug delivery applications because of their biodegradable and biocompatible nature (Efthimiadou, E. K. *et al.*, 2018).
- E.g.: Polycarptone

ii.Aliphatic copolyesters

- Aromatic/aliphatic copolyesters combine the biodegradability and biocompatibility of aliphatic polyesters with the physical properties and thermal properties of aromatic polyesters (Chen Y *et al.*, 2008). They are used for the production of bioplastics.
- Eg:Polybutylene succinate

iii.Aromatic copolyesters

- Aromatic/aliphatic copolyesters combine the biodegradability and

biocompatibility of aliphatic polyesters with the physical properties and thermal properties of aromatic polyesters (Chen Y et al., 2008). They are used for the production of bioplastics.

- Eg: Polybutyrate adipate terephthalate

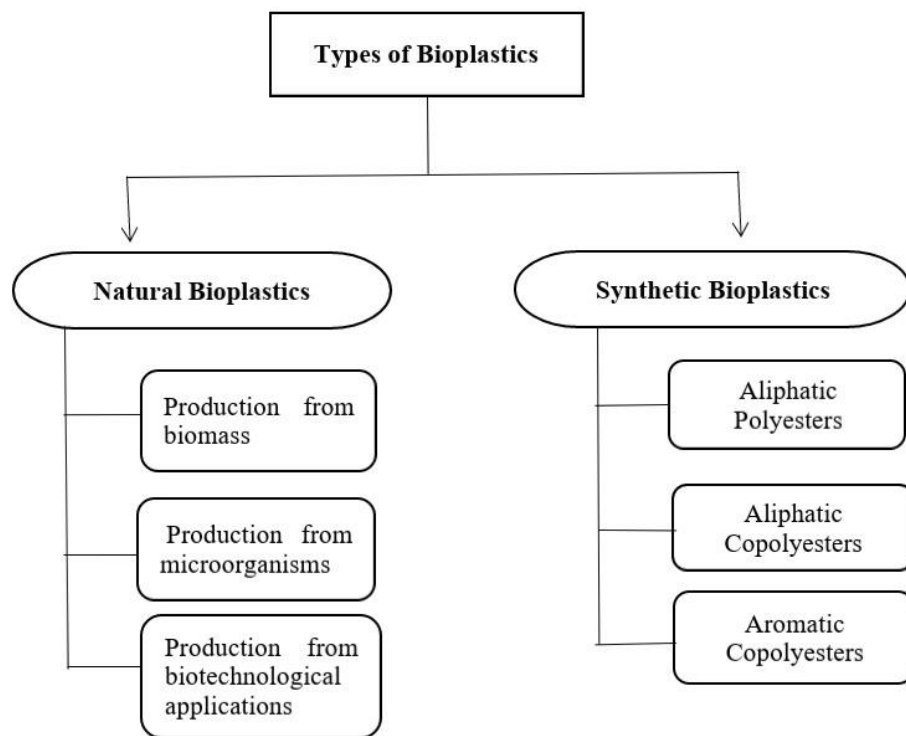


Figure 1. Types of bioplastics

PROPERTIES OF BIOPLASTICS :

- Physical properties
- Thermal properties
- Mechanical Properties

1. Physical properties:

The Physical properties of bioplastics are mold shrinkage, Density and apparent viscosity.

2. Thermal properties:

The thermal property of bioplastics Constitutes melting point, heat distortion temperature And Vicat softening temperature.

3. Mechanical properties:

Mechanical property of bioplastics relates to tensile strength, shrinkage, tensile modulus, Tensile elongation brake, compressive yield strength, Compressive modulus, flexural strength, Izod impact Strength, hardness, bending module, moisture Absorption, transparency, oxygen barrier (Venkatachalam, H *et al.*, 2020).

VARIOUS PLASTICIZERS USED IN BIOPLASTICS :

Plasticizers are organic molecules that are added to polymers to lessen their brittleness and crystallinity, increase their durability and toughness, and decrease their melting points. These lessen polymer-polymer contact, which reduces the rigidity of the three-dimensional frameworks and permits deformation without rupture. Various plasticizers are used in the production

of bioplastic, including polyols like glycol, glycerol, sorbitol, fructose, sucrose, and mannose, as well as fatty acids like palmitate or myristate. Due to its non-toxicity, affordability, and high boiling point (292°C), glycerol is the plasticizer that has been researched and used the most (Manali Shah *et al.*, 2021).

ADVANTAGES OF BIOPLASTICS:

- It lowers the carbon footprint
- They are made from renewable resources
- Production of bioplastics uses less energy
- It generates fewer greenhouse gases
- It contains no toxins
- It is environment- friendly product

DISADVANTAGES OF BIOPLASTICS:

- Bioplastics costs high
- It reduces raw materials

APPLICATIONS OF BIOPLASTICS:

- Packaging industry

Bioplastics are used in packaging sectors due to their biodegradable property.

- Catering products

Bioplastics are used as disposable crockery, spoons and bowls etc..

- Gardening

Mulch films and flower pots are made of biodegradable property are used and also they do not leave any residues in the soil.

- Medical Applications

Thermoplastic starch (polystarch) are used for the production of drug capsules.

- Automobiles

Bioplastics are used for the production of automobiles products for the car (Rajendran N *et al.*, 2012).

COMPARING BIOPLASTICS TO PETROPLASTIC:

Table 1. Comparing bioplastics to petroplastics

	Bioplastics	Petroplastics
Renewable resource	Yes or partially	No
Sustainable	Yes	No
Breakdown in the environment	Biodegradable and/or compostable	Some degradable by polymer oxidation
Polymer range	Limited but growing	Extensive

GHG Emissions	Usually low	Relatively high
Fossil fuel usage	Usually low	Relatively high
Arable land usage	Currently low	None

Source: Shamsuddin I *et al.*, 2017

CONCLUSION:

Plastic is one of the needs without it, we can't meet our day to day life. But it causes plastic pollution in the environment and also it affects the health of the living organisms. To overcome this issue, bioplastics are the best alternative option to the conventional plastics. Because bioplastics are highly degradable and environmental – friendly product.

REFERENCES:

1. Shah, M., Rajhans, S., Pandya, H. A., & Mankad, A. U. (2021). Bioplastic for future: A review then and now. *World Journal of Advanced Research and Reviews*, 9(2), 056-067.
2. Stevens 2002. *Green Plastics- An introduction to the new science of biodegradable plastics*
3. Kumar, Y., Shukla, P., Singh, P., Prabhakaran, P. P., & Tanwar, V. K. (2014). Bio-plastics. A perfect tool for eco-friendly food packaging: A Review. *Journal of Food Product Development and Packaging*, 1(1), 01-06.

4. Chisti Y 2014 How renewable are the bioplastics?. *Biotechnology Advance*. 32(7):1361.
5. Gadhave, R. V., Das, A., Mahanwar, P. A., & Gadekar, P. T. (2018). Starch based bio-plastics: The future of sustainable packaging.
6. Boonniteewanich, J., Pitivut, S., Tongjoy, S., Lapnonkawow, S., & Suttiruengwong, S. (2014). Evaluation of carbon footprint of bioplastic straw compared to petroleum based straw products. *Energy Procedia*, 56, 518-524.
7. Sushmitha, B. S., Vanitha, K. P., & Rangaswamy, B. E. (2016). Bioplastics–A Review. *International Journal of Modern Trends in Engineering and Research*, 3(4), 411-413.
8. Barker T. (2010) In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment, Report of the Intergovernmental Panel on Climate Change*. USA: Cambridge University Press. IPCC, Geneva, Switzerland. 104
9. Thompson, R. C., Moore, C. J., Vom Saal, F. S., & Swan, S. H. (2009). Plastics, the environment and human health: current consensus and future trends. *Philosophical transactions of the royal society B: biological sciences*, 364(1526), 2153-2166.
10. Mathieu-Denoncourt, J., Wallace, S. J., de Solla, S. R., & Langlois, V. S.

- (2015). Plasticizer endocrine disruption: Highlighting developmental and reproductive effects in mammals and non-mammalian aquatic species. *General and comparative endocrinology*, 219, 74-88.
11. Chozhavendhan .S, Usha.P, Sowmiya.G and Rohini.G. 2020. "A Review on Bioplastic production – A Need to the society", *International Journal of pharmaceutical science*, 05, 27-32
 12. Ritu Saharan and Jyoteshna Kharb. 2022. " Exploration of Bioplastics: (A Review)",*Oriental Journal of chemistry*, 38(4), 840-854.
 13. Rajendran, N., Puppala, S., Sneha Raj, M., Ruth Angeeleena, B., & Rajam, C. (2012). Seaweeds can be a new source for bioplastics. *J. Pharm. Res*, 5(3), 1476-1479.
 14. McAdam, B., Brennan Fournet, M., McDonald, P., & Mojicevic, M. (2020). Production of polyhydroxybutyrate (PHB) and factors impacting its chemical and mechanical characteristics. *Polymers*, 12(12), 2908.
 15. Efthimiadou, E. K., Theodosiou, M., Toniolo, G., & Abu-Thabit, N. Y. (2018). Stimuli-responsive biopolymer nanocarriers for drug delivery applications. *Stimuli Responsive Polymeric Nanocarriers for Drug Delivery Applications*, Volume 1, 405-432.
 16. Chen, Y., Tan, L., Chen, L., Yang, Y., & Wang, X. (2008). Study on biodegradable aromatic/aliphatic copolyesters. *Brazilian journal of*

chemical engineering, 25, 321-335.

17. Venkatachalam, H., & Palaniswamy, R. (2020). Bioplastic world: A review. *Journal of Advanced Scientific Research*, 11(03), 43-53.
18. Shamsuddin, I. M., Jafar, J. A., Shawai, A. S. A., Yusuf, S., Lateefah, M., & Aminu, I. (2017). Bioplastics as better alternative to petroplastics and their role in national sustainability: a review. *Adv. Biosci. Bioeng*, 5(4), 63.

