



K.S.Rangasamy
College of Technology
(Autonomous)

National Conference on
“TECHNOLOGICAL INNOVATIONS IN
LIFE SCIENCES TOWARDS SUSTAINABILITY”
(TILS-24)

17th April 2024

Editors

Dr. G. Karthikeyan
Dr. B. Kalpana
Dr. J. Philip Robinson
Dr. K. Saravanan
Dr. T.A. Sukantha
Dr. S. Meenachi

Organized by

Department of Textile Technology
Department of Biotechnology
Department of Food Technology
Department of Nano Technology
Department of Chemistry

K.S.Rangasamy College of Technology (Autonomous)
Tiruchengode-637215



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ABOUT THE INSTITUTION

The foundation of K.S.Rangasamy College of Technology was laid in the year 1994, near Tiruchengode, South India. A vital part of the enormous K.S.R Educational Institutions, it is carving a distinct place for itself under the tutelage of Lion Dr. K. S. Rangasamy M.J.F. KSRCT is located in a scenic campus area of over 200 acres with a built-up area of 12 lakh square feet. A combination of cutting-edge infrastructure and competent faculty team makes it a premier center for learning. KSRCT offers 12 undergraduate and 9 postgraduate courses in addition to M.S./Ph.D. programmes in different Science, Engineering and Technology disciplines. The college is twice accredited by NAAC A++, 6 UG programmes are accredited by NBA under Tier-1 category. KSRCT has various Centres of Excellence for students and faculty empowerment. It has signed MoUs with leading industries to facilitate industrial exposure for students and faculty, and allow in-plant training for students. KSRCT has the state of the art laboratories for a holistic learning experience. Be it accommodation, sports facilities, library and other technological amenities, the academy has the best of them all. KSRCT has strong foundation of alumni network and alumni are holding top positions in different government and private organizations. The Institution is DST-FIST sponsored, recognized as STAR college by DBT and recognized by UGC under 2(f) & 128) Department of Biotechnology has received DBT PG College Scheme to host sponsored M.Tech., Biotechnology. Recent achievements from 2020 include, AICTE- IDEA Lab funding across India among 49 Institution awardees, ICT-Learathon 2020 contest I adjudged second in National and State level, National level Toyathon Winner, New Code of Education runner up Institution in the Autonomous Category. Establishment of Centre for Design, 12 industry partners through various CoEs for placement and training

School of Life Sciences

School of Life Sciences was established with a vision of promoting inter-disciplinary learning and research. Departments of Biotechnology, Nano Science and Technology Food Technology and Textile Technology were accommodated under KSRCT School of Life Sciences for steady progression towards achieving academic excellence. The infrastructure facilities were greatly expanded through funds from the Institution and various funding agencies like DST, DRDO, DET, ICMR, AICTE, Ministry of Textiles, SERB CSIR.

Department of Textile Technology was established since 1997 with well equipped laboratories, experienced faculty and dedicated staff members to meet the technical manpower needs of the rapidly expanding textile and garment industry by creating industry-ready graduates. Curriculum has been designed to update the knowledge of students in current technological trends. The department library is stacked with good collection of books, International and National Journals, to provide ample opportunities for the students to explore their propensity for learning and innovation in their field of study. The department has received funding from various government agencies like DST, DRDO, AICTE, Ministry of Textiles, SERB, CSIR, etc. The Department has inked Memorandum of Understanding (MoU) with leading Universities and Industries for promoting research and consultancy activities. The Department conducted training through Central and State government skill development schemes for the under privileged. The Department has achieved 100% placement for the batches so far with good salary in reputed MNCs in India and abroad.



Department for Nanoscience and Technology was established since 2008 with an objective to undertake advanced technology transfer research in the field of Nanoscience and Technology. The Department is offering the Post Graduate programme in M.Tech. Nanoscience and Technology since 2008 and also offers Ph.D. in the field of Nanoscience and Technology. More than 28 candidates were awarded with Ph.D. degree. Granted 3 patents and filed 13 patents in areas such as nano-metal oxides from natural minerals, nano-silica from rice husk, and nanoparticles from herbal plants for different industrial applications. More than 200 publications in different peer-reviewed international journals. 22 completed funded projects with a value of Rs.3.64 crores from DST-DAAD-PPP, DST-SERB, New Delhi and BRNS, Mumbai Conducted many International conferences and hands-on training workshops on Nanotechnology and 15 MoU signed with international institute and industry to cater to the needs of the nanotechnology-based scientists and researchers. Five Nobel Laureates has visited the CNST, KSRCT since from 2010

Department of Biotechnology was established since 2002 which offers B.Tech, Biotechnology at the UG level, M.Tech-Biotechnology Sponsored by DBT GAT-B at PG level and Ph.D. degree at doctoral research level. The research centre is approved by Anna University, Chennai. Over two decades of existence with 15 state of art laboratories and an animal house facility, 250 research papers in peer reviewed journals, popularized articles, 17 magazines, 225 abstracts were published by the members of faculty and students in addition to 16 books, 24 book chapters, 23 general articles, 27 proceedings till date. The department have received 20 funded projects, 2 granted Indian patents and filed 24 Indian patents, 1 PCT, 4 US and 2 UK patents. About 62 students and 12 faculties have received fund for "Student Project, summer research and Young Scientist Fellowship from TNSCST and IAS. One faculty received "Young scientist fellowship from DST. Nine students have received Senior Research Fellow (SRF) from various funding agencies

Department of Food Technology was established since 2016 which offers B.Tech. Food Technology. The Department of Food technology delivers Outcome Based Education (OBE) which is effective in producing competent technologist. The department has a dedicated team of highly qualified members of having expertise in broad interdisciplinary research domains. The department trains the students in the well-equipped laboratories like Food Microbiology, Food Analysis, Fruit and Vegetable processing, Food Fermentation, Dairy engineering, Food Process Engineering, etc., All the laboratories are well-equipped with state-of-the-art equipment for the accessibility of students. Labs provide a plethora of opportunities for the students to quench their scientific pursuit. Dedicated R&D faculty teams are involved in guiding the students in their minor and major research projects which are being offered in the Department.

Department of Chemistry was established since 1994 and research centre approved by Anna University, Chennai. Faculty published more than 60 articles in peer reviewed national and international journals. Our faculty got best faculty award and young scientist award and has so many collaboration with foreign institute/universities. Dedicated R&D faculty team involved in guiding the students in interdisciplinary department projects.

ABOUT THE CONFERENCE

NCTILS 2024, is designed to bring together the scientists, researchers, industries, and students across the country to share and disseminate the knowledge, new ideas, innovative technologies, recent advances in industry and hence, to foster the research relations between the academia and the industry. This Conference will foster the teaching-learning community with the knowledge needed to advance professionally and opportunities to collaborate and learn from the experts. The Conference would offer several distinguished lectures across the domain of biotechnology, nanotechnology, food technology, textile technology, chemistry and more showcasing how technology is being used to address sustainability challenges through plenary and oral / poster sessions to create a platform for the budding researchers to share their findings among their peers and experts. Best paper awards will be presented for the research findings with the most significant innovative contributions to the field of science and technology.

Topics

S. No	Title	P. No
1	VALOURIZED FOOD PRODUCT FROM ORYZA SATIVA AND BANANA STEM POWDER	1
2	REVOLUTIONIZING SUSTAINABLE TEXTILE MANUFACTURING: POMEGRANATE EXTRACT AS A NATURAL FLAME RETARDANT FOR FURNISHING COTTON CLOTHING	6
3	MAPPING OF URBAN AREA USING DENSE CONVOLUTION NEURAL NETWORK IN HYPER SPECTRAL REMOTE SENSING IMAGE	16
4	ENHANCING SUSTAINABILITY AND COST EFFICIENCY IN CHILDREN'S GARMENT MANUFACTURING THROUGH AI-DRIVEN DESIGN OPTIMIZATION	26
5	SYNTHESIS OF SELENIUM NANOPARTICLES FROM SERICIN AND BANANA SAP AND FORMULATION OF WOUND HEALING GAUZE	31
6	RECENT ADVANCES ON CUPERPHOSPID (CU ₃ P) FOR ELECTROCHEMICAL WATER SPLITTING APPLICATION	45
7	SYNTHESIS AND CYTOTOXIC ACTIVITY OF ISOMERIC DIBENZONAPHTHYRIDINES	50
8	DEVELOPMENT OF CHAINMAIL STRUCTURE USING 3D PRINTING TECHNOLOGY	57
9	APPLICATIONS OF BORASSUS FLABELLIFER FRUIT PULP: A COMPREHENSIVE REVIEW	64
10	EVALUATION OF TOTAL PHENOLIC CONTENT AND ANTIOXIDANT POTENTIAL OF LEAF EXTRACTS OF MUSA ACUMINATA	71
11	ENHANCING FILTRATION EFFICIENCY WITH BAMBOO-BASED NON-WOVEN SPUN-BONDED MASKS: A SUSTAINABLE SOLUTION FOR PERSONAL PROTECTIVE EQUIPMENT	75
12	REMOVAL OF PARACETAMOL FROM AQUEOUS SOLUTION USING TITANIUM DIOXIDE	81
13	MICROBIAL PRODUCTION OF BIOETHANOL FROM CRUDE GLYCEROL	81
14	INNOVATION OF NOVEL COMFORT HELMET WITH BAMBOO KNITTED FABRIC	82
15	DEVELOPMENT OF COMPOSITES FROM BAGASSE FIBRE AND POLYPROPYLENEUSING EPOXY RESIN	82
16	ELECTROCHEMICAL SENSING OF ANILINE BASED ON BIO-INSPIRED CAULIFLOWER SHAPED TIN-OXIDE NANOPARTICLE USING SOLANUM TRILOBATUM LEAF EXTRACT	83

17	IMPROVING WASHING AND SUNLIGHT FASTNESS OF SILK YARN USING NATURAL MORDANTS	83
18	MANUFACTURING OF ECO-FRIENDLY SANITARY NAPKIN	84
19	DEVELOPMENT AND MECHANICAL CHARACTERISTICS OF NONWOVEN PRODUCED FROM SILK WASTE AND POLYPROPYLENE	85
20	PHYTOREMEDIATION OF URBAN AND INDOOR AIR POLLUTANTS BY PLANTS MICROBES' INTERACTION.	85
21	PHYTOREMEDIATION OF HEAVY METAL-CONTAMINATED SOIL: MECHANISMS, PLANT SPECIES SELECTION, AND FUTURE PROSPECTS	86
22	EXPERIMENTAL ANALYSIS ON THE EFFECT OF CBR RESULTS FOR FLY ASH PURIFIED CLAYEY SOIL MATERIALS	86
23	DEVELOPMENT OF POLYHERBAL FORMULATION FOR THE TREATMENT OF DIABETES MELLITUS USING MEDICINAL PLANTS	87
24	A STUDY ON CONSUMER PREFERENCE TOWARDS INSTANT FOOD PRODUCT	87
25	CONTROLLED ATMOSPHERIC PACKAGING FOR CHILLED MEAT	88
26	DEVELOPMENT OF FORTIFIED FEED FROM MAIZE COB	88
27	INSTANT IDLI BATTER PELLET	89
28	SEMI- AUTOMATED CASHEW PROCESSING MECHANISM	89
29	IMPACT OF BUYING BEHAVIOUR OF CONSUMERS TOWARDS INSTANT FOOD PRODUCTS	90
30	FORMULATION OF NUTRIENT CHOCO BAR USING KODO MILLET	90
31	FUNCTIONAL FOOD. PRODUCT DEVELOPMENT, MARKETING AND CONSUMER ACCEPTANCE	90
32	A NOVEL PROCESS FOR EXTRACTION OF NATURAL SWEETENER FROM LICORICE (GLYCYRRHIZA GLABRA) ROOTS	91
33	FORMULATING EXTRACTS FROM HIBISCUS ROSA-SINENSIS PETALS AND PSIDIUM GUAJAVA LEAVES.	91
34	DEVELOPMENT OF HEALTH MIX BY USING FISH SCALE WITH HIGH CALCIUM AND IRON CONTENT	92
35	DETECTING FOOD ADULTERATION FOR FRUITS	92
36	WASTE PRODUCT UTILIZATION: PREPARATION OF TUTTI FRUTTI FROM WATERMELON RIND	95
37	ASSESSMENT OF SPECTROSCOPIC TECHNIQUES FOR ADULTERATION DETECTION OF RAW MATERIALS USED IN BIOPHARMACEUTICAL MANUFACTURING	95

38	EVALUATION OF PLANTS GROWTH BY USING NANOFERTILIZER	94
39	EVALUATION OF ANTI-DIABETIC ACTIVITY OF SOLANUM TORVUM AGAINST 3T3-L1 CELL LINE	94
40	MICROBIAL DIAGNOSTICS	95
41	CONTRIBUTION OF STARCH TO THE FLAVOR OF RICE-BASED INSTANT FOODS	95
42	PHYSICOCHEMICAL PROPERTIES OF GREEN MEDIATED IRON OXIDE NANOPARTICLES	96
43	PREPARATION OF CO ₃ O ₄ NANOPARTICLES FOR ANTICORROSION APPLICATION	96
44	DESIGN OF DIFFERENT SIZE NANOSPHERES FOR SKIN APPLICATION AS AN OINTMENT – KETOCONAZOLE	97
45	PHARMACOLOGICAL ACTIVITY ON ALZHEIMER’S DISEASE BY USING LICHENS	97
46	REVITALIZE BONE: DRIVING OSTEOBLAST CELL ACTIVATION FOR ADVANCED BONE REGENERATION	98
47	A REVIEW OF THE MAGIC COCKTAIL GENERATING LUNG'S CRITICAL IMMUNE CELLS IN THE LAB	98
48	PREPARATION OF POLYHERBAL SHAMPOO FOR TREATING TELOGEN EFFLUVIUM	99
49	AN EXTENSIVE REVIEW OF PHYTOCHEMICAL EVALUATION AND ANTIMICROBIAL ACTIVITY OF TULSI (OCIMUM TENUIFLORIUM)	99
50	SYNERGIC TREATMENT OF HERBAL CREAM FOR SKIN INFECTIONS	101
51	STUDY OF VACUUM PRESERVATION METHOD ON SHELF LIFE OF TOMATO (SOLANUM LYCOPERSICUM)	101
52	DIABETIC WOUND HEALING: HARNESSING FIBROBLAST POTENTIAL FOR ENHANCED RECOVERY	102
53	ANTICANCER ACTIVITY OF TURBINARIA ORNATA POLYPHENOLS AGAINST HUMAN CANCER CELL LINES	102
54	TRANSZEN: A COMPREHENSIVE TRANSPORTATION MANAGEMENT APP	103
55	STUDIES ON DEEP FAT FRIYING OF FRENCH FRIES AND ANALYSIS OF ITS QUALITY PARAMTERS	103
56	DISTINCT NICKEL-PRECURSOR SYNTHESIZED NIO NPS ON THE DEGRADATION OF BIOLOGICAL STAINING DYES: A GREEN ROUTE	104
57	COMPARATIVE STUDY ON COCOA BUTTER AND SHEA BUTTER IN CONFECTIONERY PRODUCTS	104

58	HIGH PROTEIN MILK SOLID FROM ZEA MAYS	105
59	COTTON BED SPREADS TREATED WITH ACHYRANTHES ASPERA AND SENNA AURICULATA: ECO-FRIENDLY COMFORT FOR SHORE-BASED PATIENTS AND SENIOR CITIZENS	105
60	THE MECHANISM OF WHEY PROTEIN AND BLUEBERRY JUICE MIXED SYSTEM FERMENTED WITH LACTOBACILLUS INHIBITING ESCHERICHIA COLI DURING STORAGE	106
61	ENHANCED PHOTODEGRADATION OF ORGANIC POLLUTANTS USING MOS ₂ -SNS ₂ HETEROJUNCTION PHOTOCATALYST UNDER VISIBLE LIGHT IRRADIATION	106
62	NUTRACEUTICALS AND MENTAL HEALTH: EXPLORING THE INTERSECTION FOR HOLISTIC WELLBEING	107
63	ROLE OF PREBIOTICS AND PROBIOTICS IN HEALTH AND NUTRITION: AN OVERVIEW	107
64	LEAD (II) ION REMOVAL FROM WATER THROUGH BIOSORBENT CARBON	108
65	PHYTO – FABRICATION OF MGO NPS USING VARIOUS SEEDS FOR ANTIMICROBIAL AND WATER TREATMENT APPLICATIONS	108
66	THE EFFECT OF MODIFIED YARN PATH, TWIST LEVEL AND INCREASED NUMBER OF DRAWFRAME PASSAGES ON THE HAIRINESS OF POLYESTER COTTON BLENDED YARN	109
67	EFFECT OF SILICA SOL ON MGO/PVA NANOCOMPOSITE FILM FOR ADSORPTION AND REDUCTION OF CO ₂ AND HYDROCARBON IN VEHICLE EXHAUST	109
68	STACKED G-C ₃ N ₄ NANORIBBONS EMBEDDED IN MGO NPS FOR THE DEGRADATION OF INDUSTRIAL DYE EFFLUENT	110
69	THE ENRICHMENT OF TRIGONELLA FOENUM-GRAECUM A MICROGREEN VEGETATION USING COCOPEAT ANALYZED UNDER HERMETIA ILLUCENS FRASS COMPOST AND ZNO MATERIAL	110
70	ANTI FOULING & COROSSION PREVENTION ON MAGNESIUM PLATE USING TIO ₂ COATING ON MARINE METAL SURFACE	111
71	ADVANCE STROKE MANAGEMENT USING IOMT	111
72	GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM LEPTOGIUM MARGINELUM (SW) ENHACING RADICAL SCAVENGING POTENTIAL AND LARVICIDAL ACTIVITY AGAINST THREE MOSQUITO SPECIES- ANOPHELES STEPHENSI CULEX QUINQUEFASCIATUS AND AEDES AEGYPTI.	112
73	RADICAL SCAVENGING ABILITY AND ANTIBACTERIAL EFFICACY OF GREEN SYNTHESIZED SILVER NANOPARTICLES FROM MUNTINGIA CALABURA - AN IN VITRO APPROACH.	113

74	SYNTHESIS OF SILVER NANOPARTICLES FROM CYANOBACTERIA AND THEIR ACTIVITY AGAINST ANTIOXIDANT AND ANTI-INFLAMMATORY FUNCTIONS: A COMPREHENSIVE CHARACTERIZATION STUDY	113
75	COMPARATIVE STUDY OF THE ABSORPTION OF NITROSAMINE BY ACTIVATED CHARCOAL FROM COCOS NUCIFERA AND SUGARCANE BAGASSE.	114
76	DEVELOPMENT OF ALGAL AND RICE STRAW PULP FOR HANDCRAFTED PAPER PRODUCTION	115
77	PRODUCTION OF ANTIBIOTICS BY USING BACILLUS SPECIES ISOLATED FROM HOSPITAL SAMPLE	124
78	UNLOCKING RENEWABLE ENERGY: HARNESSING AGRICULTURAL RESIDUES FOR BIOETHANOL PRODUCTION.	125
79	IN VITRO PRODUCTION OF ATROPINE FROM DATURA METEL	125
80	IN VITRO CYTOTOXIC EFFECT OF TRIDAX PROCUMBENT LEAF EXTRACTS TESTED AGAINST CANCER CELL	126
81	ROLE OF RENEWABLE ENERGY FOR AGRICULTURAL PEST CONTROL TECHNOLOGY - A REVIEW	131
82	FORMULATION AND EVALUATION OF HERBAL COOKIES ENRICHED WITH CENTELLA ASIATICA L.	137
83	DEVELOPMENT OF HIBISCUS ROSA SINENSIS BASED TEA MASALA POWDER	152
84	DEVELOPMENT OF MEDICAL PLASTERS AND BANDAGES USING ARTHROSPIRA PLATENSIS	159
85	DEVELOPMENT OF HYGIENIC NAPKINS USING NATURAL FIBERS	164
86	INVESTIGATION OF MOISTURE MANAGEMENT PROPERTIES OF RECYCLED WOVEN FABRIC	179
87	NUTRITIONAL PROWESS UNVEILED: ESSENTIAL ELEMENTS WITHIN INDIAN MICROGREENS	187
88	DEVELOPMENT OF COMPOSITES FROM BAGASSE FIBRE AND POLYPROPYLENE USING EPOXY RESIN	197
89	INNOVATION OF NOVEL HELMET LINER WITH BAMBOO KNITTED FABRIC	203
90	PRODUCTION OF ANTIBIOTICS BY USING BACILLUS SPECIES ISOLATED FROM HOSPITAL SAMPLE	215
91	FUNGAL STRAIN IMPROVEMENT FOR MAXIMAL LACCASE PRODUCTION AND PRODUCTIVITY ANALYSIS IN LAB FERMENTER LEVEL	224
92	IN VITRO PRODUCTION OF ATROPINE FROM DATURA METEL	230

1 VALOURIZED FOOD PRODUCT FROM ORYZA SATIVA AND BANANA STEM POWDER

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Abstract

In Indian population, about 90% of them are expected to have anaemia and out of which 40% are pregnant women and 29.4% are at reproductive age and 20% are nonpregnant women. In ancient times *Oryza sativa* (Poongar rice) is consumed by pregnant women which contains all the nutrients that are needed during pregnancy and helps in baby development. Even during pregnancy 'urinary tract infection' may also end up in kidney stone. Our project is to develop a bread using Poongar rice and *Musa* (banana) stem, which is rich in vitamin B12 and potassium respectively helps to cure the kidney stones and increases the haemoglobin level. The main insight of this project is to have a dietary food which can be consumed by all age people and reducing the risk factor of developing anaemic condition, UTI and enriching the development of womb during pregnancy time.