Chapter – XXVIII

28

A STUDY ON VISITORS SATISFACTION TOWARDS TOURIST PLACE IN UDHAGAMANDALAM

R.Sivasankari

Assistant Professor and Head

Department of commerce(CS)

Sri Paramakalyani College

Alwarkurichi

Tenkasi district,Tamilnadu

Mail Id:sankarispkc@gmail.com

Abstract:

Ooty, officially known as Udhagamandalam (also known as Ootacamund abbreviated as Udhagai), is a city and a municipality in the Nilgiris district of the Indian state of Tamil Nadu. Ooty is part of the ecoregion South Western Ghats montane rain forests. Tourism one of the most dynamic and successful industries of the world. Its capacity to create employment, combined with its capacity to generate foreign revenue. Tourism plays an important role in maintaining peace and world unity by building bridges between different cultures and encouraging tolerance through cultural exchange. In this study reseaecher analysed the visitors satisfaction towards tourist place in udhagamandalam with a sample size of 52, structured questionnaire is used to collect the primary data from respondents and analysis was made using percentage, weighted average and chi square. Water facilities available in the tourist place occupies priority among tourists.

Key words: Tourism, visitors satisfaction,

I. Introduction :

“Nilgiris” the name is Sanskrit means BLUE MOUNTAINS and in Tamil

NEELAMALAI. The Nilgiris District is situated in the Western Ghats. It is surrounded by the Coimbatore District, Kerala State and Karnataka State on the eastern, western and the northern side respectively. The Nilgiris District is a celebrated summer resort for the tourists from all of India. Udhagamandalam popularly called, as Ooty is the Queen of Hill Stations in India. Udhagamandalam is the capital of the Nilgiris district. The Nilgiris Hill forms a part of the Western Ghats. The name Nilgiris was due to by the blue haze envelops the range with most distant hills of considerable size. Doddabetta, the highest peak in South India with an altitude of 2,595 Meters lies in this District. The other prominent hills of this District are Elk hills, Devarshola peak, Hulical hill and Cairn hill. The main tourist attraction in this District is the Botanical Garden. Besides the Botanical Garden there are several other places. The important among them are the boat house near Bus-stand, the Rose Garden, the Deer Park, and the Doddabetta peak in Udhagamandalam. Sim's park, Pasture Institute, Kateri falls, Lamb's rock and Dolphin's nose are the Important Tourist sports in Coonoor. In Kotagiri block Kodanadu view point and St. Catherine's falls are the two main tourist attractions. In Gudalur block the main tourist attraction in Mudumalai wild Life Sanctuary.

II Significance of the study

Tourism has become, over the years, one of the most dynamic and successful industries of the world. Its capacity to create employment, combined with its capacity to generate foreign revenue. Tourism plays an important role in maintaining peace and world unity by building bridges between different cultures and encouraging tolerance through cultural exchange. Tourism related services are a very important or the most important foreign exchange earner. "The tourism sector is a huge employer, creator of economic security and contributor to society. It also strengthens trade by boosting income for the poorest countries as well as for global suppliers. In this backdrop, the focus of the present study is to measure the Visitors Satisfaction towards tourist places in Udthagamandalam. Visitors are to be get satisfied with the facilities in the tourist places to improve the tourism.

III Objectives of the study:

The study has been conducted to find solution to the following objectives:

- To analyse the socio-economic profile of the respondents.
- To find out the most preferred Tourist spot in Ooty
- To find out the influencing demographic factor with the water

facilities available in Ooty.

- To offer valuable suggestions from the study.

IV Research Methodology

➤ *Area of the study*

This study was conducted among the visitors in Udhagamandalam district

➤ *Sample size*

The researcher has proposed to interview 60 visitors present in the study area and out of the given 60 questionnaires, 52 respondents were collected with full details and presented in the study

➤ *Sources of data*

The study is based on both primary and secondary data. The primary data were collected through structured questionnaire. The required secondary was collected from books, magazines and web-sites.

➤ *Sampling techniques*

The simple random technique was adopted for selecting respondents available in the Tourist places of udagamandalam district.

➤ *Tools for analysis*

- *Percentage analysis:*

If refers to special kind of ratio. Percentages are used in making comparison between two or more series of data, and used to describe the relation. Percentages reduced everything to a common base and thereby allow meaningful comparison.

- *Weighted mean index:*

To find out the satisfaction of courier services six factors were analysed with the help of weighted mean index. The respondents are asked to rate the six factors at five point scale namely first rank, second rank, third rank, fourth rank, fifth rank. The scores assigned on these ratings are 5,4,3,2 and 1 respectively.

- *Chi-square test*

Chi- square test is applied to test the goodness of fit, to verify the distribution of observed data with assumed theoretical distribution. Therefore it is a measure to study the divergence of actual and expected frequencies; karl pearson's has developed a method to test the difference between the theoretical (hypothesis) and the observed value.

V Limitation of the study

The study confined the following limitations:

- The study is limited to Tourist places of Udagamandalam

districts only.

- Time and cost are the others factors limiting the study sample to 52 respondents.
- Present study is mainly based on primary data. Hence the possibility of sampling error is inevitable.
- It is difficult to know whether the willing respondents are truly representative

VI. Analysis and interpretation

Table 1.1- Demographic analysis

Particulars		No. of respondents	Percentage
Gender	Male	8	15%
	Female	44	85%
Marital status	Married	10	19%
	Unmarried	42	81%

Education qualification	School level	2	4%
	UG	36	69%
	PG	10	19%
	Others	4	8%

Occupation	Private employee	12	23%
	Public employee	6	12%
	Business	4	8%
	Others	30	57%
Monthly income	Below 25000	36	69%T
	25000-50000	12	53%
	Above 50000	4	8%
Family size	Below - 3	8	15%
	3-5	34	66%
	Above - 5	10	19%
Nationality	Indian	52	100%

Source: Primary data

INTERPRETATION

From the above table reveals that, Majority is 85% of the respondents are female, Majority is 81% of the respondents are unmarried, Majority is 69% of the respondents are having an UG level of qualification, Majority is 69% of the respondents are having monthly income below 25000, Majority is 66% of the respondents are having family size of 3-

5., and all the respondents are 100% are Indian.

Table 1.2 WEIGHTED AVERAGE MEAN

PARTICULARS	I	II	III	IV	V	VI	VII	VIII	Tot al	weigh tedve ragem ean	Rank
Botanical garden	112	140	36	20	24	6	0	0	338	9.39	1
Emerald lake	0	56	108	60	8	18	4	4	258	7.17	2
Avalanche lake	0	42	72	70	18	0	4	2	238	6.61	4
Deer park	0	70	36	30	56	18	8	3	221	6.14	5
Doddabetta peak	192	14	0	20	24	0	4	2	256	7.11	3
Kalhatty water falls	0	14	24	30	16	18	20	18	140	3.59	8
Ooty lake	32	56	12	0	16	24	28	10	178	4.94	6
Kamaraj sagar dam	0	0	12	40	0	60	28	6	146	4.05	7

INTERPRETATION:

In the above table it was found that Botanical garden takes first rank, Emerald lake got second rank, Doddabetta peak takes third rank,

Avalanche lake fourth rank, Deer park has got fifth rank, Ooty lake takes sixth rank, Kamaraj sagar dam takes seventh rank and kalhatty water falls got eighth rank. From the above data, botanical garden is the most preferred tourist spot in Ooty.

HYPOTHESIS FRAMED

- 1.H0 = There is no significant relationship between Gender and Water Facilities
2. H0 = There is no significant relationship between Occupation and Water Facilities.

Table 1.3 Chi square result of Gender and water facilities

Observed	Expected	(O-E) ²	X ² = (O-E) ² / E
4	2.15	2.92	1.36
2	5.23	10.43	1.99
2	0.61	1.93	3.16
10	11.85	3.42	0.29
32	28.77	10.43	0.36
2	3.38	1.90	0.56
Total			X ² = 7.72

$$d.f = (r-1) (c-1)$$

$$(2-1) (3-1)=2$$

Chi square table value for d.f at 5% level of significance is 5.991

INTREPRETATION

The calculated value is higher than the table value. we have to accept the Ho and conclude that there is a significant relationship between gender and water facilities.

Table1.4 Chi square result of Occupation and water facilities

Observed	E	(O-E)²	X² = (O-E)² / E
4	3.23	0.59	0.18
6	7.39	1.93	0.26
2	1.38	0.38	0.27
2	1.62	0.14	0.09
4	3.69	0.10	0.03
0	0.69	0.48	0.70
2	1.08	0.84	0.78
20	2.46	0.21	0.08
0	0.46	0.21	0.46
6	8.08	4.33	0.53

20	18.46	2.37	0.13
4	3.46	0.29	0.08
Total			$X^2 = 3.59$

$$d.f = (r-1) (c-1)$$

$$4-1) (3-1)=6$$

Chi square table value for d.f at 5% level of significance is 12.592.

INTREPRETATION

The calculated value is higher than the table value. we have to accept the Ho and conclude that there is a significant relationship between occupation and water facilities.

VII FINDINGS

From the above study the major findings revealed that Majority is 85% of the respondents are female, Majority is 81% of the respondents are unmarried, Majority is 69% of the respondents are having an UG level of qualification, Majority is 69% of the respondents are having monthly income below 25000, Majority is 66% of the respondents are having family size of 3-5., and all the respondents are 100% are Indian. Botanical garden is the most preferred tourist spot in Ooty and hypothesis result suggest that there is significant relationship between

gender, occupation with the water facilities available in the tourist place.

VIII SUGGESTIONS

The study recommends the following suggestions

- Tourists spots Cleanliness is the main thing that to be take more attention in Ooty
- Banking services and internet facilities should be improved
- Majority of the Tourists were in price sensitive category, Price variations in tourist
- places should be avoided
- Public people are facing problem in accommodation facilities and food facilities should be improved by the government.

IX CONCLUSION:

Tourist's satisfaction plays a vital role in the growth and development of the tourism industry. Earning profit is possible only through tourist's satisfaction. Ooty has a high image among the tourist in respect of its nature beauty and climate. Therefore the image around the world in this spot has a great reputation for its earnings. In order to retain the fame the government must know the tourists suggestion. Then help them with proper and more facilities regarding all the spots.

References

1. Anukrathi Sharma (1988), "Tourism in new life styles".
Tourism Management, Vol 14 , Page 15. 2.
2. Bindu V.T (2000), Tourism and Hospitality Administration , Vol
12, page 12 3.
3. N.Rangaswamy (2002), Indian Journal of Marketing , Vol 3,
Page 18. 4.
4. Karan Hughes (1991), Icfai Journal of tourism, Vol 2 , page 2 5.
5. Abraham Pizam (1999), Tourism industries in worldwide, Vol
20, Page no 8. 6.
6. Atila Yuksi (2001), Icfai Journal of Indian tourism,vol 2 7.
7. A.L.Hardy(2001), Tourism Management, vol 14, page no 23 8.
8. Héctor San Martín (2002), Tourism and Hospitality
Administration, vol 3

Chapter – XXIX

29

SIROP DE TABAC AND IT'S IMPLICATION IN MIXOLOGY

Kaustav Dutta

Research Scholar & Assistant Professor

Guru Nanak Institute Of Hotel Management, Jis University, Wb,
India

kaustav.dutta@gnihm.ac.in

ABSTRACT:

This study concentrates on the implication, formulation, evaluation and acceptability of tobacco as cocktail ingredients in form of syrup or liqueur and its incorporation in one a classic cocktail. Developed tobacco cocktails are tested for their ingredients and sensory evaluation on hotel management students. Data analyzed using tasting card and evaluation of association of taste and flavours of tobacco based cocktail were enlisted, while consumer research methods also offer useful insights as the product is being developed. This paper introduces sensory evaluation and consumer research methods and provides a detailed analysis of applications of tobacco as cocktail ingredients. The respondents are from the different age groups who tasted all the samples of cocktails. Research data was collected through structured tasting cards which applied qualitative methods of research. Present study revealed that using of tobacco as cocktail ingredients in form of Sirop de Tabac enhances the taste & flavour of the classic cocktail modified, and give new shape to the drink where customer show the acceptability towards the tobacco based alcoholic drink(s).

KEYWORDS: Conceptualisation, Accessibility, Ingredients, Cocktails, Flavours.

BACKGROUND OF STUDY:

Sugar, our everyday sweetener, has huge impact in gastronomy from time immemorial. From confectionary dusting to cake icing, from candy caramel to candy floss, sugar at its varied formation at differential temperature plays a major role as essential commodities. So be it in mixology, any professional bar is incomplete without well blended sugar syrup. Along with lemon juice,

sugar syrup forms the seasoning of any cocktails or non-alcoholic mixed drink or beverage.

Commonly mistaken with Gomme syrup, these are a staple liquefied mixing ingredient commonly found in a number of cocktails and mixed drinks. Just like simple syrup, gomme (or, gum) syrup is a viscous cocktail sweetener that is made up of dissolved sugar and water. The key difference between the two, however, is that gomme syrup also contains gum arabic – a resin that naturally grows from Northeast Africa's Acacia tree. Simple syrup, on the other hand, just contains dissolved sugar and water.

Cocktail syrups, home-made like elder beery syrup or ready-made concoction like blue curacao or mojito mint, serves a huge purpose for crafty bartenders thanks to the unique (mostly sweet) flavours and different textures they can add to a mixed drink. Various bartenders & bar professionals working in upscale bar create their own signature concoction with infused sugar syrup, such as cinnamon flavoured sugar syrup or sugar syrup infused with orange peel. A ginger flavoured one is very common to that of rosemary infused sugar syrup.

The advantage of using flavoured sugar syrup is that it not only adds the spiked aroma of the infused herb / condiments but also impart colour substance to the final magic that the bartender tries to devise. From various homemade sugar syrup such as Apropos to mixology, caramel sugar is extensively used in adding colour to some popular distilled beverages such as rum and whisky at the last stages of manufacturing, i.e., before blending.

SIGNIFICANCE OF STUDY:

As a research scholar, a long and continued term in industrial and academics career in food and beverage operation and management have induced a strong sense of inquisitiveness. A precise aptitude on alcohol and mixology, had directed to the threshold of vivid experiments, which, not only broaden knowledge, but also created a moral impact on students for future scope in research & development methodology. In relation to the topic of this article, needless to say it is one of own theory and experimentation on the vastness of food and beverage core competencies: an ideal blend of tobacco in sugar to recreate a signature cocktail. After giving an intensive thought to bring out the product, in which there is a merge of tobacco, sugar & alcohol, it is a product of own intention to be appreciated by tobacco connoisseurs..

Why smoke and drink when you can just drink tobacco in your alcoholic beverage? According to NPR's food blog The Salt and consequent article on Delish (JAN 16, 2014), headed as "No Longer Smoking Tobacco? Now You Can Drink It" By Zoe Bain, the latest trend in mixology is bringing tobacco back to bars. A taste that is reminiscent of smoking seems to be appealing to those who would be otherwise lighting up a cigarette at bars if it weren't for widespread smoking bans. Plus, for now at least, tobacco-infused cocktails seem to be something of a novelty drink. Sang Yoon, chef-owner of Father's Office bar and restaurant in Los Angeles, did a lot of experimenting with tobacco and alcohol before creating a new drink called the Oaxacan. It features pipe tobacco-infused simple syrup. A bar in Alexandria, VA brews its own "sweet tea" out of pipe tobacco and clove cigarettes, which then makes an

appearance in a cocktail dubbed Smoker's Delight. Still another Washington D.C. watering hole offers a drink that includes house made tobacco bitters.

REVIEW OF LITERATURE:

A. TOBACCO TRADE AND BUSINESS:

According to the WHO Framework Convention on Tobacco Control (2005), Tobacco is one of the most widely used addictive substances in the world. It is well versed that tobacco and tobacco products are not well accepted a healthy nutritional society. The tobacco plant, (scientific name: *Nicotiana Tabacum*), containing 1 – 3 % of the alkaloid nicotine, produces a narcotic effect by stimulating the human nervous system, when smoked, snuffed or chewed, is a plant with a global presence. However tobacco trade is growing profitable with every growing day. According to WHO, Tobacco is grown in over 124 countries as a cash crop, using an estimated 3.2 million hectares of fertile land including Argentina, Brazil, China, Greece, Italy, Malawi, Mozambique, Spain, Tanzania, Turkey, and the United States with China being the biggest consumers. It can be grown in any warm, moist environment, which means it can be farmed on all continents except Antarctica. Tobacco is an agricultural commodity product, similar in economic terms to agricultural foodstuffs: the price is in part determined by crop yields, which vary depending on local weather conditions. The price also varies by specific species or cultivar grown, the total quantity on the market ready for sale, the area where it is grown, the health of the plants, and other characteristics individual to product quality.

B. TOBACCO TRADE & EMPLOYEMENT GENERATION IN INDIA:

India is the second largest tobacco producer behind China & the 2nd largest exporter of tobacco behind Brazil. During 2022-23 (till August), India exported 68,550 tonnes of FCV tobacco. The quantity of total exports in August 2022 was 15,224 tonnes (valued at US\$ 56.21 million), a 192.2% increase from the same period in the previous year. The value of the total FCV tobacco exports during 2021-22 was Rs. 2,858 crore (US\$ 359 million). In the same year, the country exported 27,742 tonnes. The export of unmanufactured tobacco during 2022-23 (till August) was 65,682 tonnes. During April 2022 and May 2022, the exports of unmanufactured tobacco increased by 51% and 14%, respectively, over the same period in the previous year. The value of the total exports during the same period was Rs. 4,102 crore (US\$ 515 million). (Indian Trade Portal 2023)

During the year 2021-22, India exported tobacco and tobacco products worth a total of US\$ 923.80 million. About 20 million farm labourers were employed under tobacco industry across India as of May 2021. The tobacco industry provides direct and indirect employment to approximately 45.7 million people in the country ranging from leaf pickers to factory workers. (Indian Trade Portal 2023)

C. POPULARITY OF TOBACCO & TOBACCO PRODUCTS:

A Popular blog named Tobacco Free Life in their article on Smoking and Drinking (2016) stated that consuming tobacco and alcohol together can augment & enhances the pleasure thereby complimenting each other. Various fragrance companies such as Tom Ford, Diptyque Orphéon & Mancera Red manufacture tobacco Eau de Parfum, which ranges from \$180.00 to \$ 720.00

in the international market, are a well demanded & desired product. Traditional French dinner ends with boisson aka beverages where guests are cordially escorted to the lounge and sommelier serves them their choice of spirits, usually whisky or brandy with humidor by the side for the choice of cigars on offer, which later on became the custom of the continents. Based on the same ideas, I ponder on my quest on mixing tobacco laced sugar syrup and using it in a mild rate with whisky to recreate the classical cocktail, named Old fashioned.

D. PERIQUE: TOBACCO LIQUEUR BY JADE LIQUEURS:

Is it right to celebrate the use of an ingredient that many us still consider as taboo or unlawful? Daniel Tapper, award-winning editor and full-time food writer, in his Word of Mouth Cocktail blog (Feb 2012) answers this vividly. Tobacco – reduced through distillation – has become the latest ingredient in bartenders' recipe books, reports Daniel. Tobacco as an ingredient in drinks isn't completely new, but it is rare. Back in 2003, a group of Floridian cocktail makers began making tobacco-spiked cocktails in an attempt to defy the smoking ban. One such drink was the 'Nicotini' made using vodka infused with tobacco leaves – its purpose being to recreate the effects of a cigarette, says Daniel. Tobacco as an ingredient in drinks isn't completely new, but it is rare. Back in 2003, a group of Floridian cocktail makers began making tobacco-spiked cocktails in an attempt to defy the smoking ban. One such drink was the 'Nicotini' made using vodka infused with tobacco leaves – its purpose being to recreate the effects of a cigarette.