Keywords- UTI, anaemia, Poongar rice, Banana Stem Powder.

1.INTRODUCTION

In Indian population, about 90% of them are expected to have anaemia and out of which 40% are pregnant women and 29.4% are at reproductive age and 20% are non-pregnant women. Even during pregnancy 'urinary tract infection' may also end up in kidney stone. The *Musa* (banana) stem, which is rich in potassium helps to cure the kidney stone. In ancient times *Oryza sativa* (Poongar rice) is consumed by pregnant women which contains all the nutrients that are needed during pregnancy and helps in baby development. So, these two components integrate to form a valourized food product. Poongar rice is also known as women rice. Benefits of Anthocyanin present in poongar rice, it has the capacity to control the blood pressure to suit the human body poongar rice contains high amount of iron, which helps to improve and maintain a good haemoglobin count. Banana Stem is a rich food source of potassium and vitamin B6 which helps in the production of insulin and haemoglobin.

2.MATERIALS AND METHODOLOGY

2.1 Poongar rice

Poongar rice is also known as red rice which retains its bran and germ, making it more nutritious than white rice. It is rich in antioxidants and essential nutrients compared to its white counterpart.

2.2 Banan stem powder

Banana stem has diuretic properties and helps to detoxify the body. Banana stem is full of fiber and including it in a weight loss plan will show faster results. Since plantain stem is full of fiber, it will greatly help people who are constipated. Hence, we use Banana stem powder, and it has to be incorporated with Rice flour for bread making process.

2.3 Gluten powder

Gluten powder is most often used as an additive for various flours that are low in Gluten or Gluten free. Wheat Gluten contains a lot of nutritional value. Which helps to processed food and considered safe and healthy to eat. Gluten is composed of two types of proteins called gliadin and glutenin. It is especially helpful for bread recipes using low protein flour varieties such as whole wheat or rye bread.

2.4 Yeast

Yeast may be best known as the agent in bread that makes it rise. When you add yeast to your flour and water mixture, it breaks down the large starch molecules into simple sugars. During this process, the yeast creates carbon dioxide and ethyl alcohol, which make the air bubbles that causes the bread dough to grow.

2.5 Baking powder

Baking powder is used to increase the volume and lighten the texture of baked goods. It works by releasing carbon dioxide gas into a batter or dough through an acid– base reaction, causing bubbles in the wet mixture to expand and thus leavening the mixture.

2.6 Egg

Eggs help the dough to rise and create a large crumb which is great for soaking up liquid. The result is a rich, buttery flavor, and deep golden-brown crust. Eggs add structure, leavening, color, and flavor to our bread. We collected it from a local grocery store.

2.7 Water

Water serves as a solvent and dispersing agent (for salt, sugar, and yeast). Water is necessary for yeast fermentation and reproduction; softer dough will ferment more quickly than dry dough. Water is responsible for the consistency of bread.

2.8 Milk

In the dough stage, milk increase water absorption. The milk contains fats which helps to soften the crust and crumbs and they will stay softer for longer period. We collected from a local grocery store.

2.9 Oil

Oil provides better slicing. Furthermore, it tenderizes baked items and helps in prolonging shelf life by slowing deterioration or staling. Here we used vegetable oil and it is also collected from a local grocery store.

METHODOLOGY

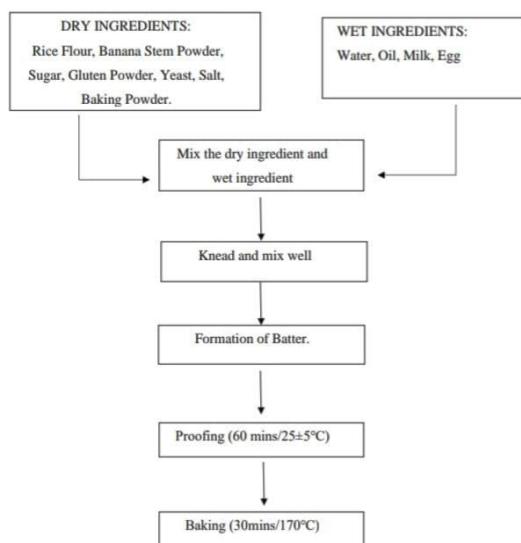


Fig: 1 Flowchart of Bread making process.

3. ANALYSIS OF BREAD

3.1 Physical analysis:

Determination of Height:

To measure the height of bread first place the bread upright on a flat surface, and using a ruler or tape measure, measure the distance from the bottom of the bread to the highest point on the top of the loaf.

Determination of Breadth:

To measure the breadth of bread first place the bread on its side on a flat surface and measure the distance across the widest part of the bread.

Determination of Length:

To measure the length of bread first place the bread on its side on a flat surface and measure the distance from one end to the other end of the bread.

Determination of Volume:

The volume of the bread can be calculated by multiplying the height, breadth, and length of the bread. The formula for calculating the volume of a rectangular object is $V = l \times b \times h$, where V is the volume, l is the length, b is the breadth, and h is the height.

Determination of Weight of the bread:

To calculate the weight of bread using a weighing balance, simply turn on the balance, place a plate or container on it, add the bread to the plate or container, and read the weight on the display screen. If necessary, subtract the weight of the plate or container by resetting the balance to zero with the plate or container on it. If the bread is too large, cut it into smaller pieces and weigh them individually, then add up the weights to get the total weight. Finally, convert the weight to a different unit using an online converter or conversion chart, if necessary.

3.2 Sensory analysis:

Sensory analysis was performed by using hedonic scale. Bread was evaluated by using 9-point hedonic scale. For evaluation of bread the sensory parameters were appearance, freshness, and texture. The hedonic scale is used to vary from 1 = Dislike extremely to 9 = Like extremely.

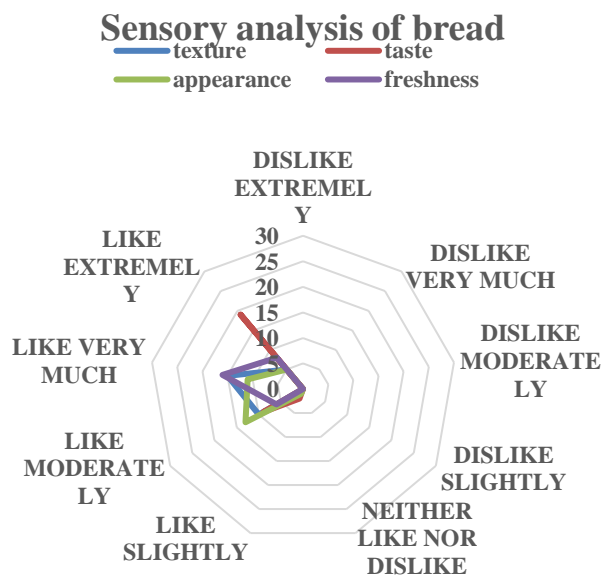
Parameters	Control Bread	Rice Flour Bread
Height (cm)	7.4	5.0
Breadth (cm)	10.5	9.6
Length (cm)	21.0	20.0
Weight (g)	250	285
Volume (cm ³)	1285.056	773.432

4. RESULT AND DISCUSSION

4.1 PHYSICAL ANALYSIS

When comparing the physical properties, including length (in centimeters), breadth (in centimeters), height (in centimeters), weight (in grams), and volume (in cubic centimeters), of rice flour bread and commercial bread, it was observed that the properties of length, breadth, height, and volume were reduced in the rice flour bread due to the presence of banana stem powder and poongar rice. However, the weight of the rice flour bread was found to be greater than that of commercial bread, owing to the higher density of the former.

4.2 SENSORY ANALYSIS



The sensory analysis was carried out among various department students and staffs. The taste was very much liked by most of the students and they said that it gives some rice cereal taste and the freshness of the bread also liked by most of the students. They said that the texture and appearance of the bread was seemed different than normal bread, it is due to the presence of red rice.

5. CONCLUSION

In this work, we prepared a value-added bread product using poongar rice flour and banana stem powder. The study results showed that the bread sample prepared with these ingredients had higher nutritional values such as fibre, protein, carbohydrates, potassium, Vitamin B6, and B12 when compared to commercial bread. It was also observed that the bread prepared with poongar rice flour had a higher potassium content and the richness of the aforementioned nutrients this bread may be effective in treating kidney stones and increasing hemoglobin levels. The main finding of this project highlights the need for a diet that can be consumed by people of all ages, which can help lower the risk of anaemia, urinary tract infections, and promote healthy womb development during pregnancy.

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2 REVOLUTIONIZING SUSTAINABLE TEXTILE MANUFACTURING: POMEGRANATE EXTRACT AS A NATURAL FLAME RETARDANT FOR FURNISHING COTTON CLOTHING

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Abstract:

The research investigates the potential of pomegranate extract as a natural flame retardant for textile manufacturing. Pomegranate peel, typically discarded as agricultural waste, is revealed to contain abundant bioactive compounds with diverse pharmacological benefits, such as antioxidant and anti-inflammatory properties. Utilizing environmentally conscious green extraction methods, these compounds can be efficiently extracted, offering sustainable alternatives for treating textiles. The study also probes into the mechanism underlying flame retardancy, proposing that pomegranate rind extract may modulate combustion pathways, thereby diminishing flammability.

While the findings showcase promise, further exploration is essential to gauge its efficacy and durability in real-world textile applications. Pomegranate extract emerges as a compelling candidate for developing eco-friendly flame-retardant finishes in the textile industry. By harnessing this natural resource, not only can textile manufacturers mitigate the environmental impact of traditional flame retardants, but they can also capitalize on the multifaceted benefits of pomegranate bioactive compounds. This research underscores the potential of leveraging agricultural by-products for sustainable innovation, paving the way for greener practices in textile production and enhancing fire safety standards without compromising environmental stewardship.

Keywords:

Pomegranate extract, Flame retardant, Sustainable alternatives, Antioxidant properties, Anti-inflammatory properties

1. INTRODUCTION

Despite advancements in textile manufacturing, the industry still faces challenges in achieving both sustainability and safety in fabric production. Traditional flame-retardant treatments often involve the use of synthetic chemicals that pose environmental and health risks. Additionally, the disposal of agricultural waste, such as pomegranate peel, remains a significant issue. To address these challenges, there is a need to explore natural alternatives for flame retardancy in textile manufacturing, particularly for cotton fabrics. Pomegranate peel, abundant in bioactive compounds with antioxidant and anti-inflammatory properties, presents a promising solution. However, further research is required to understand its efficacy and durability in practical textile applications. Therefore, the problem statement revolves around identifying and evaluating the potential of pomegranate extract as a natural flame retardant for cotton fabrics. This involves investigating its effectiveness in reducing flammability while maintaining fabric quality and sustainability. Additionally, the research aims to address any practical challenges or limitations associated with the utilization of pomegranate extract in textile manufacturing.

2. LITERATURE REVIEW

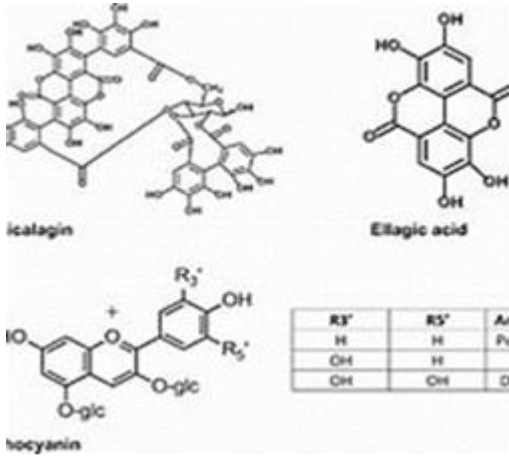
Pomegranate rind extracts exhibit multifunctional properties as fire retardants, natural dyes, mordants, and antimicrobial agents when applied to cellulosic textiles. Treatment with 400 g/L of pomegranate rind extract drastically reduces the burning rate of cotton fabric and demonstrates antimicrobial efficacy and mordanting capabilities, attributed to its rich content of tannins, metal ions, and amino acids, as revealed by Gas Chromatography Mass Spectroscopy analysis. [1] Pomegranate rind extract enhances cotton fabrics with natural colours, acts as a mordant, and imparts fire retardancy and antimicrobial properties. Studies reveal improved functional attributes at varied concentrations, including significantly lower burning rates and effective antimicrobial action against both Gram-positive and Gram-negative bacteria.[2] A novel combination of sodium tri-polyphosphate (STPP) and pomegranate rind extract (PRE) renders cotton fabric flame-retardant, significantly increasing its limiting oxygen index (LOI) and reducing burning time. The (PRE+STPP) formulation enhances char formation and drastically reduces peak heat release rate, making the fabric safer and more resilient to fire.[3] Banana peel powder (BPP), coconut shell extract (CSE), and pomegranate rind extract (PRE) demonstrate significant fire resistance when applied to cotton fabric, with PRE exhibiting the highest efficacy, reducing vertical burning rate by up to 12 times. Thermo-gravimetry analysis and limiting oxygen index values highlight PRE-treated fabric's superior thermal stability and structural integration, attributed to high molecular weight aromatic phenolic compounds and tannin-based compounds found in the extracts, while maintaining fabric tensile strength and imparting natural colour.[4] A novel blend of sodium lignin sulfonate (SLS) and pomegranate rind extract (PRE) renders cotton fabric flame-retardant, significantly elevating limiting oxygen index (LOI) to 32% and reducing burning time, with enhanced char formation. Thermo-gravimetry analysis shows substantial char mass retention at 450°C, indicating improved fire resistance attributed to deposition of nitrogen-containing alkaloids and polyphenolic compounds from PRE, along with sulfonate groups from SLS, preserving fabric integrity.[5] Chemicals play a crucial role in textile processing, but the industry seeks eco-friendly alternatives. Bioactive agents offer promise in mitigating environmental pollution from synthetic dyes, with natural extracts providing UV protection, antimicrobial properties, and aroma functionality for sustainable textile substrates.[6] Textile finishing enhances product value but often involves hazardous chemicals. With rising environmental awareness, both manufacturers and consumers demand sustainable solutions, prompting the adoption of eco-friendly finishing processes. This chapter explores sustainable preparatory processes and finishing techniques, including flame retardant, antimicrobial, bio-finish, and UV protection treatments, utilizing bio-based alternatives for a greener supply chain.[7] Developing flame retardant textiles is vital for human protection, but traditional methods pose challenges like toxicity and fabric alteration. Researchers explore innovative routes such as nanotechnology and hydrogel-based finishes, alongside natural resource-based options, for sustainable flame retardancy. Advanced techniques like UV curing and microencapsulation are also investigated for efficient flame-retardant coatings in textiles.[8] Textile substrates, ubiquitous in daily life, pose fire risks due to inherent flammability, necessitating effective flame retardancy measures. Traditional flame retardants, while efficient, often pose toxicity and environmental risks, driving the exploration of cleaner, greener alternatives like nanotechnology and biomimetic coatings. Interdisciplinary efforts aim to meet evolving safety regulations while minimizing harm to living beings and the environment, emphasizing the importance of ongoing scientific and engineering research.[9] In recent years, a growing focus on health, hygiene, lifestyle, and luxury has spurred demand for luxurious textiles enriched with natural fibres and innovative functional attributes. Integration of organic and inorganic nanoparticles, plant molecules, and biomaterials enhances textiles with properties such as antimicrobial, UV protection, and skin-nourishing benefits, meeting diverse consumer preferences sustainably.[10]

3. MATERIAL AND METHODOLOGY

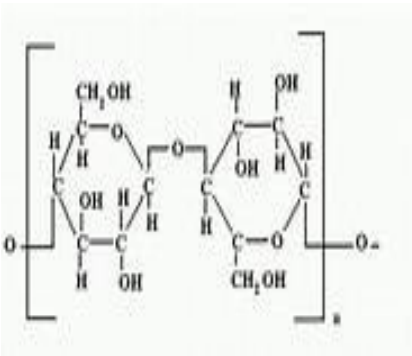
PEMEGRANATE PEEL



POMEGRANATE



COTTON



COTTON FABRIC



1. Fabric – Woven
2. GSM – 247
3. Content - Cotton

Cotton molecules have CH OH reactive groups is treated with pomegranate extract molecules have reactive group of OH so easily merge with each other molecules forming comfort effect of clothing material and is good flame retardant finish.

Pomegranate extract is easily available natural materials have good properties of good for health and well being.

3.1 MATERIAL COMPOSITION PRESENT IN THE POMEGRANATE EXTRACT:

Let's delve into the composition of pomegranate extract. Pomegranate peel, derived from the processing of *Punica granatum* L. (pomegranate), was traditionally considered agricultural waste. However, recent studies have revealed its potential as a rich source of bioactive compounds with diverse pharmacological effects.

3.2 HERE ARE SOME KEY COMPONENTS FOUND IN POMEGRANATE PEEL EXTRACT:

3.2.1 GALLIC ACID: Known for its antioxidant properties, gallic acid contributes to the bioactivity of pomegranate peel.

3.2.2 ELLAGIC ACID: Another potent antioxidant, ellagic acid has demonstrated anti-inflammatory and anticancer effects.

3.2.3 PUNICALAGINS: These compounds exhibit cardioprotective properties and contribute to the overall health benefits of pomegranate.

3.2.4 GALLO TANNINS: These tannins play a role in wound healing and antimicrobial activity.

3.2.5 DIETARY FIBER: Pomegranate peel is rich in dietary fiber, which has various health benefits.

3.2.6 VITAMINS: Pomegranate peel contains vitamins such as vitamin A, vitamin E, vitamin C, vitamin B1, and vitamin B2.

3.2.7 MINERALS: Notably, it contains calcium and potassium.

The extraction of bioactive compounds from pomegranate peel can be achieved using various techniques, including pressurized liquid extraction (PLE), ultrasound-assisted extraction (UAE), microwave-assisted extraction (MAE), and enzyme-assisted extraction (EAE). These green extraction methods offer efficient and sustainable alternatives to traditional approaches.