The Guardian Magazine in 2012 also supported Daniel by stating that in 2010 a hotel bartender called Jonathan Condesa in Mexico City invented a cocktail

called the D.F. Irreverente, made by mixing rum, pineapple juice and the contents of a cigarette together and then straining it into a glass. But until now, there hasn't been a liqueur actually distilled using tobacco.

Latest tobacco liqueur on the market, Perique by Jade Liqueurs where the manufacturer of this product uses distillation techniques to eliminate nicotine and has it tested before shipment. Jade Liqueurs was founded in 2000 by T.A. Breaux, a professional scientist who has dedicated almost two decades of research toward resolving the mysteries and myths associated with absinthe. A relentless quest for the unadulterated truth has taken him across the globe in search of obscure, overlooked, and forgotten information that documents this often maligned subject.

Ted Breaux, who makes the spirit in France using distilled Louisiana Perique – one of the rarest and strongest tobaccos in the world. "It's made in roughly the same way as gin is," says Ted. "But instead of using juniper berries we use tobacco. The concept was to take an immensely powerful substance and then to reduce it through distillation into something very subtle but full of flavour."

A native of New Orleans, Louisiana, Breaux has made significant content and editorial contributions to fine publications such as "Absinthe, Sip of Seduction: A Contemporary Guide" (Corvus Publishing, Year 2008) and "Absinthe, A Myth Always Green" (L'Esprit Frappeur, Year 2003). Breaux's reputation for uncovering the facts is surpassed only by his unceasing passion for recreating history through the fine art of absinthe crafting. Through these ongoing efforts, Jade Liqueurs ® remains established as an artisanship and a cornerstone of authenticity and quality. Breaux's research has been recognized in books, magazines, newspapers, television, and filmed

documentaries, and his educated insight is frequently sought by writers, researchers, and historians.

Jade Liqueurs ® was established for the sole purpose of offering the connoisseur the opportunity to experience unequivocal recreations of the classic absinthes that fuelled the creative fires of the Belle Époque. Whereas the recent absinthe renaissance has spawned a rash of inferior, industrially prepared, chemically dyed 'absinthes' that are commonly sold to unsuspecting consumers at a considerable profit, the absinthes crafted by Jade Liqueurs deliver historical accuracy and handcrafted authenticity down to unimaginably minute details. The absinthes recreated by Jade Liqueurs ® were made possible only through the discovery and acquisition of immaculately preserved bottles of the most famous original absinthes of the 19th century. Armed with an education and experience in applied analytical sciences, Breaux has worked in conjunction with other accomplished scientific minds in perfecting the sophisticated techniques needed to unlock the many secrets of the original liquor. Some of this research has been published in peer reviewed scientific journals, and includes objective insights into mysterious topics, such as the content of vintage absinthe and facts about thujone.

One of their craft products Jade's Perique Tobacco Liqueur was released in 2006 following many months of careful development. Louisiana Perique happens to be the rarest and strongest tobacco in the world – with aromas and spiciness provided by the unique terrier of the mighty Mississippi River. The Perique tobacco liqueur is 31% abv (62 proof) and made for Jade Liqueurs by Distillerie Combier in France.

E. ABOUT LOUISIANA PERIQUE:

When the Acadians made their way into Louisiana in 1719's, the choctaw and chickasaw tribes were cultivating a variety of tobacco with a distinctive, strong and fruity aroma and flavour. A farmer named Pierre Chenet is credited with first turning this local tobacco into what is now known as Perique in 1824 through the technique of pressure-fermentation. And since then the cultivating tradition has been continued for centuries.

Early French settlers learned the secrets of Perique cultivation from the native peoples, and while their descendents have continued the tradition for centuries, very little Perique tobacco exists today. The unique terrier of the Mississippi River gives Perique the intense spices and aromas that contribute to the delicate balance of this fine liqueur.

The tobacco plants are pruned to exactly 12 leaves through their early growth. In late June, when the leaves are a dark, rich green and the plants are 24-30 inches tall, the whole plant is harvested in the late evening and hung to dry in a open walls curing barn. Once the leaves have partially dried the leaves are moistened with water and stemmed by hand. The leaves are then rolled into "torquettes" of approximately 1 pound and packed into hickory whiskey barrels. The tobacco is kept under pressure using oak blocks and massive screw jacks, forcing nearly all the air out of the still-moist leaves.

Approximately once a month the pressure is released, and each of the torquettes is worked by hand to permit a little air back into the tobacco. After a year of this treatment, the Perique is ready for consumption; although it may be kept fresh under pressure for many years. Extended exposure to air degrades the particular character of Perique. The finished tobacco is dark brown, nearly black, very moist with a fruity, slightly vinegary aroma.

Most Louisiana Perique has been cultivated by farmer Percy Martin in Grande Pointe, Louisiana. For reasons unknown, the particular flavour and character of Louisiana Perique can only be acquired on a small triangle of Saint James Parish, less than 3 by 10 miles. Although at its peak Saint James Parish was producing around 20 tons of Perique a year, output is now merely a few barrelsful. Most of the Perique used in pipe tobacco is not Perique at all, but green river burley that is processed in the same manner as Perique. Although the process produces a strong, spicy tobacco, it is a far different product from the genuine Perique grown on Percy Martin's and the Poche family's farms. So the world's supply of Perique tobacco – all 12 acres is farmed only 50 miles from downtown New Orleans and planted and harvested all by hand. No wonder this is a very exquisite liqueur. Moreover it's the only tobacco crop in the US to be fermented in whiskey barrels – an unusual way for tobacco to be processed – but no fermentation is no Perique.

Nobody knows exactly why Perique only grows in St James parish but there are three factors that make Perique distinct from all other tobacco – the soil of St James, the Perique seed and the fermentation process which sweetens the tobacco by soaking it in its own sap. Some says St James parish sits on top of a mineral deposit that apparently gives the tobacco it's distinct, spicy and robust flavour but nobody knows for sure – this is one of the world's mystery crops.

The Perique tobacco liqueur is distilled since 2006 by Ted Breaux but since not much Perique tobacco exists as of today, this purely artisanal liqueur is available only in limited quantity. In an effort to bring attention to this endangered tradition, Jade Liqueurs® created Perique liqueur to captivate

one's senses with the wonderful aroma of this native, organically cultivated tobacco, but in a form that effectively negates the health concerns associated with tobacco use. It's entirely artisanal construction has been meticulously developed and scientifically proven to embody the nuances of this ancient tobacco while excluding harmful qualities associated with the plant. Perique is best enjoyed in the same manner as one would a fine liqueur or brandy. Due to the difficulty in procuring this rare tobacco, Perique® liqueur is available only in limited quantities.

A review from then Slashfood 2007 (now HuffPost Food) reads as follows: "The aroma is unique, but with touches of cognac, woody tones, Perique tobacco, spices, and briny sea air. In addition I was surprised and intrigued by a complex base of fermented notes in the aroma which bring to mind just a touch of belacan or bagoong alamang suspended pleasantly within. Some could think this a negative aroma, but as in the iodine brine of good seaside single malt Scotch, it adds a unique touch that brings the other components together. The taste is sharp, but smooth, with a mild sweetness that balances the fire in the liqueur. The tangy fermented Perique tobacco comes through more so than in the aroma, as do the hints of spices. Then it has a woody finish combined with fine leather, as if you were sitting in an old leather armchair, in a cozy library where your favourite grandfather had smoked his pipe a few hours before."

Perique has recently appeared on the menus of some of London's most exclusive cocktail bars, including Barts, Paramount and Ten Manchester Street. And its popularity is spreading, by the sounds of it. "We're struggling to keep up with demand," says Ted. "A lot more people are starting to order it

across Britain and Japan. And our plan is to start selling it to the USA in the upcoming year."

But what of the health ramifications? Surely, mixing two of society's most costly, destructive and addictive recreational drugs is a recipe for disaster? Ted Breaux is adamant that drinking liqueur made from tobacco can in no way be compared to smoking it. "The end product comes in a form that greatly diminishes the health concerns associated with tobacco use," he says. "After distillation you end up with none of the nasties like cyanide, tarry compounds or carcinogens that you'd get from a cigarette. And only a trace amount of nicotine." However Cancer Research and the British Heart Foundation couldn't comment as they'd never heard of tobacco liqueur.

But are these 'trace' amounts still addictive? Barts' own advertisements claim that tobacco cocktails "provide the ultimate fix without having to venture outside". If this is the case, it would seem like a shrewd move on behalf of a cocktail bar owner, keeping customers indoors spending money on drinks. Barts' head barman, Greg Mantey, assures me that this isn't the case. "You'd have to drink a hell of a lot before the nicotine had any effect," he says. "In fact, the alcohol would have floored you before the tobacco."

A spokeswoman from Action on Smoking and Health (ASH) said; "there is no safe exposure to tobacco no matter how small. And it would seem like a bad idea to promote the taste or aroma of tobacco, especially to someone who is trying to give up smoking."

With the reference of an article published in an award-winning rum, tiki and cocktail blog, ("A Mountain of Crushed Ice, March 18, 2012), writer Helena Tiare Olsen, a rum connoisseur and tiki drink and cocktail enthusiast living in

Stockholm, Sweden, gives a reference of a Perique liqueur de Tabac from St. James parish, Louisiana, eau de vie, clearly stating that fermented Perique tobacco have a hint of sweet sugarcane.

The Perique liqueur is golden amber in colour and the nose is that of fine tobacco, light and delicate yet masculine with warm woody notes – it's light but certainly not weak. The flavour is the same but more intense and with some fire – yet very smooth, it's like a fine cognac spiced with tobacco and leather sweetened with sugarcane – but still more on the dry side than sweet and Perique liqueur is of course free from nicotine. Even though the tobacco adds a leathery masculine touch it's balanced by a light and feminine sweetness without being too sweet – it's rather on the dry side and the tobacco flavour is not overpowering in any way but still clearly present, Helena says.

Perique liqueur makes an interesting drink-mixer but can also be sipped neat like a fine cognac. Also for those who doesn't smoke (like me) but still enjoys the aroma of a good cigar or pipe this liqueur will allow you to do just that without any of the harmful elements you find in a cigarette. It goes well with not only cognac but also dark rum, whiskies and tequila reposado or anejo.

Helena have formulated three very nice cocktails with it, the Louisiana Sour and the Smoky Sidecar plus a twist made of the Louisiana Sour adding rum and curacao bitters. The Louisiana Sour was created by Amanda Humphrey at Paramount in London and the Smokey Sidecar was made by the Cocktail Lovers.

LOUISIANA SOUR

INGREDIENTS	DIRECTIONS
<ol style="list-style-type: none"> 1. 0.75 oz Perique Tobacco Liqueur 2. 0.75 oz Pierre Ferrand Cognac Ambre 3. 0.75 oz Fresh lemon juice 4. 0.5 oz Sugarcane syrup 5. 2 dashes Chocolate bitters 6. 2 dashes orange bitters 7. Squeeze of egg white 	<ul style="list-style-type: none"> • Dry shake with no ice (or use a hand-mixer) for a few sec • Shake hard with ice and strain into a rocks glass • Garnish with orange and lemon wheel, top with cherry.

LOUISIANA RUM SOUR

INGREDIENTS	DIRECTIONS
<ol style="list-style-type: none"> 1. 0.75 oz Perique Tobacco Liqueur 2. 0.75 oz dark rum - i used St 	<ul style="list-style-type: none"> • Dry shake with no ice (or use a hand-mixer) for a few sec

<p>Nicholas Abbey 12 yo</p> <p>3. 0.75 oz fresh lime juice</p> <p>4. 0.5 oz sugarcane syrup (Petit canne)</p> <p>5. 2 dashes chocolate bitters (Mozart)</p> <p>6. 2 dashes Curacao bitters (Master of Malt) or use orange bitters</p> <p>7. Squeeze of egg white</p>	<ul style="list-style-type: none"> • Shake hard with ice and strain into a rocks glass • Garnish with orange and lemon wheel, top with cherry.
--	--

SMOKEY SIDECAR

INGREDIENTS	DIRECTIONS
<p>1. 1.5 oz Merlet Cognac</p> <p>2. 0.75 oz MerletÂ Triple Sec</p> <p>3. 1 oz Perique Tobacco Liqueur</p>	<ul style="list-style-type: none"> • Shake all ingredients together over ice • Strain into a chilled cocktail glass.

<p>4. 0.5 oz fresh lemon juice</p> <p>5. Garnish: orange peel</p>	<ul style="list-style-type: none"> • Spritz the orange peel over the drink before dropping into the glass
---	--

F. TOBACCO BITTERS OR FAUX TOBACCO:

There are also commercially-available brands of bitters that are labelled as tobacco bitters that do not contain any tobacco. Amongst them Bitter Queen's tobacco bitters are most popular. Summoning the earthen character of tobacco, these Tobacco Bitters from Bitter Queens are made with smoked tea, clove and vanilla. Ideal for aged spirit cocktails, they'll make a magnificent Manhattan. These are typically flavoured with smoked tea, clove and vanilla and have an alcohol percentage of 50% v/v. A 10cl bottle cost INR 3028.00 at Indian market, commercially exported.

Free Brothers (Bevnet.live summer 2023 press release Apr. 27, 2023) announced its newest product, Turkish Tobacco Bitter. It is the company's latest in a line of new flavours from the brand, a family-owned business since its founding in 1864, the business is currently owned and operated by fifth-generation brothers Jon Spacher, CEO, and Benn Spacher, COO. Fee Brothers makes fine bitters, botanical waters, mixes, brines, and cordial syrups for distribution around the world. Turkish Tobacco Bitters is designed to add richness reminiscent of sun-cured tobacco and hints of coffee, clove, and nutmeg to cocktails. Bitters traditionally are used to add both balance and complexity to the flavour of a beverage. "Turkish Tobacco layers a unique

earthy and savoury flavour into a cocktail,” Jon Spacher, CEO of Fee Brothers, said in a news release. “I’m an Old Fashioned fan myself, and using Turkish Tobacco bitters heightens the drink in a way that exceeds my expectations.” In addition to bourbon cocktails, the hints of spice in Turkish Tobacco create depth in drinks with Mezcal, rum, or cognac.

“The feedback we got from bartenders and mixologists around the world was that they want more of our bitters and they love our wide range of flavours,” said Fee Brothers’ Product Development & QA Manager Justin F. Marcus, who also developed the additional flavours being released later this year. “While there is no actual tobacco in the Turkish Tobacco Bitters, we’ve incorporated natural flavours and ingredients to capture the warmth, acidity, and herbaceous quality of the plant. We’re getting very positive reactions from those who have tried it so far.”

OBJECTIVE OF STUDY:

As a research scholar, the objectives of this study are laid upon:

1. To explore the existing status of Liqueur de Tabac and Sirop de Tabac created by domestic means & to explore the ideas for an innovative drink recipe and the feasibility / benefits of the same for consumers.
2. To establish Liqueur de Tabac and Sirop de Tabac as a useful cocktail ingredients.
3. To test a classic cocktail recipe using Liqueur de Tabac and Sirop de Tabac as a twist.
4. To collect numerous feedback as a tasting sample for the formulated drink.

5. To appraise and recommend the use of Liqueur de Tabac and Sirop de Tabac in future drink recipes which has been long casted out as legal and social taboo.

ANALYSIS AND DEVELOPMENT:

Subsequent study with Sirop de Tabac & Liqueur de Tabac, one a non alcoholic tobacco syrup and another a alcoholic liqueur, one of kind similar to that of Jade's Perique Tobacco Liqueur, developed on domestic scale, evidence shows that in recent years, some bars have been serving classic cocktails such and Manhattans & Margaritas, containing tobacco infused into syrups, bitters, and base spirits. Some bartenders have inquired about using fresh tobacco leaves as garnish in cocktails. Some bartenders have inquired about "nicotine-free tobacco" and searches result in some scientific studies on plant development, but we have not yet identified commercial products meant to taste like tobacco that could be used safely in drinks; only herbal cigarettes and the like.

I'm not a smoker but I do like the aroma of tobacco. Barts' Up In Smoke cocktails menu have cringe-worthy names, ranging from Holy Smoke (a tangy blend of Perique, Hennessy, Havana Club and vanilla syrup) to In Vogue (Perique, tequila, raspberry puree, Gomme syrup and Crème de Framboise). Most popular is 'Cig'nature', made with Perique, Lindisfarne Mead, lemon juice and Perrier Jouet Champagne. It tastes with all the fizzy sharpness of a sparkling wine and lemon juice, but with strong notes of caramel and wood (like a good Cognac). And finally, there is the vanilla-y aroma of a freshly opened bag of moist tobacco.

A. MAKING OF ALCOHOLIC TOBACCO LIQUEUR:

Pour 5 fl oz of old rum into a saucepan and add 200 g of raw sugar. Place over medium heat and bring to a boil. Stir until the sugar dissolves (if the alcohol catches fire, cover the pan with a lid to extinguish the flame), then simmer for 10 to 20 minutes. Remove from the heat and pass through a sieve filled with 50 g of pipe tobacco, in another saucepan. Repeat this several times until the syrup absorbs the flavour of the tobacco; make sure not to put pipe tobacco in the syrup. Cool, pour into a bottle and store in the fridge for up to a month.

B. MAKING OF NON ALCOHOLIC TOBACCO SYRUP aka SIROP DE TABAC:

The blend of tobacco and sugar syrup brings in a thoughtful process in which, proportion and time plays a pivotal role. For making tobacco syrup, infused 3 fully grown dried tobacco leaf with sugar syrup in an airtight glass jar, and keep in cool dry place for 72 hours for the infusion. After 72 hours of complete infusion, the sugar syrup will have acquired a dark colour and will develop a spicy flavour & aroma, which will complement the flavour of angostura bitter in the desired concoction. Steeping on the other hand is not recommended as the bitterness of tobacco leaf may over shadow the final product.



SIROP DE TABAC
(INFUSION)



SIROP DE TABAC
(AFTER INFUSION)

Implication of Sirop de Tabac (non- alcoholic) is made in collaborating with one of a classical whisky based cocktail, Old Fashioned. After a critical thinking, a name of TOBACCO FASHIONED was suggested for the final concoction. The recipe understated as follows:

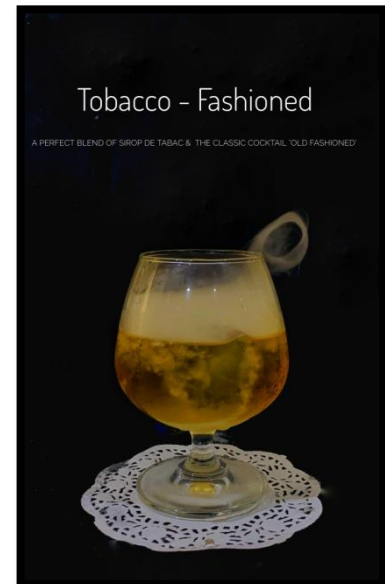
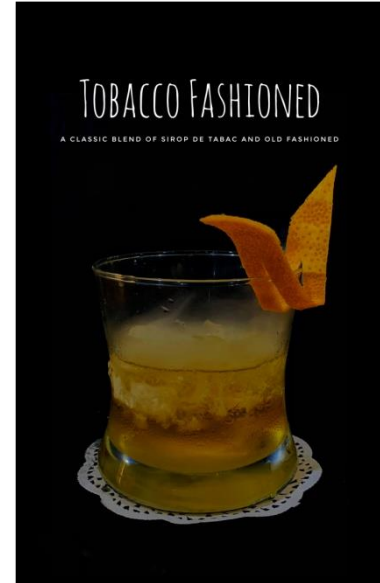
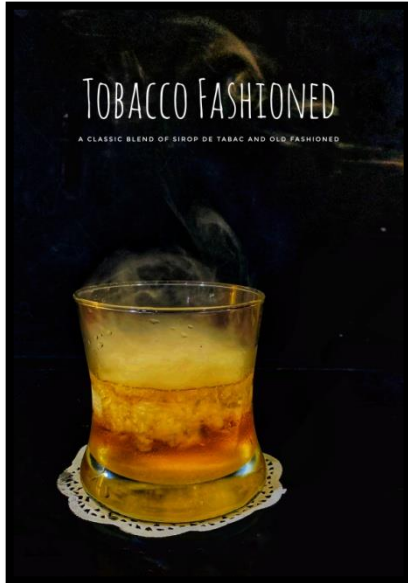
Preparation	TOBACCO	Servings:1
Time:	FASHIONED	
3 minutes	A traditional old fashioned with a twist	

INGREDIENTS:

- SIROP DE TABAC (non alcoholic): 2 dash
- Simple sugar syrup : A table spoon
- Mineral Water: A teaspoon
- Ice: Traditional old fashioned cocktails are served over ice.
- Bourbon / rye whiskey : 1.5 fl oz
- Garnishes: An orange slice and a maraschino cherry.