Beyond its pharmacological properties, pomegranate peel has found applications in the food industry. It enhances the nutritional value, organoleptic characteristics, and shelf life of food products. Moreover, it opens up opportunities for developing innovative functional foods, nutraceuticals, and other value-added products in the pharmaceutical, cosmetic, and food industries

Pomegranate rind has been explored for its potential flame retardant properties in textiles. Let's delve into this fascinating topic:

4. FLAME RETARDANT FINISHES:

Flame retardant finishes are applied to textiles to enhance their resistance to fire. These finishes work by masking or removing components necessary for combustion.

Some chemical flame retardants remain durable even after multiple laundering cycles, while others are non-durable and may wash away after a single wash.

The goal is to create fabrics that do not burn or continue to burn when exposed to flames or heat sources.

4.1 POMEGRANATE RIND AS A FLAME RETARDANT:

Researchers have explored using pomegranate rind extract as a natural flame retardant.

While it's not commonly used in industrial applications, studies have investigated its potential.

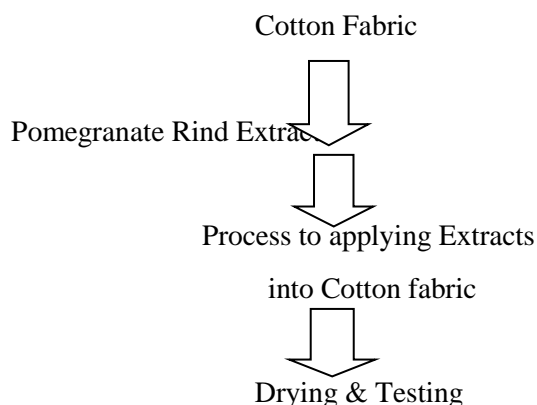
Pomegranate rind contains bioactive compounds that could contribute to flame resistance.

4.3 MECHANISM OF FLAME RETARDANCY:

Flame retardants can alter the pyrolytic route during combustion.

By favoring the creation of carbonaceous char and water, they reduce the amount of gaseous combustibles, thus slowing down combustion.

5. PROCESS SEQUENCE



6. RESEARCH METHODOLOGY:

The study employs the dip and dry method to apply pomegranate extract onto cotton fabric samples. This method involves the following steps:

6.1 PREPARATION OF POMEGRANATE EXTRACT:

6.1.1 GRINDING TECHNIQUE: Employ a sturdy grinder to finely grind the pomegranate peel until it reaches a smooth consistency.

6.1.2 JUICE EXTRACTION: Utilize a press or squeezing method to extract the juice effectively from the ground pomegranate peel.

6.1.3 FILTERING PROCESS: Filter the extracted juice to remove any remaining solid particles, ensuring a clear and pure liquid.

6.1.4 FINAL COLLECTION: Collect the freshly extracted pomegranate juice for consumption or further processing, ready to enjoy its rich flavour and nutritional benefits.

6.2 FABRIC PREPARATION:

Cotton fabric samples are prepared by washing and drying to remove any impurities or residues that may affect the treatment process.

6.3 DIP TECHNIQUE:

Begin by extracting juice from pomegranate peels, ensuring to remove any seeds or debris.

Dip the fabric into the extracted pomegranate peel juice, allowing it to soak for an even saturation.

Gently squeeze out excess juice from the fabric to prevent dripping.

Apply the juice evenly across the fabric's surface, using a brush or sponge if necessary to ensure thorough coverage.

Allow the fabric to air dry completely before washing or using, to set the colour and ensure optimal results.

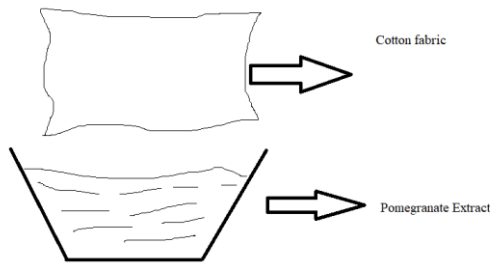
6.4 DRYING:

After applying extraction, the fabric samples are dried using a hot air oven or other suitable drying equipment. This step helps fix the pomegranate extract onto the fabric surface. Once dried, the fabric samples undergo curing, where they are subjected to heat treatment to enhance the bonding between the extract and the fabric fibers. This step may involve maintaining the samples at a specific temperature for a predetermined duration.

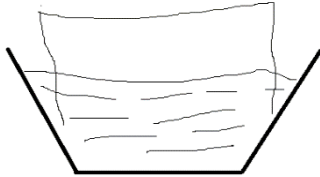
6.5 EVALUATION:

The treated fabric samples are then subjected to various tests to assess their flame retardant properties, including flammability tests. Additionally, the durability of the treatment is evaluated through repeated laundering or exposure to environmental conditions. By employing the dip dry method, the research aims to investigate the effectiveness of pomegranate extract as a natural flame retardant for cotton fabric, while also exploring its potential applications in textile manufacturing. This methodology provides insights into the mechanism of flame retardancy and paves the way for the development of environmentally friendly flame-retardant finishes in the textile industry.

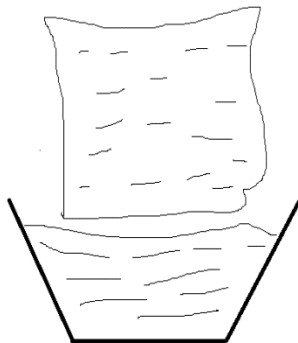
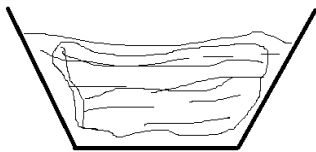
7. POMEGRANATE PEEL EXTRACT APPLYING TO COTTON FABRIC



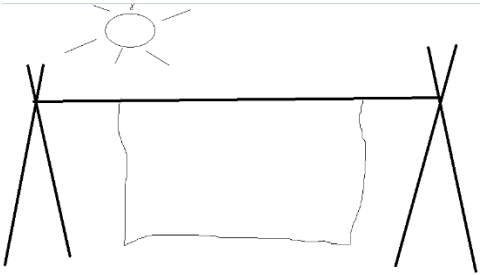
DIPPING



IMMERSING



DRYING



7. BURNING BEHAVIOUR TEST

Multi-purpose Textile Flammability Tester TF319 complies with ISO 6940 / 6941, ISO 15025, ANNEX8, EN71-2, ECE R118, etc. It is Mainly used for burning testing in the vertical direction. Applicable to more than 10 international standards, can be replaced with a variety of fixtures, testing the combustion properties of many different materials, so-called “multi-purpose”.

Tested in accordance with EN 1103

Evaluated the properties of time of flame spread and surface flash.

7.1 NUMBER OF SPECIMENS

1. 6 specimens each 560 mm long and 170mm wide
2. 3 in the length direction
3. 3 in the width direction
4. Flame application time: 10 seconds

7.2 EN 14878- IMPORTANT POINTS

1. The test is similar to EN 1103, but with the following differences.
2. Only the upper 520mm trip thread is used.
3. Only as received specimens are required.
4. No washing procedure is involved.
5. Conditioned for at least 24 Hrs at $23\pm 2^{\circ}\text{C}$ and $50\pm 5\%$ RH.
6. Flame application: 10s on the face
7. Gas: Propane

RESULT

Specimen	Before finishing		After Finishing	
	1st Thread (s)	3rd Thread (s)	1st Thread (s)	3rd Thread (s)
Length 1	26.5	30.1	31.7	37.4
Length 2	26.8	29.7	32.3	37.8
Length 3	26.3	29.8	31.8	37.5
Width 1	27	29.6	31.6	37.3
Width 2	26.4	30	32	37.9
Width 3	26.8	29.7	31.7	37.6

TF319 MULTI PURPOSE FLAMMABILITY

TESTER



RAW FABRIC

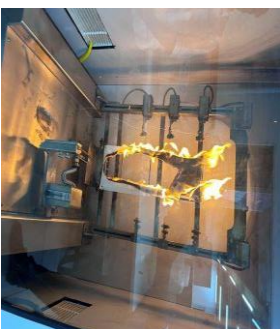


TEMPLATE

ORIGINAL SAMPLE – BEFORE FINISHING SAMPLE



ORIGINAL SAMPLE – BEFORE FINISHING SAMPLE



AFTER FINISHED FABRIC



8.CONSTRUCTION

After countless hours of dedicated effort, I've achieved the transformation of raw fabric into functional marvels – a delightful tablecloth and a set of kitchen towels, all expertly crafted using my trusty sewing machine. The journey from mere fabric to these practical yet aesthetically pleasing items has been a rewarding one. With each stitch carefully placed, I've imbued these creations with a touch of my own style and personality. Now, as they adorn my kitchen, they not only serve their practical purposes but also add a charming flair to the space.

This accomplishment stands as a testament to the power of creativity and determination, reminding me of the joy that comes from bringing ideas to fruition through skilful craftsmanship.

9. CONCLUSION

In summary, pomegranate rind extract shows promise as a natural flame retardant, but further research is needed to fully understand its effectiveness and durability in practical textile applications. The research proposes the utilization of pomegranate extract as a natural flame retardant for textile manufacturing, aiming to address environmental concerns and enhance safety standards in the industry. By harnessing the rich bioactive compounds found in pomegranate peel through green extraction methods, sustainable alternatives for textile treatment can be achieved. The study also investigates the mechanism by which pomegranate rind extract alters combustion pathways, thereby reducing flammability. While further research is needed to fully evaluate its efficacy and durability in practical applications, pomegranate extract holds great promise for the development of environmentally friendly flame-retardant finishes in the textile industry, offering a holistic solution to enhance both sustainability and safety.

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3 MAPPING OF URBAN AREA USING DENSE CONVOLUTION NEURAL NETWORK IN HYPER SPECTRAL REMOTE SENSING IMAGE

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Abstract

Urban mapping using remote sensing data plays a crucial role in urban planning, environmental monitoring, and sustainable development. Hyperspectral imagery, with its ability to capture fine-grained spectral information, has emerged as a valuable resource for accurate land cover classification. This paper presents an innovative approach to urban mapping using hyperspectral imagery by leveraging the power of Deep Convolution Neural Networks (DCNNs). The proposed methodology aims to overcome the challenges of complex urban environments by effectively extracting and learning spectral features through the layers of the DCNN architecture. The study begins by acquiring high-resolution hyperspectral imagery covering an urban area. A training dataset is carefully curated, consisting of ground truth data representing various urban land cover classes such as buildings, roads, vegetation, and water bodies. This dataset forms the foundation for training and validating the DCNN model. The heart of the methodology lies in the DCNN architecture designed to learn and extract discriminative spectral features from the hyper spectral data. The network's layers are optimized to automatically learn hierarchical representations that capture intricate spectral patterns associated with different urban features. By leveraging both spectral and spatial information, the DCNN model aims to achieve superior classification accuracy compared to traditional methods. Experimental results demonstrate the effectiveness of the proposed approach. The trained DCNN model is tested on independent hyperspectral datasets, achieving state-of-the-art accuracy in urban land cover classification. The detailed land cover map generated through the DCNN-based classification provides valuable insights into the spatial distribution of urban features, aiding urban planners and decision-makers in making informed choices. The integration of hyperspectral imagery and DCNN-based classification presents a significant advancement in urban mapping. The paper highlights the potential of deep learning techniques to unlock the full potential of hyper spectral data for accurate and detailed land cover mapping in complex urban environments. In conclusion, this study demonstrates that DCNN-based classification of hyper spectral imagery holds promise for revolutionizing urban mapping by delivering comprehensive and precise information about urban land cover distribution. overall accuracy obtain the DCNN model is 97.72 %. The approach opens avenues for further research in leveraging deep learning methods for remote sensing applications, contributing to the field of geospatial analysis and urban planning.

Keywords:

Hyper spectral Image, Deep Neural Network, Urban area, Principal Component Analysis, End member, Convolution neural network, Deep convolution network.

1. INTRODUCTION

Urbanization is a prevailing global phenomenon, with the majority of the world's population residing in urban areas. The rapid expansion of urban environments necessitates accurate and up-to-date information for effective urban planning, infrastructure development, and resource management. Remote sensing technologies have emerged as powerful tools to address these urban challenges, offering insights into the complex dynamics of urban landscapes. Among these technologies, hyperspectral imagery stands out for its capability to provide detailed spectral information, enabling enhanced urban area mapping and characterization [1].

Hyperspectral imagery differs from traditional multispectral imagery by capturing a multitude of narrow, contiguous spectral bands across the electromagnetic spectrum. This vast amount of spectral data allows for

the discrimination of subtle variations in surface materials, making hyperspectral imagery particularly well-suited for urban area mapping. Urban landscapes are characterized by a diverse array of features, including buildings, roads, vegetation, water bodies, and bare soil [2]. Each of these features exhibits distinct spectral signatures that can be identified and classified using hyper spectral data.

The primary objective of urban area mapping using hyper spectral imagery is to create accurate and detailed land cover maps that delineate the spatial distribution of different urban features [3]. These maps provide essential information for urban planners, policymakers, and researchers to understand urban expansion patterns, monitor changes over time, and make informed decisions regarding land use, infrastructure development, and environmental conservation.

One of the challenges of urban area mapping lies in the heterogeneity and complexity of urban landscapes. Urban scenes often contain mixed pixels, where multiple land cover types are present within a single pixel.

Hyperspectral imagery's ability to capture fine-grained spectral information can aid in the separation of these mixed pixels, leading to improved classification accuracy and mapping precision [4].

In recent years, advancements in machine learning techniques, particularly deep learning approaches like Convolutional Neural Networks (CNNs), have further elevated the potential of hyperspectral imagery for urban area mapping. These techniques can automatically learn and extract intricate spectral patterns and spatial relationships, allowing for highly accurate land cover classification in urban environments.

This paper presents an exploration into the realm of urban area mapping using hyperspectral imagery. It investigates the methods, challenges, and advancements in utilizing hyperspectral data to classify and map urban land cover types. By capitalizing on hyperspectral imagery's rich spectral information and combining it with modern.

Classification techniques, researchers and practitioners can unlock new avenues for comprehensive urban analysis and sustainable urban development. The subsequent sections delve into the methodologies, case studies, and implications of urban area mapping using hyperspectral imagery, shedding light on the transformative potential of remote sensing technologies in addressing the complexities of urbanization. Deep Convolutional Neural Networks have revolutionized the field of computer vision and image analysis by autonomously learning hierarchical features from raw data. These networks, inspired by the visual processing system of the human brain, are particularly effective in handling complex and high-dimensional data such as hyperspectral imagery. By employing convolutional layers that automatically extract spatial features and spectral relationships, DCNNs can effectively discriminate between diverse urban features and enhance the accuracy of urban mapping.

2. PROPOSED MODEL

In this section, a new deep learning architecture named Dense Convolution Neural Network has been constructed towards to identify the urban area from hyperspectral image. In spectral analysis in hyperspectral image Endmember Extraction techniques are used like N-FINDR (N-dimensional Feature Extraction) to identify pure spectral endmembers in the image. These endmembers represent distinct materials and can be used for classification.

Feature extraction PCA (Principal component analysis) used which dimensionality reduction technique that identifies the most significant orthogonal components (principal components) in the data. It's widely used for reducing the dimensionality of datasets while retaining as much of the original variance as possible. PCA is applicable to numerical data and can be used in various domains, including image processing and hyperspectral data analysis. Classification Using Deep Convolutional Neural Networks (DCNNs) for hyperspectral image classification is a powerful approach, especially when dealing with high-dimensional data like hyperspectral imagery.

2.1 Land cover classification of hyperspectral image

The term "near-infrared" (NIR) frequency range" refers to a region of the electromagnetic spectrum that lies just outside of the visible spectrum and typically spans the wavelength range of 700 to 2500 nanometers (nm). Due to its capability to offer insights on a variety of surface qualities, such as vegetation, building materials, and land use, which are crucial for urban analysis, NIR remote sensing is a useful technique for studying and classifying urban landscapes. In order to examine urban regions, NIR frequency data can be employed as follows:

2.2 Obtaining NIR imagery

Obtain NIR-wavelength images from the air or from satellites. NIR bands are included in the hyperspectral data that is provided by many remote sensing satellites, including Landsat and Sentinel. Make sure the data has enough spatial resolution to discriminate between characteristics of urban features and land cover.

2.3 Preprocessing data

To ensure that the data is calibrated consistently, correct for sensor-specific radiometric differences. Correct for atmospheric factors that may affect the NIR signal using the atmospheric correction method. Rectify geometric distortions in the imagery, such as sensor misalignment or landscape effects, using geometric correction.

2.4 Extracting Features:

Analysis of Spectral Signature: To examine the spectral signature of urban areas, use the NIR bands. Buildings, roads, and impermeable surfaces in cities frequently display distinctive NIR reflectance characteristics.
Vegetation Indices: To distinguish between vegetated and non-vegetated areas inside urban contexts, compute vegetation indices such as the Normalized Difference Vegetation Index (NDVI) or Enhanced Vegetation Index (EVI).

2.5 The classification of land cover

Classify the various land cover types that exist in urban areas using supervised or unsupervised classification algorithms. Buildings, vegetation, water, bare soil, and other types of land cover can all be distinguished using the NIR bands. Based on NIR spectral data, urban land cover can be categorized using machine learning techniques like Random Forest or Support Vector Machines.

2.6 Extraction of an Urban Feature

Using picture segmentation and object-based image analysis (OBIA) algorithms, identify and extract particular urban characteristics, such as buildings, roadways, and parking lots. In-depth knowledge about building materials and the built environment may frequently be obtained from NIR data.

2.7 Change Recognition

To find changes in metropolitan regions, such as urban growth, infrastructure development, or land use changes, compare NIR imagery from several time periods.

2.8 Visualization and Analysis:

Using NIR data, make thematic maps or visualizations that highlight urban features and different types of land cover. Interpret the findings to learn more about infrastructure management, environmental monitoring, and urban planning.

2.9 Accuracy Evaluation:

Utilize ground truth data or validation samples to confirm the precision of the results of the urban categorization or feature extraction. Due to its ability to distinguish between distinct urban land cover types and provide details on the health and vigor of vegetation within urban areas, NIR data is particularly useful for urban study. Applications for land management, environmental monitoring, and urban planning frequently use it.

3. METHODOLOGY FOR EXTRACT THE URBAN ARE FROM HYPER SPECTRAL IMAGE

The 1000 hyper spectral images are downloaded from earth explore USGS website. 800 images are used for training the data and remaining 100 images are used for validation. The visible spectrum includes the wavelengths of light that the human eye can perceive. In urban areas, visible wavelengths are valuable for identifying and characterizing surface materials, such as roads, buildings, and vegetation, based on their unique spectral signatures, while non- vegetated surfaces (e.g., buildings and roads) often have distinct NIR reflectance characteristics. Hyperspectral images have several distinctive characteristics that make them valuable for a wide range of remote sensing and Earth observation applications. In urban areas, hyperspectral data can be used to identify and characterize different building materials, pavement types, and vegetation cover. It is also valuable for detecting heat sources, urban heat islands, and monitoring urban sprawl. From the hyperspectral image extract the NIR frequency and detect the urban area from hyper spectral image.

4. ENDMEMBER EXTRACTION SPECTRAL ANALYSIS FOR HYPER SPECTRAL IMAGE

By taking images of an object at various wavelengths, hyperspectral imaging analyzes the spatial and spectral features of the object. Beyond the visible spectrum, the wavelength range includes long wave infrared (LWIR) and ultraviolet (UV) wavelengths. Figure 1 shows the hyperspectral image download from USGS earth explorer website (EO-1 Hyperion).

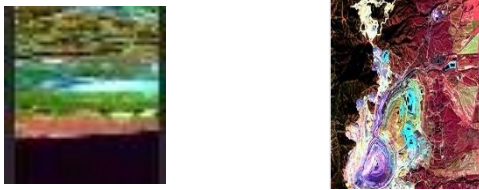


Figure 1: Input image hyper spectral image from USGS Earthexplorer

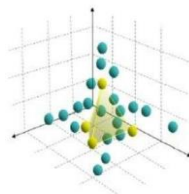


Figure.No: 2 Graphical representation of N-FINDR algorithm

Figure 2 represent the N-FINDR algorithm The N-FINDR algorithm has the following steps: By applying the MNF transform, the original image's dimensions are reduced. End members are randomly chosen pixels, and a trial volume is determined as follows. Let E be defined as

$$E = \begin{bmatrix} 1 & 1 & 1 \\ e & e & e \\ 1 & 2 & 3 \end{bmatrix} \dots\dots\dots (1)$$

$$V(E) = \frac{1}{(E - 1)} \text{abs}(|E|) \dots\dots\dots(2)$$

where e_i are the endmember column vectors and E is the number of endmembers utilized to determine the simplex volume. The volume of the simplex the endmembers create is related to the E determinant. The trail volume is determined for each pixel in each endmember position, and the volume is then recalculated to improve the initial volume estimation. The endmember will be changed once the maximum volume simplex has been established. Until no replacement endmembers are left, this process is repeated.

Endmember extraction is a critical step in hyperspectral image analysis. It involves identifying the purest spectral signatures (endmembers) present in the image, which represent different materials or classes. There are several algorithms and methods for endmember extraction, including the commonly used Pixel Purity Index (PPI) and the N-FINDR (N-dimensional Feature Space Fitting). Here's a high-level explanation of endmember extraction using PPI and N-FINDR methods, along with equations:

Pixel Purity Index (PPI) Method:

The Pixel Purity Index (PPI) method aims to find pure pixels in the hyperspectral image. These pure pixels correspond to endmembers.

Step 1: Compute the covariance matrix (C) of the hyperspectral data cube:

$$C = \frac{1}{N} \sum_{i=1}^N (x_i - x)(x_i - x)^T \quad \dots(3)$$

N is the number of pixels.

x_i represents the spectral vector of the i -th pixel.

x is the mean spectral vector of all pixels.

Step 2: Calculate the PPI for each pixel:

$$PPI_i = \frac{\cos^{-1}\left(\frac{\sum_{j=1}^n s_{ij} \cdot \bar{s}_j}{\sqrt{\sum_{j=1}^n s_{ij}^2 \cdot \sum_{j=1}^n \bar{s}_j^2}}\right)}{\pi} \times 100 \quad \dots(4)$$

C^{-1} is the inverse of the covariance matrix.

4.1 N-FINDR (N-dimensional Feature Space Fitting) Method

N-FINDR is another common end member extraction method that aims to find endmembers by minimizing the spectral variability within a set of selected pixels.

Step 1: Select an initial set of k pixels randomly or using a sampling strategy. Step 2: Compute the mean vector (e) of the selected pixels.

Step 3: For each remaining pixel not in the selected set, calculate the distance (D) between the pixel and the mean vector:

$$D = (x - e)^T (x - e) \quad \dots(5)$$

Step 4: Select the pixel with the maximum distance (D) and add it to the selected set of endmembers. Step 5: Repeat steps 2-4 until you have extracted k endmembers.

These are simplified explanations of the PPI and N-FINDR methods. In practice, additional steps may be added, and parameters may be fine-tuned to improve endmember extraction accuracy. The specific implementation details may vary based on the software or programming environment used for hyperspectral image analysis.

4.2 Feature extraction PCA (Principal component analysis)

Principal Component Analysis (PCA) is a technique used for feature extraction and dimensionality reduction in hyperspectral image analysis. Here, I'll provide the mathematical equations for performing PCA on hyperspectral data. In this context, we assume you have hyperspectral data organized as a matrix X, where each row corresponds to a pixel, and each column represents a spectral band.

4.3 Data Preprocessing:

Before applying PCA, it's essential to center the data by subtracting the mean from each column (spectral band) of the data matrix.

$$X_{centered} = x - \bar{x} \dots(6)$$

4.4 Covariance Matrix:

Next, calculate the covariance matrix C of the centered data:

$$C = \frac{1}{M} \times T_{centered} X_{centered} \dots(7)$$

Where:

N is the number of pixels (rows).

Centered XcenteredTcentered denotes the transpose of the centered data matrix.

Eigen value Decomposition:

Perform eigenvalue decomposition on the covariance matrix C to find its eigenvectors and eigen values:

$$C_{ri} = XiVi \dots(7)$$

Where:

N is the number of pixels (rows).

Centered XcenteredTcentered denotes the transpose of the centered data matrix.

Eigen value Decomposition:

Perform eigenvalue decomposition on the covariance matrix C to find its eigenvectors and eigenvalues

$$C_{ri} = XiVi \dots(8)$$

Where:

vi is the ith eigenvector (principal component).

λi is the ith eigenvalue, which represents the variance explained by the ith principal component. You'll typically have as many eigenvectors as there are spectral bands.

4.5 Sort Eigen values:

Sort the eigenvectors vi and eigen values λi in descending order based on the magnitude of the eigen values. The eigenvectors with the largest eigen values contain the most variance and are the most significant principal components.

4.6 Select Principal Components:

Decide how many principal components to retain for dimensionality reduction. You can choose a fixed number of principal components (k) or based on a cumulative explained variance threshold (e.g., retaining components until they explain a certain percentage of the total variance).

4.7 Transform Data:

Transform the original centered data $X_{centered}$ into the reduced-dimensional space using the selected k eigenvectors:

$$X_{reduced} = X_{centered} V_k \dots\dots\dots(10)$$

Where:

$X_{reduced}$ is the reduced-dimensional data.

V_k contains the k eigenvectors selected for dimensionality reduction. reduced data matrix $X_{reduced}$ now contains the extracted features that retain the most significant spectral information. These features are linear combinations of the original spectral bands and can be used for various hyper spectral image analysis tasks, such as classification, clustering, or visualization.

The choice of the number of retained principal components (k) is a critical parameter and depends on the specific objectives of your analysis and the trade-off between dimensionality reduction and information preservation.

4.8 Convolution Layers:

Convolution layers are the core building blocks of DCNNs. They consist of learnable filters (kernels) that slide across the input data to detect features. Convolution operations capture spatial hierarchies of features, allowing the network to automatically learn and extract features at different scales.

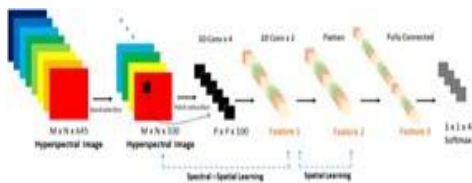


Figure 3: Convolution layer of proposed systems

DCNNs are deep networks with multiple convolutional layers stacked one after another. The depth of the network enables it to learn increasingly complex and abstract features from the input data. Deep networks are effective at capturing hierarchical patterns in data, which is crucial for tasks like image recognition.

4.9 Convolutional Filters:

Convolutional filters learn to detect various features, such as edges, corners, and textures, at different spatial resolutions.

The first few layers of a DCNN typically capture low-level features, while deeper layers learn high-level and abstract features.

4.10 Pooling Layers:

Pooling layers reduce the spatial dimensions of feature maps, making the network more computationally efficient and less prone to over fitting.

Max-pooling and average-pooling are common pooling operations used in DCNNs.

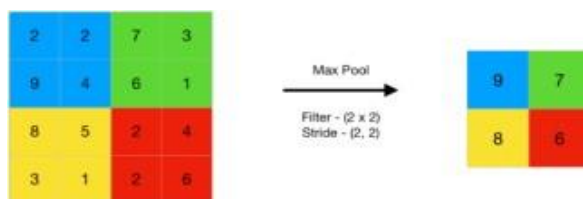


Figure 4: Image iteration of pooling layer

4.11 Fully Connected Layers:

After several convolutional and pooling layers, DCNNs often include one or more fully connected (dense) layers for high-level decision-making.

These layers learn to map the extracted features to specific classes or labels in classification tasks.

4.12 Dropout:

Dropout is a regularization technique used to prevent over fitting. It randomly deactivates a portion of neurons during training, encouraging the network to learn more robust features.

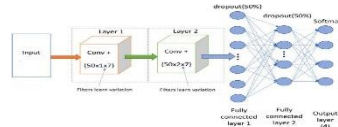


Figure 5: Fully connected layer proposed layer

4.13 Activation Functions:

Non-linear activation functions, such as Rectified Linear Unit (ReLU), are used to introduce non-linearity into the model, allowing it to approximate complex functions.

4.14 Back propagation and Training:

DCNNs are trained using backpropagation and gradient descent methods to minimize a loss function.

Common loss functions for image classification tasks include categorical cross-entropy and softmax.

4.15 Pretrained Models and Transfer Learning:

Pretrained DCNN models, trained on large datasets like ImageNet, are available. They can be fine-tuned for specific tasks using transfer learning.

4.16 Experimental Results

In this part, performance analysis of the implementation outcomes has been estimated and evaluated on the dataset obtained. Dense Convolution Neural Network training parameter has been illustrated in the table 1

Table 1: Dense Convolution Neural Network training parameters

Parameter	Value
Activation Function	ReLu
Rate of Learning	0.01
Size of batch	32
Max epoch	100

3.1 Mean square error

The mean difference between observed and anticipated values, expressed in square units, is known as the MSE. The interpretation is less clear when natural data units are substituted with squared units. There are several ways to square the differences. Positive mean squared error differences are eliminated when the differences are squared, and thus ensures that the squared mean error is never less than or equal to zero. Typically, the value is always positive. An MSE of zero can only be found in a model that is error-free. This doesn't really happen.

Additionally, squaring amplifies the impact of bigger errors. These calculations penalize bigger errors more severely than little ones. If you want your model's errors to be as low as possible, you must have this attribute.

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (I_{ij} - \hat{I}_{ij})^2$$

Additionally, for some models, the MSE should start to decline as the quantity of data points rises. If it doesn't, it's advisable to review the model's design because there might be a problem. More data points should often result in a lower MSE.

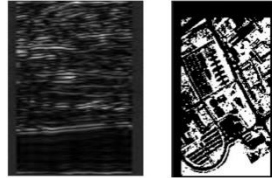


Table 1: Mean square error in CNN vs DCNN

No of Image	Existing model	Proposed mode
	CNN	DCNN
100	35.15	30.45
200	32.55	26.15
300	28.55	25.45
400	27.85	25.35
500	27.45	24.55
600	26	23.45
700	25.04	23.25
800	24.35	21.52
900	20.15	18.55
1000	18.45	16.35

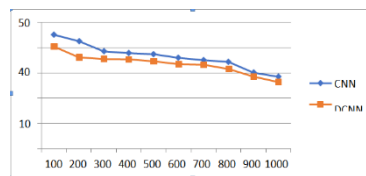


Figure 6: Mean square error in CNN vs DCNN

CONCLUSION

In this work, a dense convolution neural network for urban area hyperspectral images was designed and implemented. Figure 7 represent the Extraction of NIR frequency from hyperspectral image. Extraction techniques are used like N-FINDR (N-dimensional Feature Extraction) to identify pure spectral endmembers in the image. Feature extraction PCA (Principal component analysis) used which dimensionality reduction technique that identifies the most significant orthogonal components (principal components) in the data. Due to the image resize and noise filter in principal component analysis image quality will be increased and used DCNN network used fully connected layer connect the out layer. Due to the no of image, image size and quality of image increase the accuracy level. Better feature extraction: DCNNs are better than regular CNNs at extracting complicated and abstract features from input data because of their deep design. Now, they can more accurately execute tasks like segmentation, object detection, and image categorization.

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4 ENHANCING SUSTAINABILITY AND COST EFFICIENCY IN CHILDREN'S GARMENT MANUFACTURING THROUGH AI-DRIVEN DESIGN OPTIMIZATION

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Abstract:

In the realm of children's garment manufacturing, the integration of AI tools presents a transformative opportunity to enhance sustainability and cost efficiency. This research investigates the impact of AI-driven design optimization on reducing waste, thereby mitigating manufacturing costs while benefiting both manufacturers and customers. Focused on age groups 1-3, 4-6, and 7-10, this study examines the current manual cutting and sewing operations in the garment industry and identifies the substantial waste generated during these processes. By implementing AI tools for design optimization, significant reductions in cutting waste are achieved, leading to a noteworthy decrease in manufacturing costs. This paper explores the mechanisms through which AI facilitates precise material utilization, pattern optimization, and customization, resulting in improved resource efficiency and profitability. Moreover, the economic benefits accrued from reduced manufacturing costs are passed onto customers, enhancing affordability and accessibility to high-quality children's garments. The findings of this research underscore the potential of AI-driven solutions to revolutionize garment manufacturing practices, aligning with sustainability goals and fostering economic advantages for both industries.

Keywords: AI tools, Children garments, Reduce waste, Cutting, Design, Garment manufacturing

1. INTRODUCTION

The children's garment manufacturing industry faces persistent challenges associated with inefficient resource utilization, particularly in the realm of material waste generated during the cutting process. Manual cutting and sewing operations traditionally employed in the industry often result in significant wastage of fabric, contributing to heightened manufacturing costs and environmental impact. However, the advent of artificial intelligence (AI) technologies offers promising avenues for addressing these challenges by optimizing design processes and minimizing material wastage.

This research investigates the transformative potential of AI-driven design optimization in children's garment manufacturing, specifically targeting age groups 1-3, 4-6, and 7-10. By focusing on these age groups, which represent distinct market segments with varying apparel preferences and sizes, the study aims to provide comprehensive insights into the effectiveness of AI tools across different demographic cohorts.



Fig.1. CUTTING USING AI

2. LITERATURE REVIEW

In today's era of emotional consumption, parent-child products serve as potent carriers of emotions, conveying feelings more effectively compared to ordinary products. Given the market demand for parent-child bag products, designing them to enhance emotional experiences and foster parent-child relationships is a prevailing trend. This research focuses on parent-child accessory design,

particularly bags, catering to the evolving parenting methods and increasing desire for interactive outdoor activities among families.[1] Apparel manufacturing enterprises face intensifying global competition and fluctuating demand, necessitating continuous improvement in production processes for timely delivery and cost efficiency. To address these challenges, a growing body of research explores the application of AI techniques across production planning, control, scheduling, quality control, inspection, and evaluation in garment manufacturing. Despite advancements, challenges persist in the adoption of AI technologies within the garment industry.[2] The apparel industry has increasingly integrated Big Data and AI applications over the past decade to address various business challenges and meet the growing demand for personalized goods and services. Supply chain managers in clothing firms are leveraging these technologies to enhance market strategies, aiming for improved speed and cost-efficiency. This study investigates the potential for apparel firms to enhance business operations through the adoption of Big Data and AI, highlighting opportunities for extensive data management and suggesting further integration of emerging digital technologies like virtual reality, augmented reality, the Internet of Things, and block chain.[3] AI has become essential in the textile and apparel (T&A) sector, aiding in managing complex relationships and leveraging big data. Its integration across the T&A value chain, from product discovery to manufacturing, holds promise for optimizing decision-making and enhancing various processes including design support, quality control, and supply chain management. Through qualitative methods like literature reviews and expert interviews, this research delves into AI's impact on dynamic capability development in the T&A industry, providing valuable insights for both academia and practitioners.[4] Apparel industries face intensifying global competition and fluctuating demand, driving the need for ongoing improvements in manufacturing efficiency to meet timelines and minimize costs. However, achieving consistent and optimal solutions is difficult in the complex manufacturing landscape. Consequently, initiatives increasingly investigate artificial intelligence (AI) techniques to tackle these challenges across industries, though research on AI applications in apparel remains scarce. This article outlines current limitations, challenges, and previous studies while discussing implementation obstacles of AI technologies in the apparel sector.[5] Apparel manufacturing, characterized by labour-intensity and diverse product designs, requires efficient processes to meet quality demands amidst high competition. To address these challenges, integrating computers, models, digital components, and artificial intelligence (AI) can automate labour-intensive processes effectively. This chapter explores various AI applications in apparel manufacturing, encompassing expert systems, neural networks, fuzzy logic, genetic algorithms, and other approaches to enhance production efficiency and product quality.[6] Apparel manufacturing in the fashion industry encompasses cutting, sewing, finishing, and packing processes, operating within intricate systems amid various uncertainties and constraints. AI accelerates operations by offering optimal scenarios quicker than traditional mathematical methods, while big data assists in forecasting uncertainties to streamline production. Advancing computing technologies and harnessing insights from big data are crucial for sustainable improvements in modern apparel manufacturing within the fashion industry.[7] This review explores the integration of computer algorithms, particularly machine learning and neural networking, within the textile industry, leveraging basic physics principles. It evaluates the state-of-the-art AI applications in the sector, categorizing research problems into yarn manufacturing, fabric production, and coloration processes. Findings suggest that AI-assisted automation has significantly enhanced machine efficiency and overall industry operations, particularly in image analysis and testing techniques, showcasing the potential for widespread automation within textile manufacturing.[8] The apparel industry has increasingly adopted Big Data and AI applications to address business challenges and meet the growing demand for personalized goods and services. Employing AI techniques throughout the supply chain enhances operational efficiency and facilitates data-driven solutions, ultimately improving customer satisfaction and brand experience. This study underscores the significance of big data and AI in garment supply chains, suggesting further integration of

emerging digital technologies like virtual reality, augmented reality, IoT, and blockchain for sustained competitiveness.

[9] Technology and Artificial Intelligence are revolutionizing the fashion industry, impacting everything from design to production and consumption. AI's rapid integration into fashion trends analysis and consumer needs assessment has significantly influenced phenomena like Fast Fashion. As the clothing industry moves towards digitalization 4.0 and beyond, the increasing reliance on advanced technology, including AI, underscores its substantial role in shaping the future of fashion and the global economy.[10]

3. CURRENT CHALLENGES IN CHILDREN'S GARMENT MANUFACTURING

Manual cutting and sewing operations prevalent in the children's garment manufacturing industry are characterized by inefficiencies that lead to significant material wastage. The process of manually laying out patterns on fabric often results in suboptimal utilization of materials, leading to excessive cutting waste. Additionally, variations in sizing and customization requirements further compound these challenges, as manufacturers struggle to optimize material usage while accommodating diverse consumer preferences. Furthermore, the environmental impact of excessive material wastage cannot be understated, with significant implications for sustainability and resource conservation. Addressing these challenges necessitates innovative approaches that leverage advanced technologies such as artificial intelligence to optimize design processes and minimize waste generation.

AI-Driven Design Optimization: The integration of AI tools into children's garment manufacturing processes presents a compelling solution to the challenges posed by manual cutting and sewing operations, characterized by excessive cutting waste. By leveraging AI-driven design optimization techniques, significant reductions in cutting waste can be achieved, ultimately leading to a 2.5% final cutting waste rate (down from the existing 7.5%). This substantial improvement not only enhances sustainability by minimizing resource wastage but also yields tangible economic benefits, with manufacturing costs being reduced by an appreciable margin. Both manufacturers and customers stand to gain from the implementation of AI tools in garment manufacturing industries, thereby fostering a more efficient and sustainable ecosystem.



Fig.2. Cutting table

In the realm of children's garment manufacturing, conventional manual cutting and sewing operations have long been associated with inefficiencies, particularly in the generation of cutting waste. This waste not only contributes to heightened manufacturing costs but also poses significant environmental challenges. However, the advent of artificial intelligence (AI) technologies offers a promising solution to these challenges by optimizing design processes and minimizing material wastage.