Directions:

- Add 1 tbsp of powdered sugar into a pre chilled traditional old fashioned glass.
- Add 2 dash (<1/2 tsp) of SIROP DE TABAC.
- Add 1tbsp of water and stir to combine.
- Pour the bourbon.
- Add ice cubes
- Garnish with orange slices and/or maraschino cherries.



SENSORY EVALUATION TEST:


This evaluation plays an important role in developing of the new recipe and to check the acceptance of the targeted population. The sensory evolution was conducted with randomly 25 selected students of Hotel Management and experts in food and beverage service for the testing the sample and table 2 shows the findings / scores, which were documented based on presentation,

tasting nodes and overall experience and after-taste. The score rating card mentioned on the table 1 below with their value.


Table1: Score Card for evaluating recipe on tobacco based cocktail:

SL	EVALUATION / COMMENTS	PRESENTATION SCORE	TASTING SCORE	EXPERIENCE SCORE
01	Extremely Disliked	0/25	0/25	0/25
02	Disliked	0/25	0/25	1/25
03	Satisfactory	1/25	5/25	8/25
04	Good / Liked	15/25	9/25	10/25
05	Better / Much Liked	5/25	9/25	2/25
06	Extremely Liked	3/25	2/25	3/25
07	Scope for Improvement	1/25	0/25	1/25

Table2: Tasting notes / card for evaluating recipe on tobacco based cocktail:



COCKTAIL
Tasting Notes













COCKTAIL NAME / NOTES :











1











PRESENTATION SCORE :

TASTING SCORE :

EXPERIENCE SCORE:

CRITICAL EVALUATION AND INTERPRETATION:

As a research scholar, the tobacco syrup desired to cast turned out dark leathery semi-opaque brown in colour with sharp smoky sweet leathery tobacco aroma having up front smoky leather tight tannic edge Aftertaste of it have a lasting tannic tobacco, light bitterness and smooth dark faint sweetness. It is not really so much bitters as thought of, as it rounds the flavour element. More bitter ingredients could be added to make it truly bitter, but it will be more enjoyed if used as flavouring.

As for the final drink recipe, its tasting is concerned, a scotch would be much preferred than any other whiskies, as because the scotch has a distinct characteristic which is generally not found in any other whiskies on offer. The taste and aroma of tobacco in case of other whiskies when blended, seems to take an upper hand of the palate. Neat Scotch would be more preferable to a connoisseur who is, incidentally, a non-smoker.

CONCLUSION:

Conclusion from experiment, evaluation and interpretation and working relentlessly for the days together, the finding of the blend was appreciated by many senior professionals at work. Some also found the concoction, a bit weird and came out with a frown. But at the end of the day, this creation seemed welcomed with most of the connoisseurs who preferred a smoke with their drink and eventually there was some sense of satisfaction as they gulped down the last sip and gave a smile of appreciation. Thus as a research scholar, happiness and satisfaction prevail over my research. Hopefully, it would be a day, when, Sirop De Tabac would bestow a patent right to the affiliation undersigned.

REFERENCES:

1. Tobacco in Cocktails - Art of Drink. 24 Mar. 2011,
2. Allan, M. Carrie. "Dangerous Drinks and How to Spot Them." Imbibe Magazine, 24 Apr. 2017,
3. Clarke, Paul. "Why Tobacco Cocktails Are a Terrible Idea." Imbibe Magazine, 28 June 2017,
4. Jade Liqueurs Fine Absinthes. "Tobacco and Nicotine Safety in Cocktails." Cocktail Safe, "No Longer Smoking Tobacco? Now You Can Drink It." Delish, 16 Jan. 2014,
5. WHO Framework Convention on Tobacco Control Overview. Indian Trade Portal. "Smoking and Drinking: A Deadly Combination." Tobacco-Free Life, Tapper, Daniel. "Tobacco Added in to the Cocktail Mix." The Guardian, 17 Feb. 2012.
6. Absinthe: Sip of Seduction: A Contemporary Guide - Betina Wittels; Robert Hermes; Ed. T. A. Breaux: 9780972577618 - Corvus Publishing - ISBN: 1933108215, year 2008
7. Absinthe: A Myth Always Green (L'Esprit Frappeur) - Benoît Noël; Peter Verte; Artemis Ed. T. A. Breaux:: 9782844052001 - Softcover ASH. "Spokespeople." ASH,
8. Perique Liqueur de Tabac – A Taste of France and Louisiana | Rum, Tiki & Exotic Cocktails. 18 Mar. 2012.
9. Marie Laveau – Tobacco Bitters by Bitter Queens,

10. "Fee Brothers Announces Launch of Turkish Tobacco Bitters."
BevNET.Com, 27 Apr. 2023.

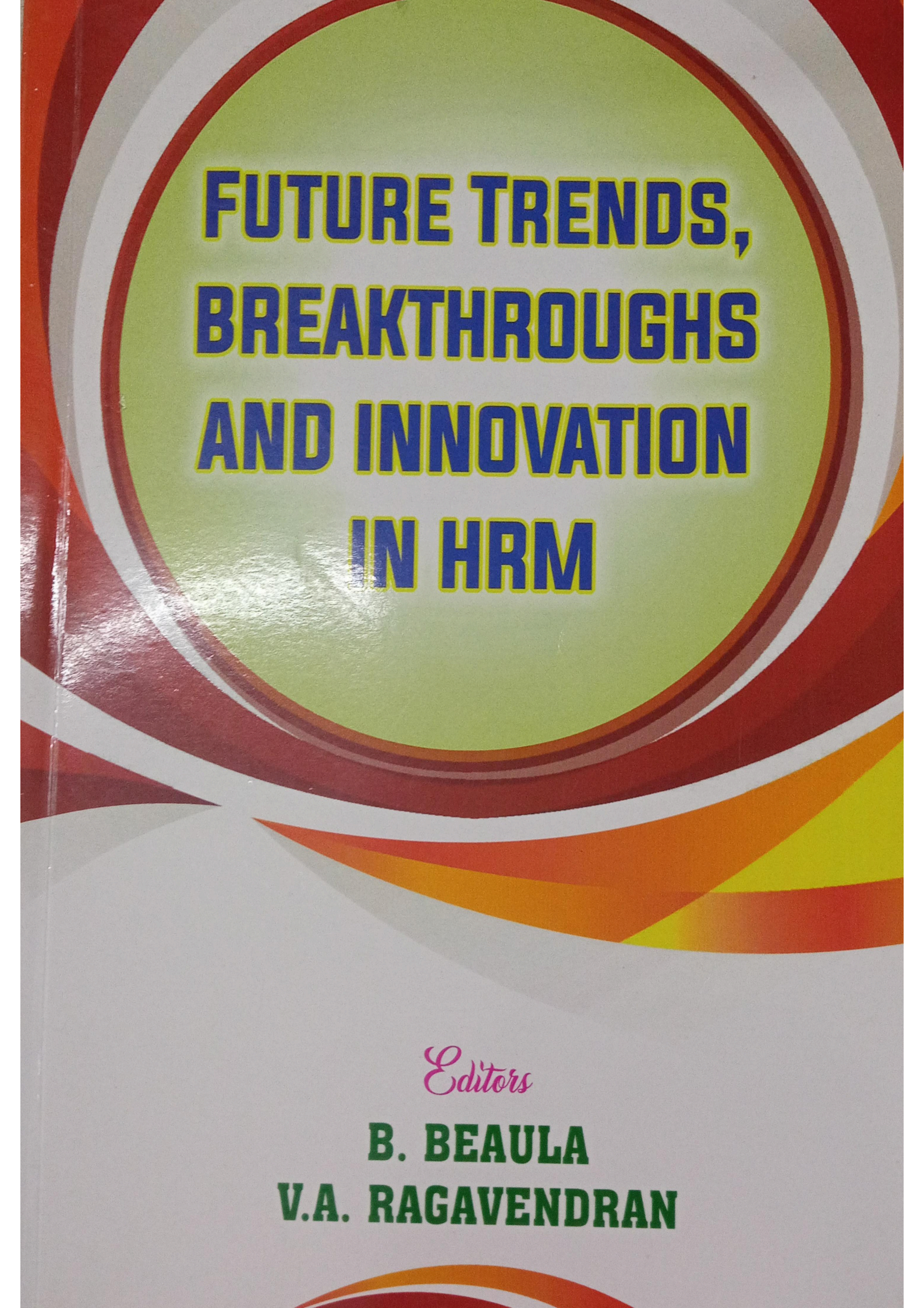


ISBN: 978-93-91387-26-6



Published and Printed By

**Association of Global Academician and Researchers
(AGAR), Publications, Tamil Nadu, India.**



**FUTURE TRENDS,
BREAKTHROUGHS
AND INNOVATION
IN HRM**

Editors

B. BEAULA

V.A. RAGAVENDRAN

FUTURE TRENDS, BREAKTHROUGHS AND INNOVATION IN HRM

Editor's

B. Beaula

*Assistant Professor in Business Administration,
Mannar Thirumalai Naicker College,
Pasumalai, Madurai.*