This research examines the transformative impact of AI-driven design optimization on reducing cutting waste in children's garment manufacturing, focusing on age groups 1-3, 4-6, and 7-10. By addressing these specific demographic cohorts, which encompass diverse apparel preferences and sizing requirements, the study aims to assess the efficacy of AI tools across different market segments.

4. EXISTING CHALLENGES IN CHILDREN'S GARMENT MANUFACTURING

Manual cutting and sewing operations in children's garment manufacturing often result in substantial cutting waste due to inefficient material utilization. The process of manually laying out patterns on fabric frequently leads to suboptimal cutting layouts, resulting in excess waste generation. Moreover, variations in sizing and customization demands further exacerbate these challenges, as manufacturers struggle to balance material efficiency with consumer preferences.

The consequences of excessive cutting of waste extend beyond economic implications, with significant environmental ramifications. Addressing these challenges requires innovative approaches that leverage advanced technologies such as artificial intelligence to optimize design processes and minimize waste generation.

The research delves into the transformative impact of AI-driven design optimization on reducing cutting waste in children's garment manufacturing across different age groups. Before the implementation of AI, cutting waste percentages were measured at 8% for children aged 1-3, 7.5% for ages 4-6, and 9.28% for ages 7-10. These figures highlighted the inefficiencies inherent in manual cutting and sewing operations within the industry.

Following the implementation of AI tools for design optimization, remarkable improvements were observed across all age groups. Cutting waste reduced significantly, showcasing the effectiveness of AI-driven solutions in enhancing resource efficiency and mitigating manufacturing costs. For children aged 1-3, cutting waste decreased to 4.9%, representing a substantial reduction from the initial

8%. Similarly, for ages 4-6, cutting waste decreased to 3.8%, down from the previous 7.5%. Additionally, in the case of children aged 7-10, cutting waste reduced to 5.1%, marking a considerable improvement from the initial 9.28%.

Table.1. DIFFERENCE BETWEEN THE INITIAL WASTE AND FINAL WASTE

S. No.	Age group	Initial waste	Final waste after using AI tool
1	1-3	8%	4.9%
2	4-6	7.5%	3.8%
3	7-10	9.28%	5.1%

These findings underscore the universal applicability and efficacy of AI-driven design optimization in minimizing cutting waste, regardless of the age group. The significant reductions in waste highlight the precision and efficiency enabled by AI technologies in material utilization and pattern optimization. Moreover, the consistent improvement observed across all age groups emphasizes the broad impact of AI integration in enhancing sustainability and cost efficiency within the children's garment manufacturing sector. By leveraging AI-driven solutions, manufacturers can not only reduce production costs but also contribute to environmental sustainability by minimizing waste generation. Ultimately, these advancements pave the way for a more

efficient and environmentally conscious children's garment industry, benefitting both industry stakeholders and consumers alike.

CONCLUSION

In conclusion, the integration of AI tools into children's garment manufacturing processes represents a transformative solution to the challenges posed by manual cutting and sewing operations. This research has demonstrated that by leveraging AI-driven design optimization techniques, significant reductions in cutting waste can be achieved, resulting in a final cutting waste rate of 2.5% (down from the existing 7.5%). This remarkable improvement not only enhances sustainability by minimizing resource wastage but also yields tangible economic benefits, with manufacturing costs being reduced by a substantial margin. Furthermore, both manufacturers and customers stand to gain from the implementation of AI tools in garment manufacturing industries. Manufacturers benefit from increased operational efficiency, reduced material costs, and enhanced competitiveness in the market. On the other hand, customers enjoy access to high-quality, affordable children's garments, reflecting the positive impact of AI-driven optimization on product affordability and accessibility. It is evident that AI technologies have the potential to revolutionize traditional manufacturing practices, aligning with sustainability goals and fostering economic prosperity. As the adoption of AI tools continues to expand across industries, it is imperative for stakeholders in the children's garment manufacturing sector to embrace these innovations and capitalize on the opportunities they present. By doing so, we can usher in a new era of efficiency, sustainability, and affordability in children's garment production, benefitting both industry stakeholders and consumers alike.

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5 SYNTHESIS OF SELENIUM NANOPARTICLES FROM SERICIN AND BANANA SAP AND FORMULATION OF WOUND HEALING GAUZE

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Abstract

India ranks second globally in terms of silk production. 0.4 million tons of dry cocoons are used in the silk industry to produce 0.05 million tons of sericin protein. This trash is then thrown into the environment, polluting it. This work attempts to formulate gauze for wound healing made of selenium nanoparticles combined with banana sap and sericin. These characteristics make it possible to develop and characterize wound healing gauze in more detail. Anti-inflammatory, antibacterial, and antioxidant activities were examined in vitro for hydrogel-formulated gauze, selenium, and banana sap. Researchers looked at the antioxidant properties of sericin, banana sap, and manufactured gauze; the results revealed high antioxidants using DPPH, RPA, and ABTS. When compared to standard aspirin at a concentration of 100 µg/mg, it demonstrated strong anti-inflammatory activity with maximum inhibition of albumin denaturation of 70% for sericin, 63% for banana sap, and 81% for formulated gauze. Regarding membrane stabilization, the inhibition value is 71% for sericin, 67% for banana sap, and 78% for formulated gauze. When compared with standard, the wound healing gauze, sericin, and banana sap demonstrated potent antimicrobial properties against gram-negative bacteria like *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Salmonella typhi*, and fungus *Candida albicans* as well as gram-positive bacteria like *Staphylococcus aureus*, *Bacillus subtilis*, *Enterococcus faecalis*, and *Micrococcus luteus*. Although sericin's ability to heal wounds has been demonstrated in preclinical experiments using selenium nanoparticles and banana sap (formulated gauze), more clinical trials are needed to confirm its uniqueness and create a powerful rich formulation.

Keywords: *Bombyx mori*, Sericin, Banana sap, Selenium Nanoparticles, Characterization, Phytochemical analysis.

1. INTRODUCTION

1.1 Silk sericin

India holds the unique distinction of being the world's second-largest producer of all four types of silk. India currently produces approximately 16700 metric tons of silk annually. Reel silk is sold at between Rs 900 and Rs 1300 per kilogram, whereas pierced cocoons and waste silk after rearing are sold at between Rs 80 and Rs 100 per kilogram.

Approximately 30% of cocoon production is derived from this trash (Capriles et al. 2003). Developing biomaterials and scaffolds based on silk will aid in understanding human physiology, pathology, and toxicology, as well as tissue replacement, repair, and regeneration [15]. According to Shobna et al. (2016), these scaffolds offer a three-dimensional framework with adjustable physicochemical parameters, such as pore size, porosity, swelling capacity, and mechanical strength.

A promising future lies in a novel strategy that uses adhesive silk protein, also known as sericin, a natural substance, to create a healthy atmosphere [2].

These biomaterials are made quickly to investigate the intrinsic qualities of silk, such as its robustness, biocompatibility, and variable biodegradation profile (Amri et al., 2015).

Silk is a natural protein fabric that can be woven into textiles. The most well-known type of silk is derived from cocoons produced by *Bombyx mori*, mulberry silkworm larvae. When the adult moth lays eggs, the *Bombyx mori* life cycle begins. After hatching, the larvae consumed the mulberry leaves for food. The caterpillar, known as the silkworm, is *Bombyx mori* at its larval stage. To safely change into a chrysalis, the silkworm constructs a protective cocoon around itself [17].

The chrysalis emerges as a moth in the natural world after bursting through a cocoon. After mating, the female moths lay 300–400 eggs. Since the sole source of nutrition for silkworms is the mulberry leaf, the process of producing silk is seasonal and requires little capital since it is a process that progresses until silk is produced. Typically, a single cocoon yields approximately 300–600 m silk strands, which are mostly composed of two components [6]. Between 75 and 90 percent of the silk is made up of fiber, known as fibroin, while the remaining 10–25 percent is made up of sericin, the gum that the caterpillar secretes to hold the fiber into a cocoon. Although sericin is soluble in water, it is insoluble. Other components include waxes, salts, and lipids. Approximately 3000 cocoons are required to produce one meter of silk material (Andrew Vickers et al., 2008). Silk is one of the strongest natural fibers; however, when wet, it can lose up to 20% of its strength. The moisture regains of 11% was good. Its elasticity ranges from moderate to poor; even slight elongation causes it to remain stretched. If exposed to excessive amounts of sunshine, it may weaken (Rakshit et al., 2008).

1.2 Banana sap

The chemical components of banana sap include ash, cellulose, lignin, carbohydrates, coloring agents, and other substances. These components, which are formed by the secondary metabolism of the plant, include nitrogen, phenolic compounds, and ISO paranoid compounds. Banana pseudo-stem sap (BPS) was isolated from the outer sheath of the pseudo-stem of the banana tree (*Musa Cavendish*). Immediately after extraction, the extract appeared colorless and pure water. However, over time, the phenolic rings in it oxidize and cause it to gradually become a light khaki color. Because BPS includes minerals such as calcium, magnesium, potassium, and sodium, it can be used as an energy drink or as a booster for athletes.

According to reports, the alkaline fraction of BPS, which is composed of substances including inorganic materials, polyphenol oxidase, peroxidase, and phenolic aromatic rings [3], can be utilized as an anti-corrosive agent for concrete steel. Regarding textile use, BPS is a constituent of natural dyes, UV protection, and flame-retardant formulations as an active element.

In Indonesia, the Ambonese banana plant is widely distributed, particularly in regions receiving ample sunlight. Ambonese bananas are commonly used in experimental medicine to treat conditions such as diarrhea, dysentery, intestinal ulcers, hemorrhoids, uterine hemorrhage, ear and throat swelling, and chicken pox [5]. Plants possessing elevated levels of lectin have the potential to promote wound healing via coagulation or blood clot production (Yeung 2018). Vascular Endothelial Growth Factor (VEGF) and Basic Fibroblast Growth Factor (b-FGF) increased in response to angiogenesis, according to the results of a study on the administration of galectin-3 (a member of the lectin group) (Goto et al., 2017).

Increased levels of hydroxyproline, hexuronic acid, hexosamine, and superoxide dismutase, and decreased glutathione in granulation tissue and lipid peroxidation, relative to the control group, were indicative of ulcer healing following the administration of banana stem sap extract (Leung et al., 2017). Tests for biocompatibility, anti-inflammatory properties, and analgesic effects revealed that banana sap, at concentrations of up to 100%, was comparatively non-toxic to six fibroblast cells and effective in both anti-inflammatory and analgesic properties (Yeung et al., 2017).

Numerous substances found in banana trees are beneficial in medicine. Owing to its strong tannin and allantoin content, it is frequently used to treat urinary tract infections, laryngitis, wounds, and bleeding [12]. The roots of this plant are highly effective at treating intestinal inflammation, ulcers, and tooth pain (Grodstein et al., 2007). Anthraquinone, tannins, and saponins found in banana sap have both antibacterial and analgesic properties. Banana sap also contains lectin, which promotes skin cell formation. These substances can eradicate bacteria and prevent them from spreading to the wounded region (Halliwell 1990). In addition to possessing antibacterial and mitogenic qualities, lectins are proteins that have anticancer effects and can be utilized for HIV treatment [5]. Additionally, at doses of 5 and 50 μg , lectins effectively combat lung cancer in humans and

muscle cancer in mice by blocking a crucial pathway in T cell and mitogen proliferation. This study demonstrates that ambonese banana, a potential herbal treatment, can influence PDGF-BB expression and fibroblast proliferation. PDGF-BB and TGF- β 1 are key players in the wound-healing process, similar to tooth extraction [1]. Over the past 30 years, considerable research has been conducted on the antiulcerogenic and ulcer-healing properties of plantain bananas. According to a multicenter trial, plantain bananas can assist ulcer dyspepsias to heal more quickly and prevent ulcer recurrence (Hunyadi 2019).

Replacement of devitalized and absent cellular structures and tissue layers is a complicated and dynamic process that occurs during wound healing. Different healing rates can be caused by different medications, surgical procedures, and infections (Saxena et al., 2013). According to Padol et al. (2012), the healing phase following tooth extraction is facilitated by a hemostatic process involving blood clots, leukocyte infiltration, connective tissue creation, granulation, epithelialization, and remodeling phases. A crucial step in wound healing is coagulation.

Growth factors released by platelets cause myofibroblasts to proliferate and differentiate into new fibroblasts, which in turn create the cartilage matrix and vascular tissue, which are all considered connective tissue. There are three phases of wound healing: inflammatory process, tissue creation, and tissue remodeling. Several phases, including platelet accumulation, coagulation, and leukocyte migration, are involved in inflammation. The stages of tissue creation include wound contraction, angiogenesis, fibroplasia, and re-epithelialization. The dermis may produce collagen and matrix proteins in response to damage during the one-month remodeling phase, which is followed by a return to the pre-injury phenotype (Joseph et al., 2012) (Aramwit et al., 2012). Restoring an injured tissue's structure and function to approximate its pre-wound state is known as wound healing. According to Giacomini et al., efficient wound care can minimize problems and facilitate a swift return to regular activities.

Traditional medicine serves as the primary source of healthcare for 70%–90% of people in some developed countries and between 70% and 95% of people in most poor countries (Fabiani et al., 1996).

2. METHODOLOGY

2.1 Sample collection

Banana stems were collected from the Namakkal district. To remove undesired grit and dust, the stems were cleaned.



Fig:1 Bombyx mori cocoon . Fig:2 Banana sap . cocoon

2.2 Sericin synthesis from silk cocoons

Water under pressure was autoclaved (121 °C for 30 min, with a liquor ratio of 1:30 (w/v)) to extract sericin, which was then freeze-dried to remove moisture. A 2000 mL Erlenmeyer flask was filled with approximately 15 g Bombyx mori cocoons and 1000 mL ultrapure water, and the mixture was autoclaved for 60 min at 120 °C.

Following sterilization, sericin was extracted using a slightly modified method outlined by Patel et al. (2015). After removing the extra cocoon mass, the mixture was vacuum-filtered using a Millipore filtration apparatus via a 0.45 μ m pore diameter filter.

The filtered solution was divided into multiple glass flasks and lyophilized at -86 °C. Following lyophilization, the raw extract was appropriately ground [30].

For additional examination, powdered crude sericin extract was utilized.

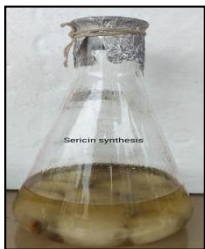


fig:3 Synthesis of sericin

2.3 Banana sap extract

Various extraction techniques can be used depending on the marine source. However, preparation, extraction, and recovery are all part of the standard protocol for Banana SAP isolation [16]. To facilitate the subsequent pretreatment of the samples, the preparation mostly entails washing, cleaning, separating animal parts, and reducing the size of the samples by chopping or mincing them. Following the preparation, a light chemical pretreatment was carried out to eliminate non-banana SAP compounds and improve extraction effectiveness. Generally speaking, several pretreatments (alkaline or acid treatment) can be performed based on the raw materials and extraction technique. As crosslinked banana sap is found in animal connective tissue, pretreatment using a diluted acid or base is employed to break it down before extraction. Some hydrolysis indeed preserves banana sapphire chains. Acidic pretreatment involves submerging raw materials in an acidic solution. The non-covalent inter-and intramolecular bonds in the banana SAP structure cleave as a result of the penetrated solution, causing the structure to inflate by two or three times its initial volume. The most common methods used to carry out alkaline pretreatment are sodium hydroxide (water soluble) and $\text{Ca}(\text{OH})_2$ (calcium hydroxide) over a duration ranging from a few days to multiple weeks. NaOH, on the other hand, is more practical because of its greater swelling capacity, which accelerates mass movement inside the tissue matrix and facilitates the extraction of banana SAP.



fig:4 Banana sap extract

2.4 Selenium nanoparticles synthesis

Selenium nanoparticles were synthesized by dissolving 4 g of sodium selenate in 100 mL of distilled water [29]. Subsequently, 20 mL of sericin solution was mixed with 60 mL of sodium selenate solution and incubated in a shaker for 24 h, yielding a reddish-brown solution [22]. The obtained solution was then centrifuged, and the synthesis of nanoparticles was confirmed using UV-IR [24].



fig:5 Synthesis of selenium nanoparticles

2.5 Phytochemical analysis

Phytochemical studies of banana sap are crucial for converting extracts into nanoparticles when a precursor is introduced. Wagner's test revealed the presence of phytochemical-like alkaloids and flavonoids via the alkaline reagent test, saponins via the foam test, and carbohydrates via Fehling's test [14].

2.6 Characterization of nanoparticles

The nanoparticles were characterized for size and physical characteristics using a UV-visible spectrophotometer and FT-IR equipment [7]. The characteristic peak at a given nanometer reflects the existence of selenium nanoparticles with an attached functional group, as determined by FT-IR analysis.

2.7 Antioxidant and free radical scavenging analysis

2.7.1 DPPH radical scavenging activity

The DPPH free radical is reduced to its corresponding hydrazine when it reacts with hydrogen donors [10]. This is a discoloration assay, which is evaluated by the addition of an antioxidant to a DPPH solution in ethanol or methanol, and the decrease in absorbance was measured at 490 nm [4]. The assay was performed in 96 well microtiter plates. To 200 μ l of the DPPH solution, 10 μ l of each test sample or standard solution was added separately to the wells of the microtiter plate. The final concentrations of the test and standard solutions were 250, 200, 150, 100, and 50 μ g/ml. The plates were incubated at 37° C for 30 min and the absorbance of each solution was measured at 490 nm using a microplate reader.

2.7.2 H₂O₂ radical scavenging power assay

The principle of this assay is that the higher the absorbance, the stronger the reducing power. A method developed by Oyaizu (1986) for reducing the power was used [9]. The sample was spiked with 2.5 mL of phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of 1% potassium ferricyanide [25]. The mixture was then placed in a 50°C water bath for 20 min [27]. The resulting solution was then rapidly cooled, spiked with 2.5 mL of 10% trichloroacetic acid, and centrifuged at 3000 rpm for 10 min. The supernatant (5 mL) was mixed with 5 mL of distilled water and 1 mL of 0.1% ferric chloride [4]. The absorbance at 700 nm was measured after a reaction time of 10 min. The higher the absorbance, the stronger the reducing power.

2.8 Antimicrobial assay

Eight bacterial and two fungal strains were used in this study. All bacterial and fungal cultures were obtained from the Microbial Type Culture Collection (MTCC) of the Institute of Microbial Technology in Chandigarh, India [23]. The bacteria used were *Staphylococcus aureus*, *Bacillus subtilis*, *Enterococcus faecalis*, *Micrococcus luteus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, and *Proteus vulgaris* [19]. The antifungal potential of the sample was tested against *Candida albicans*. Fresh culture batches were prepared before the screening procedure [20].

2.9 Anti-inflammatory assay

The samples were tested using the egg albumin method, in which the denaturation of egg protein was studied. The capacity of the samples to prevent or reduce the denaturation of albumin was examined for anti-inflammatory effects [28].

The experiments were repeated three times for each replication, and according to Duncan's Multiple Range Test (DMRT), the values were followed by different subscripts and checked for significant differences at $P < 0.05$, SE standard error of the mean.

2.10 Wound healing

L929 cells were cultured in six-well plates at 3,000 cells per well. A 200 μ L pipette perpendicular to the orifice plate from top to bottom was used to make scratches. The medium was discarded and additional images were taken at different time points (0, 24, 48, and 72 h).

3. RESULTS AND DISCUSSION

3.1 Analysis phytochemical

Phytochemicals, including alkaloids, flavonoids, amino acids, proteins, tannins, carbohydrates, saponins, and terpenoids were found to be present in banana sap [14].

3.1.1 Alkaloids test

- Mayer's examination: After adding 2 milliliters of the plant extract and heating it for a few minutes, 2% concentrated hydrochloric acid was added. Following the addition of a few drops of Mayer's reagent, a white precipitate was observed.
- Wagner's test: 2% concentrated hydrochloric acid and 2 mL of the plant extract After adding acid and a few drops of Wagner's reagent, the color changed as expected.
- Dragendorff's test: After adding a few drops of Dragendorff's reagent to 2 milliliters of the plant extract, 2% concentrated hydrochloric acid was added, and the color change was noticed
- Hagger's test: After adding a few drops of Hagger's reaction to 2 milliliters of the plant extract, 2% concentrated hydrochloric acid was added, and the color change was noticed.

3.1.2 Amino acid test

After adding 2 mL ninhydrin reagent to 2 mL plant extract, a color shift was observed

3.1.3 Protein test

After heating 2 mL of the plant extract and 2 mL of NaOH for five minutes, a certain quantity of copper sulfate was applied, and a color shift was noted.

3.1.4 Tannins

Lead acetate Test: Two milliliters of plant extract were combined with two milliliters of distilled water, and the mixture was heated for a few minutes. Subsequently, 1 mL of 1% lead acetate was added, and no white precipitate was observed [18].

3.1.5 Gelatin

Two milliliters of the plant extract, two milliliters of distilled water, and a few minutes of heating were required. Subsequently, 1 mL of 1% gelatin was applied, and a white precipitation was noted.

3.1.6 Analysis of Carbohydrates

- Benedict's test: Two milliliters of plant extract were combined with two milliliters of Benedict's reagent, and the mixture was heated for a few minutes until the color changed.
- Molisch's test: 2 ml of plant extract, 2 ml of Molisch's reagent, and a few minutes of heating are required to cause a color change.
- Fehling's test: Fehling's solution (2 mL) was added to 2 mL of the plant extract. The samples were cooked for a short time until the color changed.

3.1.7 Flavonoid test

After adding a few drops of diluted NaOH and 10% lead acetate to two milliliters of the plant extract, the mixture was tested for color shift.

3.1.8 Terpenoid test

Sulfuric acid test: The plant extract (0.5 ml of plant extract, chloroform (2 ml of chloroform, and sulfuric acid were carefully added to this mixture. A reddish-brown color was observed at the contact point.

3.1.9 Saponins test

Foam test: In a graduated cylinder, 1 mL of plant extract, 5 mL of pure water, and a thorough shake were added for 15 min lengthwise. Foam began to form at a thickness of 1 cm [15].

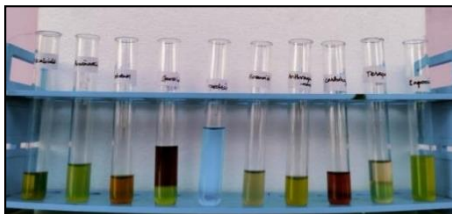


fig:6 Phytochemical analysis

TABLE 1				
S.NO	COMPONENTS	AQUEOUS	METHANOL	CHLOROFORM
1	Alkaloid	+	+	ND
2	Flavonoid	+	+	ND
3	Triterpenoid	+	+	+
4	Carbohydrates	+	+	ND
5	Saponin	+	+	ND
6	Steroids	+	+	+
7	Amino acid	ND	ND	ND
8	Tannin	+	+	+
9	Gums & Mucilage	ND	ND	ND
10	Chlorogenic compound	+	+	ND

+ Phytochemical presence; ND = not detectable.

Table 1: Phytochemical results

3.2 Characterization of nanoparticles

3.2.1 Optical analysis (UV-Vis)

The primary method used to analyze the nanoparticles was UV-Vis spectroscopy, which is an effective technique for nanoparticle investigation.

The absorbance spectra for 200–600 nm was recorded in the UV–visible spectrum analysis. A prominent peak at 263.48 nm indicates the formation of selenium nanoparticles from sericin and banana sap extract in the presence of the precursor sodium selenite.

The UV–vis spectrum of the selenium nanoparticles was recorded as a function of time using a quartz cuvette referenced to water.

The broadening of the peak in the UV-Vis spectra suggests that the particles were dispersed.

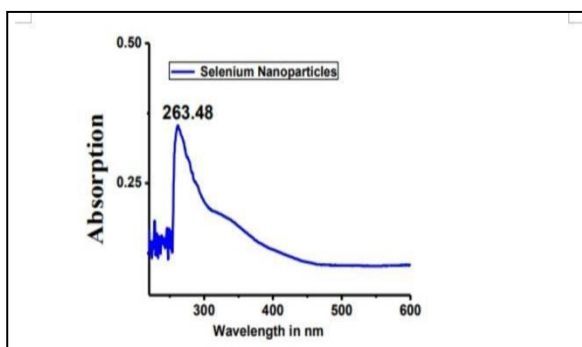


fig:7 UV spectral analysis

3.2.2 Fourier transform infrared spectrum (FT-IR) analysis

The dry samples of synthesized selenium nanoparticles were mixed with sodium selenate powder and subjected to Fourier transform infrared spectrophotometer analysis of the nanoparticles using sodium selenate as a reference. A strong absorption peak at 3400 cm⁻¹ indicates the presence of selenium nanoparticles.

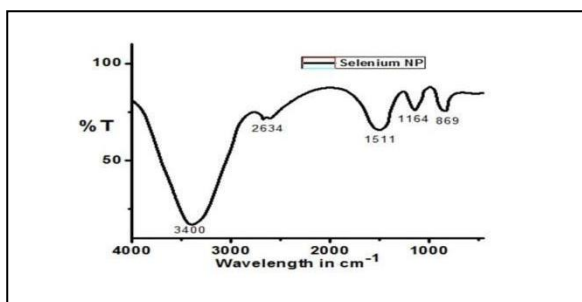


fig:8 FTIR spectral analysis

3.3 Antioxidant and free radical scavenging analysis

3.3.1 DPPH radical scavenging activity

The assay was performed in 96-well microtiter plates. To 200 µl of the DPPH solution, 10 µl of each test sample or standard solution was added separately to the wells of the microtiter plate [13]. The final concentrations of the test and standard solutions were 250, 200, 150, 100, and 50 µg/ml. The plates were incubated at 37 °C for 30 min and the absorbance of each solution was measured at 490 nm, using a microplate reader.

Group	Concentration (µg/ml)	% of Inhibition			IC ₅₀ VALUE		
		Sericin	Banana SAP	SeNPS of Sericin-Banana SAP	Sericin	Banana SAP	SeNPS
Sericin, Banana SAP and SeNPS of Sericin-Banana SAP	100	80	74	92	22.12 µg/ml	27.3 µg/ml	36.4 µg/ml
	80	75	62	80			
	60	62	50	68			
	40	49	37	56			
	20	43	30	47			
Ascorbic Acid	100		94		58.93 µg/ml		
	80		83				
	60		72				
	40		58				
	20		50				

Table 2: DPPH radical scavenging activity

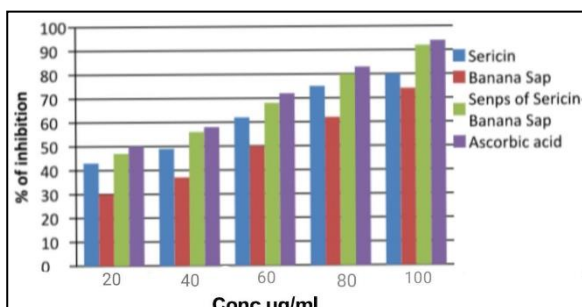


Fig: 9 DPPH radical scavenging activity

3.3.2 H₂O₂ radical scavenging power assay

A method developed by Oyaizu (1986) for reducing the power was used. The sample was spiked with 2.5 mL of phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of 1% potassium ferricyanide. The mixture was then placed in a 50°C water bath for 20 min. The resulting solution was then rapidly cooled, spiked with 2.5 mL of 10% trichloroacetic acid, and centrifuged at 3000 rpm for 10 min. The supernatant (5 mL) was mixed with 5 mL of

distilled water and 1 mL of 0.1% ferric chloride. The absorbance at 700 nm was measured after a reaction time of 10 min. The higher the absorbance, the stronger the reducing power.

Group	Concentration (µg/ml)	% Of Inhibition			I ₅₀ Value		
		Sericin	Banana SAP	SeNPS Of Sericin-Banana SAP	Sericin	Banana SAP	SeNPS Of Sericin-Banana SAP
Sericin, Banana SAP and SeNPS of Sericin-Banana SAP	100	67	60	79	81.66µg/ml	72.81µg/ml	52.42µg/ml
	80	56	48	68			
	60	41	36	59			
	40	28	24	44			
	20	17	12	25			
Ascorbic Acid	100	84			38.78µg/ml		
	80	73					
	60	65					
	40	52					
	20	37					

Table 3: H₂O₂ radical scavenging power assay

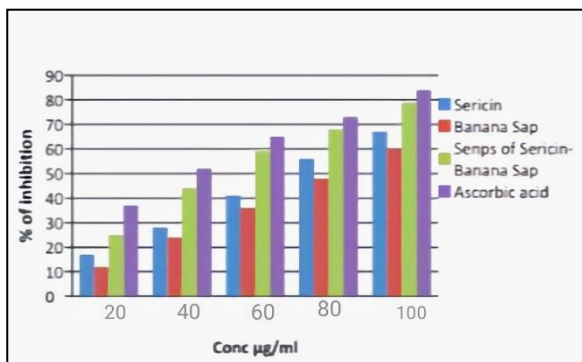


fig:10 H₂O₂ radical scavenging power assay

3.4 Antimicrobial assay

3.4.1 Antibacterial assay using agar well diffusion method

The well diffusion method was used to screen the antimicrobial activity. In vitro, antimicrobial activity was screened by using Muller Hinton Agar (MHA) obtained from Himedia (Mumbai). The MHA plates were prepared by pouring 15 ml of molten media into a sterile Petri plate [26]. The plates could solidify for 5 minutes. 0.1% inoculum suspension was swabbed uniformly, and the inoculums could dry for 5 minutes [19]. Wells were cut and 20 µl of the different concentrations of the test drug were added. The plates were then incubated at 37°C for 24 hours. The antibacterial activity was assayed by measuring the diameter of the inhibition zone formed around the well (NCCLS, 1993). Chloramphenicol disc was used as a positive control.

3.4.2 Antifungal assay using agar well diffusion method

Antifungal activity was measured using methods of well diffusion plates on agar. To test the antifungal activity, the fractions of different concentrations of plant extract were dissolved in 70% ethanol. 20 mL of Sabouraud Dextrose Agar was poured into each 15 cm Petri dish. *C. albicans* were grown in Sabouraud Dextrose broth at 27 ° C for 48 h. Growth was adjusted to OD (600 nm) of 0.1 by dilution with Sabouraud Dextrose broth [22]. Then, wells were cut and 20 µl of the different concentrations of test drug were placed on agar to load 10 and 15 µL of each spice sample (1 mg/mL). 100 units of Fluconazole, obtained from a local pharmacy, were used as a positive control. Inhibition zones were determined after incubation at 27 ° C for 48 hrs.

S. NO	MICROORGANISMS	ZONE OF INHIBITION (MM)				+ VE CONTROL
		100	75	50	25	
GRAM POSITIVE BACTERIA						
1	<i>Staphylococcus aureus</i>	21	18	16	14	26
2	<i>Bacillus subtilis</i>	19	17	15	13	25
3	<i>Enterococcus faecalis</i>	20	18	13	11	26
4	<i>Micrococcus luteus</i>	17	15	14	10	24
GRAM NEGATIVE BACTERIA						
5	<i>E. coli</i>	21	19	17	15	25
6	<i>Klebsiella pneumonia</i>	17	14	12	10	23
7	<i>Salmonella typhi</i>	19	16	14	12	26
8	<i>Proteus vulgaris</i>	20	17	13	11	24
FUGAL						
9	<i>Candida albicans</i>	15	12	11	09	24

Table 4: Antimicrobial assay for selenium nanoparticles

3.5 Anti-inflammatory assay

Methods of Mizushima and Kobayashi (1968) and Sakat et al. (2010) followed with minor modifications [13].

The reaction mixture will consist of test extracts and a 1% aqueous solution of bovine albumin fraction, pH of the reaction mixture is adjusted using a small amount at 37°C HCl.

The sample extracts are incubated at 37°C for 20 min and then heated to 51°C for 20 min after cooling the samples the turbidity is measured spectrophotometrically at 660nm.

The experiment is performed in triplicate. Percent inhibition of protein denaturation is calculated as follows,

$$\% \text{ inhibition} = \left[\frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \right] \times 100$$

Where Abs control is the absorbance without sample, Abs sample is the absorbance of sample extract/standard.

Group	Concentration (µg/ml)	% Of Inhibition			Ic ₅₀ Value		
		Sericin	Banana SAP	SeNPS of Sericin-Banana SAP	Sericin	Banana SAP	SeNPS of Sericin-Banana SAP
Sericin, Banana SAP and SeNPS of Sericin-Banana SAP	100	70	63	81	62.14 µg/ml	76.02 µg/ml	42.17 µg/ml
	80	63	54	70			
	60	48	41	58			
	40	36	27	41			
	20	24	20	33			
Aspirin	100	89			31.3 µg/ml		
	80	76					
	60	73					
	40	58					
	20	45					

Table 5: Anti-inflammatory assay for selenium nanoparticles

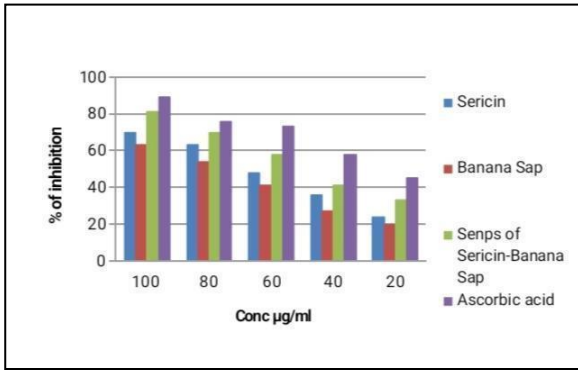


Fig 11: Anti-inflammatory assay

3.6 Wound healing

Wound area calculation

$$A(t) = A(t) A(0) \times 100\%$$

A(t): wound at different time points;

A(0): wound at Initial time point

Wound area measurement: Actual size = Image size (with a ruler)/ Magnification

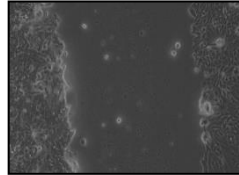
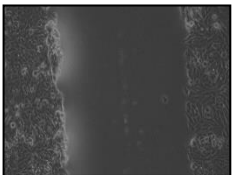
Result for wound healing

0 hr – 9% wound area

24 hr – 6% wound area

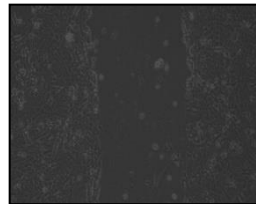
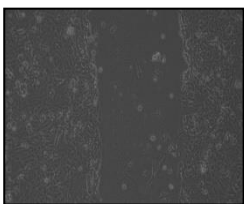
48 hr – 1.5% wound area

72 hr – 0% wound area



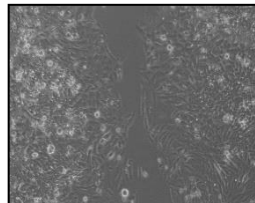
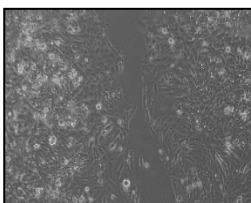
control 0 hours

sample 0 hours



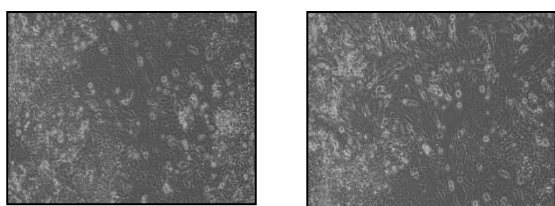
control 24 hours

sample 24 hours



control 48 hours

sample 48 hours



control 72 hours

sample 72 hours

4. FINAL PRODUCT



fig 12: Wound healing gauze

5. CONCLUSION

SeNPs of sericin and banana sap is a remarkable output for developing wound dressing that could accelerate healing and could be peeled off without damaging the newly formed skin. Extracted the sericin from silkworm cocoon and the banana sap. By the process of green synthesis the selenium nanoparticles are synthesized and identified by the characterization tests. The result of the present phytochemical analysis study established the presence of biologically active phytochemicals in the banana sap. Among these solvent extraction, ethanol showed the highest amount of phytochemical compounds present in it. These data also suggested the banana Sap contains a certain amount of components such as Alkaloids, flavonoids, Carbohydrate, tannins and terpenoids. Finally anti-fungal, anti-bacterial, antioxidants and anti-inflammatory activity was evaluated.

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6 RECENT ADVANCES ON CUPERPHOSPIDE (Cu₃P) FOR ELECTROCHEMICAL WATER SPLITTING APPLICATION

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ABSTRACT

Electrochemical water splitting is a technology that has the potential to supply clean and sustainable energy to an increasing number of people globally. Large-scale hydrogen generation still depends on the creation of affordable catalysts to replace precious metals like ruthenium or platinum. This study presents the synthesis of Cu₃P as an efficient electrocatalyst for overall water splitting in a 1.0 M KOH electrolyte. The X-ray diffraction analysis confirms the Cu₃P catalyst structure. The catalyst exhibits a low onset potential of 1.4 V to achieve a water-splitting current density of 10 mA cm⁻². This work provides a new direction along which to activate phosphide-assisted electrocatalysts to further enhance their catalytic abilities on overall water splitting.

KEYWORDS: Electrochemical water splitting, Cu₃P, Oxygen evolution reaction

1. INTRODUCTION

Future generations will be greatly affected by the growing population, the depletion of fossil fuels, energy, and environmental concerns[1,2]. As a result, the scientific community is tasked with creating environmentally benign and renewable resources. Because of its high energy density per weight, high utilization efficiency, and environmental friendliness, hydrogen (H₂) is employed as a suitable transporter of renewable energy. The production of high-purity H₂ using electrocatalytic water splitting is generally considered to be a promising technique [3,4]. A possible method for producing high-purity hydrogen in electrochemical technologies is water-splitting, which entails two half-reactions of the hydrogen evolution reaction (HER) and an oxygen evolution reaction (OER) [5]. It is necessary to build earth-abundant, affordable, and non-noble electrocatalysts for bifunctional (HER-OER) performances in comparable electrolyte solutions. Large-scale industrialization sectors require a material that is easy to manufacture, inexpensive, abundant on the earth, non-toxic and has good electrical and cycle stability. Transition metal phosphides' metallic conductance has led to their recent significant promise for HER and OER applications in alkaline, acidic media electrolytes [6,7]. Numerous electrocatalysts, including Ni₂P, Cu₃P, CoP, MoP₂, MoP, CoP, FeP, and others, have been studied for their strong catalytic performance in HER and OER. To increase the intrinsic activity of Cu-based catalysts, it is therefore possible to implement the following techniques, such as integrating Phosphide to accelerate electron transport with high conductivity. This work provides fresh insights into the construction of highly active electrodes or inexpensive electrocatalysts Cu₃P for the electrochemical overall kinetic performance.