V. A. Ragavendran

*Assistant Professor in Business Administration,
Mannar Thirumalai Naicker College,
Pasumalai, Madurai.*



SHANLAX
PUBLICATIONS

CONTENTS

S.No	Title	Pages
HR IN FUTURE		
1	Future Employee Wellness Programs: Underpinning Workplace Spirituality and Stress Therapy <i>M.H. Raamkhumar & Dr. TNVRL Swamy</i>	3
2	An Investigation into the Demand for Refurbished Electronics in the Indian Market Using Data Mining <i>K. Saiprasad & Dr. A. Meenakshi</i>	11
3	Digital Technology for Sustainable Human Resource Management <i>Dr. AV. Karthick & Dr. K. Chitradevi</i>	17
4	Effect of Performance Appraisal on Employees' Job Satisfaction <i>Ms. S. Sumathi & Dr. A. Gokula Krishnan</i>	24
5	Future of HRM in India <i>Dr. T. Vijayaragavan</i>	29
6	Software as an Assistance for Instructor and Administration in Current Education - A Conceptual Study <i>Dr. S. Arul Krishnan, Dr. K. Prakash & Dr. G. Gayathri</i>	34
7	360 - Degree Performance Management <i>Dr. S. Kumar</i>	41
8	Hybrid Workplace: The Future of Work <i>Dr. M. Pradeeba</i>	44
ARTIFICIAL INTELLIGENCE IN HR		
9	A Review of Literature on Effectiveness of Artificial Intelligence on the Sustainable Business and ESG Performance in the Organisation <i>MD. Aisha Begum & Dr. T.N.V.R.L. Swamy</i>	50
10	AI in HR <i>R. Vidhya Bharathi</i>	58
11	AI in Human Resource <i>Ms. P. Manonmani</i>	64
12	Uses of AI in HR <i>Ms. M. Sabina Yasmin & Ms. K. Jayalakshmi</i>	70
13	AI Tool for Learning and Development Strategy and its Impact on Employees' Behavioural Changes <i>Ms. D. Janifa & Dr. A. Gokula Krishnan</i>	76
14	Artificial Intelligence in Human Resource Management <i>Dr. T. Sudha</i>	79
15	Topical Inclinations Towards Generative AI and Knowledge Sustainability - A Constructive Slant <i>Dr. A. Irudhayamary</i>	85

USES OF AI IN HR

Ms. M. Sabina Yasmin, MSc., M.Phil., MBA

Assistant Professor, Department of Hospital Administration
Shrimati Indira Gandhi College, Trichy

Ms. K. Jayalakshmi, MS.c., M.Phil., MA

Assistant Professor, Department of Hospital Administration
Shrimati Indira Gandhi College, Trichy

Abstract

Computer science's field of artificial intelligence seeks to find solutions to cognitive issues that go beyond human intellect. AI gives machines the ability to "think like humans," performing functions like language processing, learning, and problem-solving. Machine learning and deep learning are the two key technologies that underpin AI today. The use of existing technologies and artificial intelligence is growing every day, which helps businesses automate tasks behind the scenes by analyzing data sets. These concepts may make clear fresh approaches to improve hiring efficiency and broaden comprehension of the workforce within the organization. When combined with knowledge of human resource management, this improved intelligence will assist businesses in reducing expenses, enhancing the caliber of their personnel, and increasing employee efficacy.

Keywords

- Automate managerial task
- pre-programming manual
- Imitate Human Brain power
- Induction pipelines to improve their ability
- Optimize processes, increase efficiency, save operating costs, and boost productivity

Introduction

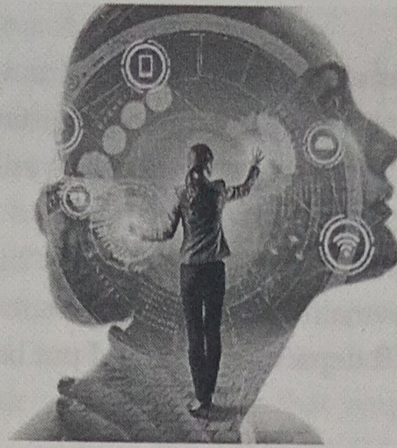
Artificial intelligence (AI) technology is quickly replacing the status norm in businesses across all industries. Because of this quick acceptance, certain operations, including human resources management (HRM), are able to optimize processes, increase efficiency, save operating costs, and boost productivity. Artificial intelligence (AI) is being incorporated into HRM processes, which is changing how businesses interact with their workers and how they are able to analyse data, foresee scenarios, and take necessary action.

What is AI in HR?

Artificial intelligence (AI) refers to machines that examine data and make resolution without human intervention. It uses either machine learning or indigenous language to instruct machines to imitate human brainpower.

AI in human resources involves pre-programming manual, monotonous activity to free up time for HR departments. With the necessary framework and company standard data, AI can quickly complete high-volume tasks.

AI taking over most of the hi-tech work, the HR team is free to focus on company's growth and remodelling.



Advantages of AI in HR

AI can get rid of managerial overhead, increase employee experience, and create meaningful reports to enlarge HR team's capability.

Get Rid of Managerial overhead

AI can handle the monotonous tasks that inhabited HR team, such as automating email responses or creating company documents. As a result, the HR team can focus less on administrative work and more on employee experience.

Increase employee experience

AI can field many employee inquiries coincide, whereas HR professionals are restricted to answering a request at a time. Additionally, AI allows HR teams to guide employees with critical issues, increase employees' overall gratification.

Create meaningful reports

AI can create vigorous reports based on the framework set. By accessing company data sets, AI can examine and enlarge associations between finances, performance, and engagement to assist in tactical decision-making – such as suggesting cost-effective solutions to inefficient company processes.

Use of AI for HR

AI can absolutely impact all areas of HR, simplifying the tasks and experiences of HR personnel and employees alike. Some of the main ways of AI tools for HR as follows:

1. Induct top aptitude.
2. Automate managerial tasks.
3. Be in charge of manpower.
4. Evolve productive performance analysis.
5. Maximise learning and development trackway.
6. Make sure adherence.

AI can solve HR challenges

AI is a crucial instrument to alter HR executives from paper-pushers to employee experience innovators. Through AI, HR departments can ensure they address employee needs timely and completely while proactively navigating enlightened the enterprises and employee dynamisms.

However, AI should not completely replace the “human” element of “human resources.” Instead, AI should remain a tool to coordinate managerial tasks, employee requests, and obligations. And HR departments should put back all the time they save into improving their workplaces.

Induct Top Aptitude

AI in induction focus on maximizing both inductor and candidate experiences. For inductors, AI can reduce monotonous tasks throughout their induction pipelines to improve their ability. For candidates, it can make job hunting a pleasant experience.

Companies have taken advantage of AI in induction for some time as its ability to handle high-volume tasks, such as résumé screening, can occupy most small HR teams’ time. Moreover, inducting agencies frequently use AI tools to reach out to potential applicants, build candidate databases, and organize multiple clients’ data to find the best candidates.

Most modern induction software and applicant tracking systems (ATS) include AI elements. For example, Zoho Recruit’s AI feature suggests top candidates by identifying keywords in job descriptions and candidates’ applications. Syncing such tools with the rest of your HR tech stack can also draw insights into important HR metrics such as attrition and turnover.

Automate Managerial Tasks

Automated workflows are one of AI’s most apparent ways to relieve HR teams of the back-and-forth frequently associated with administrative work. For example, such workflows can help HR teams by automatically responding to employees’ email inquiries.

Explore our Onboarding Software, Payroll Software, and Benefits Administration Software Guides for solutions to automate your most tedious tasks.

Be In charge of Manpower

AI in workforce management can route employee enquiries to minimize HR bottlenecks or congestion, much like an air traffic controller. In order to avoid contacting HR departments for this information, AI may, for example, provide employees with access to their files or other information through self-service portals.

While this is going on, HR teams may use workforce management AI to identify inefficiencies in their processes and begin taking preventative action to optimize them. Predictive analytics solutions, such as Bob's Attrition Indicator, for instance, alert users to potential flight threats so they may make appropriate plans and avoid any severe disruptions to business operations.

Evolve Productive Performance Analysis

Companies can create staff one-on-ones and goal-setting processes that are more successful and meaningful with the use of AI in performance management. AI can help businesses implement more equitable promotion and compensation policies to promote DEI objectives, in addition to automating performance review processes so that staff members can act on constructive criticism sooner

For example, leading performance management programs like Lattice employ AI to give managers historical and market benchmarking salary information. Because of this, businesses can guarantee fair pay procedures that emphasize data and an employee's performance history. optimize learning and development paths

Ensure Compliance

AI can assist businesses in keeping up with new laws that will affect them, particularly those that use a worldwide workforce. Similar to this, AI may search through historical data for instances of labour law violations, enabling HR teams to handle these concerns before they become serious ones.

For instance, Rippling has a dynamic employee portal that alters based on the user's location. Additionally, its AI automates payroll tax adjustments and notifies employers of violations of labour laws. HR departments may relax about constantly keeping an eye on risk to ensure compliance as a result.

Resume Examining

Leading technological company Insert Generic Company Name Here- Corporation receives hundreds of resumes daily for various job positions. The amount of applications the HR team needs to review is overwhelming them. They put in place an AI-powered resume-scanning technology to speed up the procedure. The system analyses resumes using natural language processing algorithms to extract pertinent data like skills, qualifications, and experience. The HR team can now concentrate on more strategic activities because initial resume screening takes up a lot less of their time. The AI technology efficiently shortlists the most qualified individuals by properly identifying keywords and matching them with the job requirements.