2. EXPERIMENTAL SECTION

To prepare the Cu₃P nanoparticles, by using facile hydrothermal method. In the course of the synthesis, the calculated amount of anhydrous Cu(NO₃)₂·5H₂O (1.0 g) and NaH₂PO₄·2H₂O (1.0 g) were

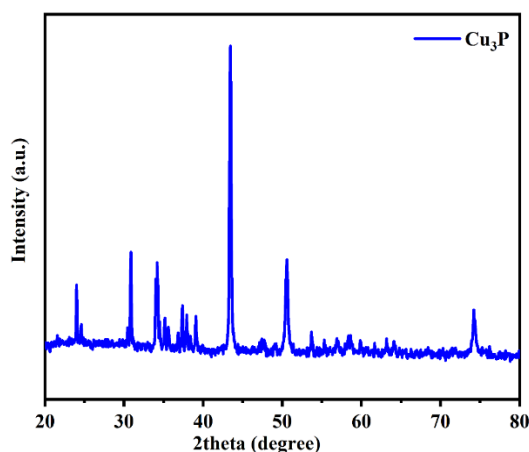
dissolved in 50 mL of distilled water under continuous stirring for 1 h to obtain a transparent solution. Then, the obtained solution was poured into a 50 mL autoclave reactor and sealed. Then, the temperature of the reactor was raised to 160 oC and maintained for 24 h. Finally, the reactor was cooled naturally to room temperature, the extract was washed with water and ethanol to remove the residues and the obtained Cu₃P nanoparticles were dried at 75 oC overnight.

2.1. Physical and Electrochemical Measurements

X-ray diffraction analysis (XRD, Rigaku D/Max-2500) examined the crystal phase formation and structure. The surface morphological analysis was identified by using (SEM, EVO18(CARL ZEISS)). The conventional three-electrode electrochemical cell set-up (origaflex), which included platinum wire as the counter electrode, Ag/AgCl as the saturated calomel electrode, and active material coated on nickel foam substrate in 1 cm × 1 cm as the working electrode, was used for Electrochemical measurements such as linear sweep voltammogram (LSV) in the range of 1.0 to 2.5 V (OER) at the scan rate 50 mV/s, chronoamperometry of catalyst we utilized 1.0 M KOH as the efficient electrolyte solution.

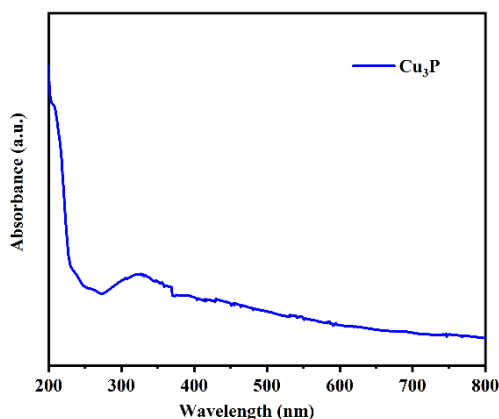
3. RESULT AND DISCUSSIONS

3.1. X-Ray Diffraction Analysis



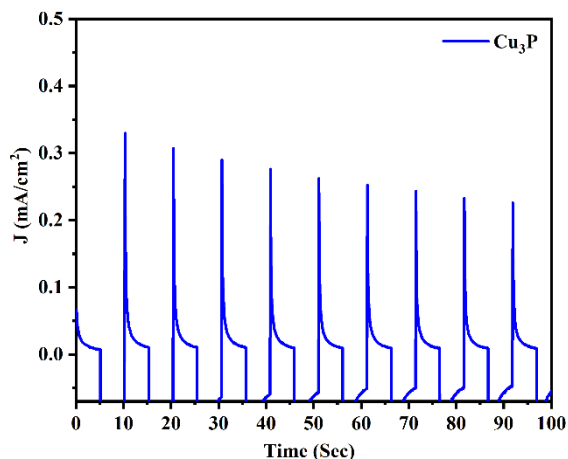
The phase structures of the products were mostly determined by XRD diffraction. The X-ray diffraction (XRD) patterns of the target electrocatalyst Cu₃P are shown in Fig. 3.1.a. The characteristic diffraction peaks at $2\theta = 30.8^\circ, 34.2^\circ, 43.8^\circ, 50.8^\circ, 54.5^\circ$ and 74.5° corresponding to the crystal faces of (112), (202), (211), (300), (113), (212) are stronger in all the reflections, which are consistent with those of the standard values (JCPDS card No. 02-1263).

3.2. UV–Visible diffuse reflectance spectroscopy Analysis



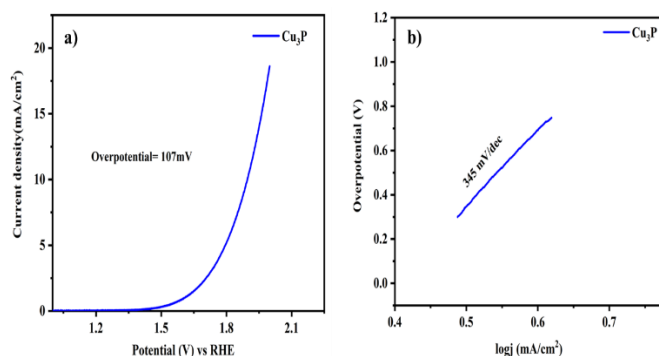
UV–visible DRS spectroscopy is used to reconnoiter the optical characteristics of the Cu₃P catalyst. In Figure. 3.2 Cu₃P catalyst displayed an optical absorbance range between 200nm, and 800 nm, respectively. Inside the wavelength range of less than 300 nm, optical absorption is mostly caused by an electron transfer from the valence band to the conduction band. These results display electromagnetic spectrum absorption exclusively in the UV region.

3.3. Chronoamperometry Analysis



The chronoamperometry (J–t curve) was performed on a fabricated electrocatalyst to examine the current response. Figure 3.3. shows the J–t curve obtained for the Cu₃P electrocatalyst. The J–t curves were collected for 100 sec at minimum voltage Vs. RHE. It can be seen that the Cu₃P electrocatalyst exhibited minimum current density while the catalyst during the electrolysis process. As an outcome, the charge carriers can straightforwardly transport between the surface and electrolyte during the water-splitting process.

3.4. Linear Sweep Voltammetry Analysis- OER (Oxygen Evaluation Reaction)



The three-electrode oxygen evaluation reaction (OER) performances of the prepared catalysts (given in Figure. 3.4.a) were evaluated using LSV over the potential window from 1.0 to 2.5 V vs. RHE in 1.0 M KOH electrolyte. As shown in the (figure 3.4.b) OER reaction exhibited a higher kinetic activity with a lower overpotential 107 mV and medium tafel slop value of 345 mV/dec to attain a current density of 10 mA cm⁻². These results demonstrate the fast reaction kinetics of high OER activity.

4. TABLE OF LITERATURE ON Cu-BASED CATALYST

S.No	Catalyst	Electrolyte	Overpotential	References
	CuCo ₂ S ₄	1M KOH	HER-65 mV OER-310 mV	[8]
	NiCo ₂ O ₄ /Cu _x O	0.5 M KOH	HER-92 mV OER-213 mV	[9]

	CuS/CoS ₂	0.5 M H ₂ SO ₄	HER-62,85, and 106 mV	[10]
	CuSe-g-CN	1.0 M KOH	OER-208 mV	[11]
	Cu ₃ Se ₂ @CoSe ₂ -NiSe ₂	1.0 M KOH	HER-42 mV OER-240 mV	[12]
	CuO _x @Co ₃ O ₄ NRs	1.0 M KOH	HER-242 mV OER-240 mV	[13]

5. CONCLUSION

This study presents the synthesis of Cu₃P electrocatalyst by the facile hydrothermal method as an efficient electrocatalyst for overall water splitting. The X-ray diffraction analysis confirms the Cu₃P catalyst structure and SEM confirms the bulk and irregular clustered morphology of the Cu₃P catalyst. The catalyst exhibits a lower over potential of 107 mV, and medium tafel slop value of 345 mV/dec to attain a current density of 10 mA cm⁻² in a 1.0 M KOH electrolyte to enhance the oxygen kinetic performance. This work provides a new direction along which to activate phosphide-assisted electrocatalysts to further enhance their catalytic abilities on overall water splitting.

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7 SYNTHESIS AND CYTOTOXIC ACTIVITY OF ISOMERIC DIBENZONAPHTHYRIDINES

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Abstract

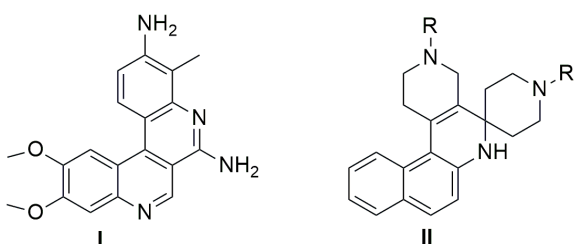
Heterocyclic compounds play a significant role in synthetic organic and medicinal chemistry because of their abundant nature and wide range of applications. The significance of chloroquinolines in the synthesis of substituted quinolines with remarkable biological activity is highlighted by extensive literature reviews. Among these, the synthesis of anilinoquinolines through amination reactions with aromatic amines has been thoroughly studied. The discovery of biologically active molecules in naphthyridine derivatives has led to a notable increase in research on the drug in recent years. After viewing the above facts, the entity of the present investigation was to study the reaction of chloroquinolines with amines. In this concern 2,4-dichlorobenzo and 2,4-dichloroquinolines was taken as a starting precursor to prepare various substituted angular and linear isomeric methoxydinaphthonaphthyridines via aminoquinoline intermediate using CuI as catalyst . The synthesized compounds were characterized using spectral studies. All the synthesized were screened for cytotoxic studies.

Keywords: Naphthyridines, CuI catalyst and Anticancer.

1. Introduction.

The reactions of chloroquinolines have been extensively studied in an aim to derive biologically active substituted quinolines,1,2 and also in the synthesis of some naphthyridine analogs.3,4 A detailed survey of the literature points out that the reaction of chloroquinolines was aimed to get substituted quinolines possessing biological activity one among them is the amination reaction involving aromatic amines thereby deriving the respective anilinoquinolines. Research on the chemistry of naphthyridines has expanded considerably in recent years in connection with the fact that biologically active compounds have been detected among the derivatives of these heterocycles.

The importance in synthesis of naphthyridine (pyridopyridine) derivatives is due to the exceptionally broad spectrum of their biological activities. Particularly, dibenzonaphthyridine of the type I act as selective-3-phosphoinostide-dependent kinase-I-inhibitor5. Moreover, the naphthonaphthyridine less common heterocycle compared with simple as well as benzonaphthyridines, it is envisioned that naphtho[2,1-c][2,7]naphthyridines, which contains both naphthalene ring and naphthyridine moieties, may afford unique and interesting biological activities, such that spironaphtho[2,1-c][2,7]naphthyridine-5,4'-piperidine derivatives II were potent inhibitors of lipid peroxidation.6



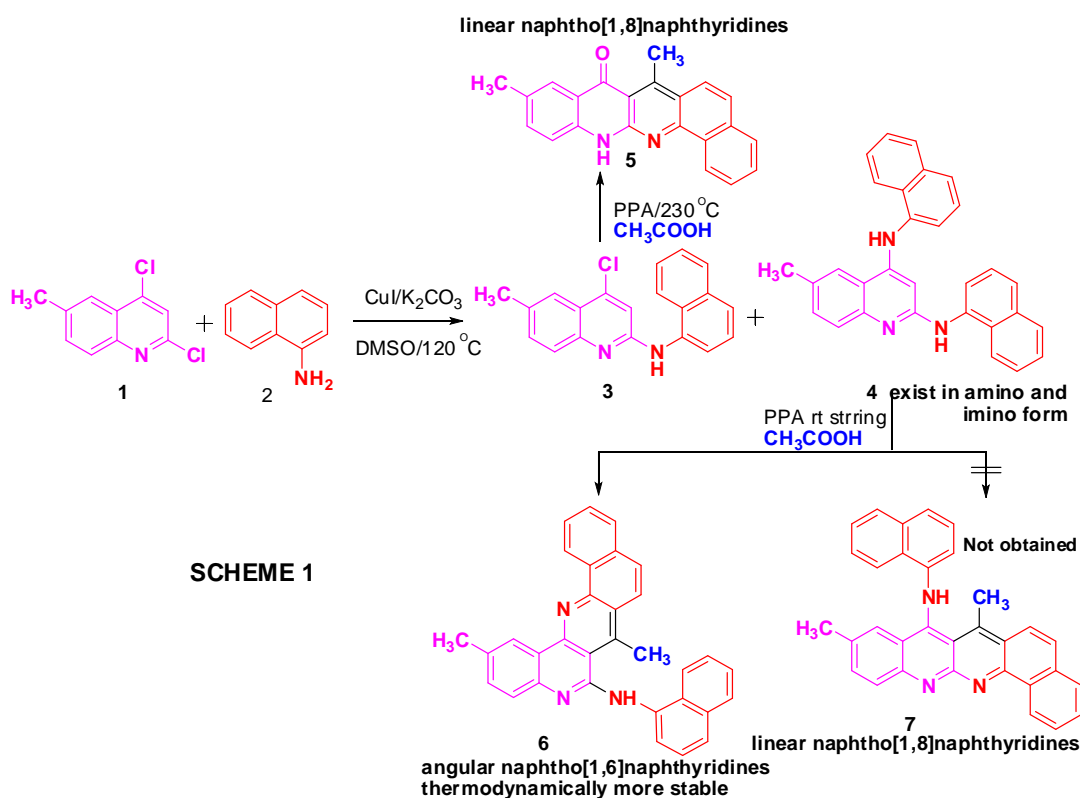
Recently considerable attention has been focused on procedures for the modification of 1,6-naphthyridine derivatives with the aim of searching for new biological active compounds. To our awareness there are no reports for the synthesis of benzonaphtho[1,6]naphthyridines, dinaphthonaphthyridines and carbazolnaphthonaphthyridines and their biological properties. Hence considerable efforts have been devoted to construct various substituted above mentioned naphthyridine derivatives utilizing the precursor 2-chloro-4-methylquinolines and 2-chloro-4-methylbenzo[h]quinoline.

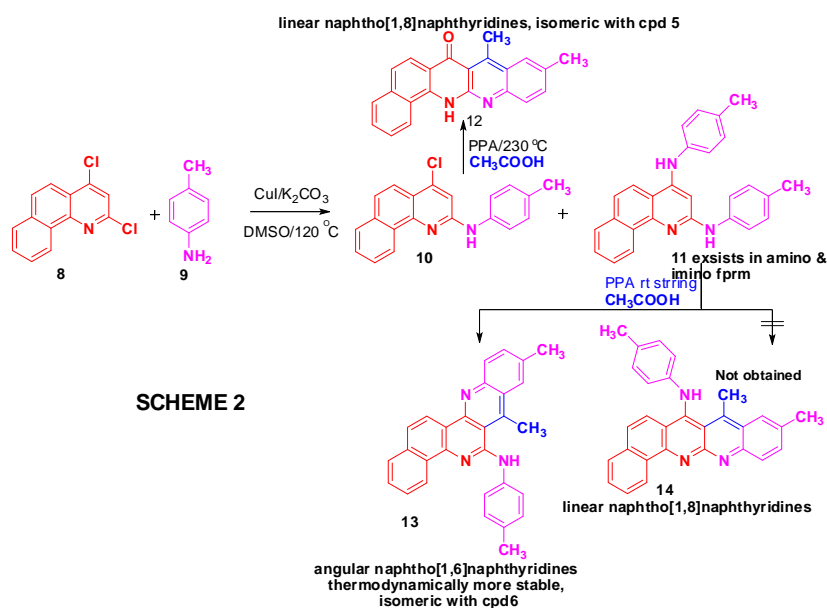
2. Present work

To the synthesis of aliphatic substituted angular and linear benzo[g]naphtho[1,2-b][1,8]naphthyridines, and benzo[h]naphtho[1,2-b][1,6]naphthyridin-6-amine from the potential precursor 2,4-dichloroquinolines (1) through the intermediates 3 & 4 as shown in scheme 1. We have carried out the amination reaction on 2,4-dichloroquinolines (1) with 1-naphthylamine (2) using CuI as promoter to afford the corresponding mono (3) and diamino (4) substituted compounds which were utilized to get the above mentioned naphthyridines (5 and 6).

In order to get linear benzo[g]naphtho[1,2-b][1,8]naphthyridines, the intermediate 3 was reacted with methoxy benzoic acid in the presence of PPA we get compound 5.

To get angular product naphtho[1,6] naphthyridine the intermediate (4) was reacted with acetic acid in the presence of PPA to give a single product in higher yield, which may be due to the presence of two NH groups which facilitate the electrophilic substitution reaction at C3 position of the quinoline skeleton. From these spectral data, the structure of product was assigned as thermodynamically more stable angular product 6 on the basis of its higher melting point, compound 6.





In order to get its isomeric form the starting precursor 8 and 9 reacted together to form the intermediate 10 and 11. Upon cyclisation of intermediates with acetic acid to afford respective isomeric (12 and 13) from of 5 and 6. (Scheme 2)

3. Cytotoxic studies.

All the synthesized compounds were screened against HeLa, HCT-116 and HCT-8 cancer cell lines. The results were shown in Table 1. After careful examination of the results obtained it is generalized that both the isomers showed different activities in different cell lines. By comparing the intermediates the compounds 3 and 4 showed potent activity that its isomeric compounds 10 and 11. Similarly by comparing the linear isomers i.e. compounds 5 and 12, compound 5 showed better activity. Also comparing the isomeric compound 6 and 13, compound 6 showed good activity that its isomeric compound 13. It was observed that the compounds derived from the dichloroquinolines showed significant activity that the compounds from benzodichloroquinolines.

Compounds	MTT IC50 μ L		
	HeLaa	HCT-116b	HCT-8c
3	4.1	8.6	7.6
4	2.4	2.2	5.6
5	10.6	12.7	15.5
6	20.0	18.1	17.2
10	8.3	8.4	6.5
11	6.45	8.23	7.2
12	18.6	19.5	20.4
13	33.1	26.4	22.1
ADR	6.3	8.7	7.2

Table 1 Cytotoxic activity expressed by IC50 in μ L of compounds for cancer cell lines

a-Human cervical cancer cells (HeLa), b-colorectal adenocarcinoma (HCT-116), c-colon (HCT-8) cancer cells. Adriamycin was used as positive control. Experiments were performed in triplicate

Experimental Section

General procedure for the reaction of 2,4-dichloroquinolines (1) with 1-naphthylamine (2); Preparation of 4-chloro-N-(naphthalen-1-yl)quinolin-2-amine (3), and N2,N4-di(naphthalen-1-yl) quinolin-2,4-diamine (4)

A mixture of 2,4-dichloroquinoline (1, 0.010 mol) and 1-naphthylamine (2, 0.010 mol) was heated under 20mL of DMSO using CuI (10mol %) and ignited K₂CO₃. The product obtained was washed with water, dried which showed a mixture of 2 products on TLC and separated by column chromatography over neutral alumina and eluted with petroleum ether : ethyl acetate (99:1) mixture to get 4-chloro-N-(naphthalen-1-yl)quinolin-2-amines (3) (recrystallised using ethanol) and the another

product eluted by ethyl acetate : methanol (95:5) mixture to get N2,N4-di(naphthalen-1-yl)quinoline-2,4-diamine (4). It was recrystallised using methanol.