HR Analytics and Reporting

Real Business Name Conglomerate is a global conglomerate with multiple business units spread across various regions. The HR department wants to gain deeper insights into their workforce to make data-driven decisions and improve HR practices. To achieve this, they implement an AI-driven HR analytics and reporting platform.

The AI platform integrates and analyses vast amounts of HR data, including employee demographics, performance metrics, training records, and engagement surveys. It provides HR professionals with comprehensive reports and interactive dashboards that offer real-time insights into key HR metrics such as turnover rates, employee engagement levels, and diversity statistics. Equipped with these insights, the HR team can identify HR trends, patterns, and areas for improvement.

Employee Onboarding

A rapidly expanding technology firm called Running Out of Fake Company Names International understands how important it is for new hires to have an enjoyable and seamless onboarding process. They introduce an AI-powered staff onboarding software to guarantee a smooth integration into the business.

The platform, which uses AI chatbots and automation, is accessible as soon as a new employee accepts an offer. The AI chatbot acts as a virtual assistant, assisting the new hire with their onboarding and responding to any queries they might have. It offers crucial details including company policies, rewards, and access to pertinent resources.

Best Practices for Implementing AI in HR

Start Small

Start with a short pilot program rather than attempting to integrate AI across all HR operations at once. Before using the technology on a bigger scale, you can test it out and uncover any problems with it through a pilot program. Additionally, it will give your HR team time to become accustomed to the new procedures and technologies.

Focus on Ethical Use

The ethical and fair application of AI in HR technology must be ensured. Be open and honest with candidates and employees about the usage of AI tools, and ensure that the algorithms are not discriminatory. There are numerous AI technologies with representational problems in their datasets. Fair use is another ethical topic that requires consideration. "Generative AI" technologies are currently facing criticism for including other people's work without getting their consent into their databases.

Invest in Training and Encourage Discussion

AI implementation in HR necessitates a large investment in training for both HR personnel and employees who will be utilizing the technology. You might want to spend money on training so you know how to utilize the tools, understand the data, and deal with any problems that come up.

When it comes to the use of AI tools in human resources or any other department, promote open conversation. Regular employee pulse surveys are a terrific method to collect feedback from your team and get people's opinions heard.

Combine AI with Human Interaction

It's vital to keep in mind that while AI can be a strong tool for HR, it cannot replace the value of interpersonal communication. Avoid the error of letting AI tools totally replace human workers. Use them instead to simplify your employees' lives. Employees, clients, and potential hires would much rather communicate with a person than an algorithm. Make careful to strike a balance between the application of AI tools and the participation of HR personnel in the recruitment and employment process.

Continuously Evaluate and Improve

It's crucial to regularly assess the efficiency of the AI technologies in your HR procedures and make adjustments as necessary. Gather feedback from workers and potential candidates, keep an eye on the data being produced, and use this data to guide your decisions on how to enhance the application of artificial intelligence in human resources.

Reference

1. Zang, S., & Ye, M. (2015). Human Resource Management in the Era of Big Data. *Journal of Human Resource and Sustainability Studies*, 3(01), 41
2. Zviran, M. (2015). Relationship between organizational and information systems objectives: some empirical evidence. *Journal of management information systems*. 7(1), 65-84
3. Tecuci, G. (2012). Artificial Intelligence. *Wires computational statistics*, 4(2), 168-180
4. Thahn, N.C.& Thahn, T.T.L (2015). The interconnection between interpretivist paradigm and qualitative methods in Education. *American journal of Educational science*, 1(2), 24-27
5. Peterson, B.L (2017). Thematic analysis/interpretive thematic analysis. *The international encyclopedia of communication research methods*.
6. Rasmussen, T., & Ulrich, D. (2015). Learning from practice: how HR analytics avoids being a management fad. *Organizational Dynamics*, 44(3), 236-242.

First Edition

E Commerce



Dr. Asha Joseph



Publisher

Innovation Online Training Academy

E Commerce

Dr. Asha Joseph



Published by
IOT Academy Publishers

Title: **E Commerce**

Editor - **Dr. Asha Joseph**

First Edition

First Published – September 2023

This edition published on September 2023 by Innovation Online Training Academy

Hardcopy

Font Size: 12

Font Style: Cambria

Number of Pages: 243

Cost per copy: Rs 650 INR

Publisher Address

Innovation Online Training Academy (IOTA) Publishers

11C, Brindha Layout,

Krishna Nagar

Coimbatore-1,

Tamilnadu.

email: iotacbe@gmail.com

www.iotacademy.in

Contact Number: **7825007500**

ISBN: 978-93-93622-54-9

Copyright © Dr. Asha Joseph

All rights reserved. No part of this publication may be reproduced, stored in or introduced into a retrieval system, or transmitted, in any form, or by any means (electrical, mechanical, photocopying, recording or otherwise) without the prior written permission of the publisher. Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages.

Typeset by Star Color Park Printers, Coimbatore



visit us at for further information

www.iotacademy.in

Preface

Welcome to the ever-evolving world of E-commerce! This book, "E-commerce," is a journey through the dynamic landscape of online business, where digital innovation meets consumer demands, and opportunities for growth are boundless. As the authors of this work, we are excited to introduce you to the intricacies, strategies, and possibilities that define the E-commerce ecosystem. The global marketplace has undergone a remarkable transformation in recent years, with E-commerce emerging as a central force of change. In this age of digital connectivity, consumers can shop for products and services from the comfort of their homes, and businesses can extend their reach to customers across borders. This book serves as a comprehensive guide to navigating this exciting terrain. We begin by laying the foundation, exploring the historical roots of E-commerce and tracing its incredible evolution. We delve into the essential components of an online business, from website design and payment processing to digital marketing and customer experience optimization. Throughout the book, we emphasize the importance of adaptability in a field where change is the only constant.

Whether you are a business owner venturing into E-commerce, a student seeking to understand the complexities of online retail, or a curious reader exploring the digital marketplace, this book is designed to provide you with a comprehensive and up-to-date perspective on E-commerce. We hope it inspires you to embrace the opportunities and challenges of this exciting digital frontier.

The Editor

CONTENTS

S. No	Title	Page No.
1.	E-commerce's Contribution to Lowering Operational Costs <i>Dr. Savya Sachi</i>	1
2.	E-Commerce In INDIA - Opportunities and Challenges <i>Dr. P.V. Amutha and Dr. M. Pushpalatha</i>	11
3.	Mobile Learning: Pocket Learning Model <i>Dr. Rakhi Gupta and Dr. Divya Chowdhry</i>	20
4.	Issues and Challenges of E-commerce <i>Dr. V. Ramadevi</i>	25
5.	The soaring commercial growth of the IT sector and the revolutionary commercial growth of health industry: unleashing the power of Artificial Intelligence <i>Dr. Asha Joseph and Dr. Shiju George</i>	30
6.	Navigating the Digital Frontier: Unveiling Amazon's E-commerce Strategy in the Indian Market <i>Mr. Venkatesh T and Ms. Ranjitha PV</i>	39
7.	E-commerce Enigma in India: Decoding the Current Landscape, Confrontations, and Prospects <i>Ms. Archana B and Ms. Dhana Lakshmi G.</i>	50
8.	Latest Trends in E- Commerce <i>Ms. Juveria Hasan</i>	62
9.	Evolution Of E-Commerce in the World of Commerce <i>Mr. J. Renish and DR. D. John Prabakaran</i>	69
10.	Instagram Marketing <i>Dhivya. M, M. Uma Maheswari, Dr. B. Nandhakumar</i>	79
11.	The Impact of Artificial Intelligence in E-Commerce in Present Scenario <i>Ms. A. Geetha</i>	94
12.	The Significance of E-Commerce in Emerging Markets <i>Dr. Kasala Nageswar Rao and K. Krishna Siri</i>	101
13.	Risk of E-Commerce <i>Mrs. Uma Chaudhary</i>	109
14.	E-Commerce and Its Applications <i>Mrs. V. Priyanka and Dr. A. Sudarvizhi,</i>	119
15.	Growth of E-Commerce in India PostCovid-19 <i>Dr. A. Sudarvizhi and Mrs. V. Priyanka</i>	128
16.	Role of Artificial Intelligence in E-Commerce: Present & Future <i>R. Subha and Dr. G. Bhavani</i>	136
17.	Risk Management in E-Commerce <i>M. Sabina Yasmin and K. Gayathri</i>	142
18.	E-Commerce with Digitalization <i>Monalisa Pattanayak</i>	152
19.	Machine Learning in E-commerce <i>Ms. M. Prema and S. Lingeswari</i>	162
20.	E- Commerce Business Models <i>Ms. Prasy V. K.</i>	173

21.	Artificial Intelligence and E-Commerce – Future Trends <i>Dr. K. Shenbaham</i>	179
22.	Problems and Challenges in E- Commerce <i>Dr. K. Kavitha Maheswari</i>	185
23.	Advantages and Disadvantages of E-Commerce <i>Dr. E. Deepa</i>	195
24.	Bills Discounting <i>Dr. Sampath Kumar V.</i>	203
25.	E-Commerce <i>Dr. B. Geethpriya and Ms. S. Ashma Begum</i>	209
26.	E-Commerce <i>Ms. V. Priyanka and Mr. H. Surendiran</i>	213
27.	E-Commerce: The Cutting Edge for Small Business <i>Dr. Rekha Chetwani and Mrs. Upma Choudhary</i>	219
28.	E- COMMERCE <i>Dr. T. M. Hemalatha and Ms. Roshini P.</i>	225
29.	E- Commerce <i>Dr. Deepa Nathwani</i>	231
30.	Factors Influencing In Ecommerce <i>Dr. R. Bhuvana and Ms. S. Maheshwari</i>	237