4-Chloro-6-methyl-N-(naphthalen-1-yl)quinolin-2-amine (3)

Pale yellow solid; mp: 109-111 oC; Yield: (45 %); IR (KBr, cm-1) vmax: 3244 (NH), 1591 (C=N); ¹H NMR (500 MHz, CDCl₃) (Fig. 3.48) (ppm) δH: δ 2.52 (s, 3H, C8-CH₃), 6.93 (s, 1H, C3-H), 7.33 (s, 1H, C2-NH), 7.46-7.82 (m, 8H, C6, C2'- C8'-H), 7.94 (d, 1H, C7-H J = 7.50 Hz), 8.10 (d, 1H, C5-H J = 8.50 Hz), ppm; ¹³C NMR (125 MHz, CDCl₃) (ppm) δC: 18.22, 110.23, 120.70, 121.92, 122.01, 122.31, 123.30, 125.69, 125.91, 126.38 (2C), 128.63, 129.03, 130.98, 134.68, 134.82, 135.21, 143.81, 147.57, 154.71 ppm; MS (EI) m/z 318(M⁺, 100), 320(M+2, 34), Anal. Calcd for C₂₀H₁₅ClN₂ (318.09): C, 75.35; H, 4.74; N, 8.79 %; Found: C, 75.31; H, 4.79; N, 8.82 %.

6-Methyl-N2, N4-di(naphthalen-1-yl)quinolin-2,4-diamine (4)

White amorphous powder; mp >300 oC: Yield : (49 %): IR (KBr, cm-1) vmax: 3340, 3197 (NH), 1600(C=N); ¹H NMR (Fig. 3.49) (500 MHz, DMSO-d₆) (ppm) δH: 2.58 (s, 3H, C6-CH₃), 6.02 (s, 1H, C3-H), 7.25-8.11 (m, 16H, C7, C8, C2'- C8', C2''- C8''-H), 8.69 (d, 1H, C5-H J = 1.50 Hz), 10.05 (bs, 1H, C4-NH amino form), 11.01 (bs, 1H, C2-NH imino form), 12.57 (bs, 1H, N1-H imino form, ratio of amino form : imino form is 1 : 1) ; ¹³C NMR (125 MHz, DMSO-d₆) (ppm) δC: 21.07, 86.09, 114.67, 121.49, 121.89, 122.77, 123.39, 124.61, 125.07, 125.50, 126.43, 127.10, 127.21, 127.29, 127.30, 127.43, 127.55, 128.49, 128.64, 128.83, 128.91, 130.03, 132.56, 133.87, 134.28, 134.56, 134.62, 136.54, 152.98, 154.66; MS (EI) m/z 425(M⁺, 990); Anal. Calcd. for C₃₀H₂₃N₃ (425): C, 84.68; H, 5.45; N, 9.87 %; Found: C, 84.75; H, 5.39; N, 9.86 %.

General procedure for the synthesis of compound (5,6)

A mixture of naphthylamino quinoline (3, 0.002 mol) appropriate acetic acid (0.0025 mol) was added to polyphosphoric acid (6 g of P₂O₅ in 3 mL of H₃PO₄) and heated at 230 °C for one hour.

A mixture of N2, N4-di(naphthalen-1-yl)quinoline-2,4-diamine (4, 0.002 mol) and carboxylic acid (0.0025 mol) was added to polyphosphoric acid (6 g of P₂O₅ in 3 mL of H₃PO₄) and stirred at room temperature for half an hour.

The reaction was monitored by TLC. After the completion of the reaction, it was poured into ice water, neutralized with saturated sodium bicarbonate solution to remove excess of carboxylic acids, extracted with ethyl acetate, purified by column chromatography using silica gel and product eluted with petroleum ether: ethyl acetate (93:7) mixture to get (5,6) which was recrystallised using methanol.

7,10-Dimethylbenzo[b]naphtho[2,1-g][1,8]naphthyridin-8(13H)-one (5)

Yellow solid; mp: 160-162 oC; Yield: (38 %); IR (KBr, cm-1) vmax: 3409(NH), 1630(C=O), 1597(C=N); ¹H NMR (Fig. 3.54) (400 MHz, CDCl₃) (ppm) δH: 2.37 (s, 3H, C4'-CH₃), 2.62 (s, 3H, C10-CH₃), 7.34-8.72 (m, 8H, C2, C3, C4, C5, C6, C11, C12-H & C13-NH), 8.88 (d, 1H, C9-H J = 1.50 Hz), 9.58 (d, 1H, C1-H J = 8.00 Hz); ¹³C NMR (100 MHz, CDCl₃) (ppm) δC: 19.10, 25.30, 112.88, 121.14, 122.21, 122.67, 123.15, 124.40, 125.29, 125.71, 125.92, 127.57, 128.96, 129.75, 134.87, 134.93, 137.11, 138.49, 148.63, 149.28, 154.37, 179.92 (C=O); Anal. Calcd. for C₂₂H₁₆N₂O (324):C, 81.46; H, 4.97; N, 8.64 %; Found: C, 81.51; H, 4.91; N, 8.59%.

2,7-Dimethyl-N-(naphthalen-1-yl)benzo[h]naphtho[1,2-b][1,6]naphthyridin-6-amine (6)

Orange prisms; mp: 231-233 oC; Yield: (56%); IR (KBr, cm-1) vmax: 3123(NH), 1622(C=N), 1568(C=N); ¹H NMR (Fig. 3.59) (500 MHz, CDCl₃) (ppm) δH: 2.69 (s, 3H, C2-CH₃), 3.02 (s, 3H, C7-CH₃) 6.97-7.98 (m, 14H, C4, C8, C9, C10, C11, C12, C2''- C8'' and C6-NH), 8.54 (d, 1H, C3-H J = 8.50 Hz), 9.25 (d, 1H, C1-H J = 2.50 Hz), 9.89 (d, 1H, C13-H J = 8.50 Hz); ¹³C NMR (125 MHz, CDCl₃) (ppm) δC: 20.03, 26.10, 111.76, 114.09, 121.87, 122.65, 123.47, 124.13, 125.18, 125.68, 126.14, 126.57, 127.31, 127.49, 127.82, 129.88, 130.22, 130.59, 130.77, 131.49, 131.84, 132.56, 133.80, 134.34, 135.82, 137.29, 141.12, 143.59, 144.90, 147.62, 149.27, 150.71; Anal. Calcd. for C₃₂H₂₃N₃ (449): C, 85.50; H, 5.16; N, 9.35 %; Found: C, 85.42; H, 5.20; N, 9.38 %.

General procedure for the reaction of 2,4-dichlorobenzo[h]quinoline with p-Toluidine.

A mixture of 2, 4-dichlorobenzo[h]quinoline (8, 0.010 mol) and appropriate p-Toluidine, (9 0.010 mol) was heated under 20mL of DMSO using CuI (10mol %) and ignited K₂CO₃. The product obtained was washed with water, dried which showed a mixture of 2 products on TLC and separated by column chromatography over neutral alumina and eluted with petroleum ether : ethyl acetate (98:2) mixture to get mono substituted anilino benzoquinolines (10) (recrystallised using ethanol) and ethyl acetate : methanol (96:4) mixture to get di substituted anilino benzoquinolines (11). It was recrystallised using methanol.

4-Chloro-N-(4'-methylphenyl)-benzo[h]quinolin-2-amine (10)

Pale yellow prisms; mp: 130-132 oC; Yield: (43 %); IR (KBr, cm⁻¹) v_{max}: 3340 (NH), 1600 (C=N); ¹H NMR (Fig. 3.62) (500 MHz, CDCl₃) (ppm) δH: 2.42 (s, 3H, C4'-CH₃), 6.79 (s, 1H, C2-NH), 7.14 (s, 1H, C3-H), 7.27 (d, 2H, C3' & C5'-H J = 8.50 Hz), 7.50 (d, 2H, C2' & C6'-H J = 8.50 Hz), 7.67-7.71 (m, 3H, C7, C8, C9-H), 7.89 (dd, 1H, C7-H J = 7.50 Hz, J = 1.50 Hz), 8.01 (d, 1H, C5-H, J = 9.00 Hz), 9.14 (dd, 1H, C10-H, J = 8.00 Hz, J = 1.60 Hz); ¹³C NMR (125 MHz, CDCl₃) (ppm) δC: 19.97 (C4'-CH₃), 108.61 (C3), 119.34 (C4a), 120.09 (C5), 121.29 (C3' & C5'), 124.30 (C6), 125.01 (C7), 125.88 (C8), 126.71 (C9), 127.43 (C10), 128.01 (C2' & C6'), 128.90 (C4'), 132.96 (C6a), 134.16 (C10a), 136.73 (C1'), 141.09 (C10b), 145.66 (C4), 152.90 (C2); MS (EI) m/z 318(M⁺, 100), 320(M+2, 34), Anal. Calcd for C₂₀H₁₅ClN₂ (318.09): C, 75.35; H, 4.74; N, 8.79 %; Found: C, 75.38; H, 4.70; N, 8.83 %.

N2, N4-Bis-(4'-methylphenyl)-benzo[h]quinoline-2,4-diamine (11)

White amorphous powder; mp >300 oC; Yield: (55 %); IR (KBr, cm⁻¹) v_{max}: 3188, 3097 (NH), 1601(C=N); ¹H NMR (Fig. 3.63) (400 MHz, DMSO-d₆) (ppm) δH: 2.27 (s, 3H, C4'-CH₃), 2.33 (s, 3H, C4''-CH₃), 6.61 (s, 1H, C3-H), 7.13-7.66 (m, 8H, C2', C3', C5', C6', C3'', C3'', C5'', C6''-H), 7.82-7.93 (m, 4H, C6, C7, C8, C9-H), 8.18 (d, 1H, C5-H J = 9.20 Hz), 9.00 (dd, 1H, C10-H J = 9.60 Hz, J = 2.4 Hz), 9.02 (bs, 1H, C4-NH), 9.61 (bs, 1H, C2-NH), 10.25 (bs, 1H, N1-H); ¹³C NMR (100 MHz, DMSO-d₆) (ppm) δC: 19.5, 21.21, 85.27, 111.17, 119.77, 121.99, 123.47, 125.10, 126.22, 127.05 (2C), 127.28, 127.79, 128.08, 128.36, 128.41, 129.49, 130.27, 132.16 (2C), 133.90, 134.68, 135.09, 135.49, 136.50, 153.44, 155.72; MS (EI) m/z 389(M⁺, 98), Anal. Calcd. for C₂₇H₂₃N₃ (389): C, 83.26; H, 5.95; N, 10.79 %; Found: C, 83.35; H, 5.89; N, 10.76 %.

General procedure for the synthesis of compounds (12 & 13) is same as that of compounds(5 &6)

8,10-Dimethylbenzo[g]naphtho[1,2-b][1,8]naphthyridin-7(14H)-one (12)

Pale yellow prisms; mp: 149-151 oC; Yield: (49 %); IR (KBr, cm⁻¹) v_{max}: 3199 (NH), 1623 (C=O), 1597 (C=N); ¹H NMR (Fig. 3.68) (500 MHz, CDCl₃) (ppm) δH: 2.53(s, 3H, C10-CH₃), 3.16 (s, 3H, C8-CH₃), 7.38-7.93 (m, 8H, C2, C3, C4, C5, C9, C11, C12-H, C14-NH), 8.27 (d, 1H, C6-H, J = 8.00 Hz), 9.10 (d, 1H, C1-H, J = 8.00 Hz); ¹³C NMR (125 MHz, CDCl₃) (ppm) δC: 20.20, 25.67, 113.99, 119.87, 121.01, 122.70, 123.21, 124.18, 125.38, 125.72, 126.58, 127.24, 127.47, 129.62, 132.29, 134.63, 135.84, 141.23, 146.32, 147.65, 151.47, 179.51; MS (EI) m/z 324(M⁺, 100); Anal. Calcd for C₂₂H₁₆N₂O (324): C, 81.46; H, 4.97; N, 8.64 %; Found: C, 81.51; H, 4.93; N, 8.70 %.

7,9-Dimethyl-N-(4'-methylphenyl)-benzo[b]naphtho[1,2-h][1,6]naphthyridin-6-amine (13)

Orange solid; mp: 225-227 oC; Yield: (51 %); IR (KBr, cm⁻¹) v_{max}: 3301 (NH), 1649 (C=O), 1593(C=N); ¹H NMR (Fig. 3.73) (500 MHz, CDCl₃) (ppm) δH: 2.31 (s, 3H, C4'-CH₃), 2.56 (s, 3H, C4''-CH₃), 2.84 (s, 3H, C11-CH₃), 7.30-7.85 (m, 11H, C1, C2, C3, C8, C10, C11, C2', C3', C5', C6'-H & C6-NH), 8.23 (d, 1H, C14-H, J = 8.00 Hz), 9.01 (d, 1H, C4-H, J = 7.20 Hz, J = 2.40 Hz), 9.30 (d, 1H, C13-H, J = 8.80 Hz); ¹³C NMR (125 MHz, CDCl₃) (ppm) δC: 19.94, 21.83, 24.66, 112.27, 115.56, 118.84, 120.14, 122.23, 123.67, 125.09, 125.41, 125.69, 126.86, 127.06, 127.45, 128.90, 129.29, 129.43, 131.39, 132.08, 134.03, 136.16, 138.07, 142.57, 144.64, 148.96, 149.37, 151.33, 153.20; MS (EI) m/z 413(M⁺, 100); Anal. Calcd for C₂₉H₂₃N₃ (413): C, 84.23; H, 5.61; N, 10.16 %; Found: C, 84.19; H, 5.58; N, 10.23 %.

4. IN VITRO ANTI CANCER ACTIVITY

The human cervical cancer cell line (HeLa) was obtained from National Centre for Cell Science (NCCS), Pune, and grown in Eagles Minimum Essential Medium containing 10% fetal bovine serum (FBS). All cells were

maintained at 37°C, 5% CO₂, 95% air and 100% relative humidity. Maintenance cultures were passaged weekly, and the culture medium was changed twice a week.

5. Cell treatment procedure

The monolayer cells were detached with trypsin-ethylenediaminetetraacetic acid (EDTA) to make single cell suspensions and viable cells were counted using a hemocytometer and diluted with medium with 5% FBS to give final density of 1x10⁵ cells/ml. One hundred microlitres per well of cell suspension were seeded into 96-well plates at plating density of 10,000 cells/well and incubated to allow for cell attachment at 37°C, 5% CO₂, 95% air and 100% relative humidity. After 24 h the cells were treated with serial concentrations of the extracts and fractions. They were initially dissolved in neat dimethylsulfoxide (DMSO) and further diluted in serum free medium to produce five concentrations. One hundred microlitres per well of each concentration was added to plates to obtain final concentrations of 100, 50, 25, 12.5 and 6.25 µg/ml. The final volume in each well was 200 µl and the plates were incubated at 37°C, 5% CO₂, 95% air and 100% relative humidity for 48h. The medium containing without samples were served as control. Triplicate was maintained for all concentrations.

6. MTT assay

MTT is a yellow water soluble tetrazolium salt. A mitochondrial enzyme in living cells, succinate-dehydrogenase, cleaves the tetrazolium ring, converting the MTT to an insoluble purple formazan. Therefore, the amount of formazan produced is directly proportional to the number of viable cells.

After 48h of incubation, 15µl of MTT (5mg/ml) in phosphate buffered saline (PBS) was added to each well and incubated at 37°C for 4h. The medium with MTT was then flicked off and the formed formazan crystals were solubilized in 100µl of DMSO and then measured the absorbance at 570 nm using micro plate reader. The % cell inhibition was determined using the following formula.

$$\% \text{ cell Inhibition} = 100 - \text{Abs (sample)}/\text{Abs (control)} \times 100.$$

Nonlinear regression graph was plotted between % Cell inhibition and Log₁₀ concentration and IC₅₀ was determined using GraphPad Prism software.

7. Conclusions

In this context we have developed a convenient methodology for the synthesis of angular and linear naphthonaphthyridines through intermediate anilinoquinolines using CuI which were prepared from chloroquinolines. The synthesized compounds were characterized using spectral studies. Furthermore, the both isomers were examined for their in vitro anticancer activity against four human cancer lines. The structure-activity relationship study revealed that the compounds derived from the dichloroquinolines showed significant activity that the compounds from benzodichloroquinolines.

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Supporting Information.

¹H NMR Spectrum of Compound 3 -6 & 10-13.

8 DEVELOPMENT OF CHAINMAIL STRUCTURE USING 3D PRINTING TECHNOLOGY

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Abstract

3D printing has been the most popular sustainable technology in recent years. It is an additive process in which layers of material are built up to make a three-dimensional part. An object is created through the additive process, which involves the application of successive layers of material, each of which can be thought of as a thinly sliced cross-section of the final product. There are five components to this process: resolution, size, orientation, thickness, and material choice. 3D printing technology uses materials such as plastic, powder, polypropylene, polylactic acid, carbon fiber, resins, and metals. 3D printing is integral technology for economic and national security issues. This technology is classified into three major types such as stereolithography (SLA), selective laser sintering (SLS), and fused deposition modeling (FDM). Application of 3D printing technology includes fields such as aerospace, healthcare, automotive, construction, food, bioprinting, etc.,. In textile 3D printing is used to create 3D printed dentures, chainmail structure and various application in medical textile. Chainmail is a structure where small patterns are linked together the structured fabric consists of three-dimensional single cell particles have various application in technical textiles particularly in medical textile. First, polyamide 12 was used to produce the chainmail cloth utilizing 3D printing technology. The flexible fabric in chainmail is made possible by the links and rings sliding against one another. Chainmail serves two primary purposes: defense and technical effects in life science.

Keywords: chainmail structure, fused deposition modeling, 3D printing technology, polypropylene

1.Introduction

Three dimensional printing(3DP) enables the production of extremely complex objects and provides user customization.[1] There are four 3DP methods in manufacturing textiles and categorized into three methods to use 3DP in textile manufacturing for printing fibers, printing flexible structures and printing on textiles. [2] In 3D printing a physical object is created from a digital model by building it up layer .It involves using a 3D printer. A machine that prints three-dimensional objects by laying down successive layers of materials, such as plastic, metal or ceramic .In order to create 3D printed object, the foremost step is to create digital (CAD) software. [3] The digital model is then sliced into thin layers and sent to the 3D printer which reads the instructions and lays down the appropriate materials in desired shape. [4]

The material is typically extruded through a small nozzle, which moves back and forth as it lays down the material building up the object layer. [5]It usually made from polypropylene, coating by layer to create the final object and the 3D printer deposits the material.

3D Printed fabrics have the following properties and applications in the fields such as:

CUSTOMIZATION: 3D printing allows for highly customized fabric, production, creating complex geometries and patterns that would be difficult or impossible to achieve with traditional manufacturing methods, **SUSTAINABILITY:** 3D printing reduces the amount of material waste generated during the production process, making it a more sustainable option for fabric production, **SPEED:** 3D printing allows for rapid prototyping and production of small quantities of fabric which can be helpful for manufacturers looking to produce limited runs, **VERSATILITY:** 3D printing technology can create a wide range of fabrics including those made from traditional materials like cotton and polyester as well as more innovative materials like plastic and metal.

3D Printing Technology

Three-dimensional printing (3DP) enables the production of extremely complex objects and provides user customization. There are four 3DP methods in manufacturing textiles and categorized into three methods to use 3DP in textile manufacturing for printing fibers, printing flexible structures, and printing on textiles. Traditional 3D printed models exhibit a rigid, solid behavior, but more recent initiatives aim to develop flexible structures that can conform to the shape and motion of things. The resulting structures resemble loose chain mail or stiff cloth.[6] The use of three-dimensional printing (3DP) technology to create prototypes in a variety of manufacturing sectors, including the automotive, healthcare, aerospace, sporting goods, textile, garment, and fashion industries, has grown significantly.[7]

Classification of Materials used in 3D Printing

Powder bed fusion (PBF), Material extrusion (ME), Material jetting (MJ), Vat photo-polymerization (VP), Binder jetting (BJ), Sheet lamination (SL), and Direct energy deposition (DED) are the seven methods that ASTM.[8] The major classification includes: Solid filament, Liquid resin, and Powder In Additive Manufacturing (AM), fused filament fabrication, or FFF, is a popular technique of solid filament type. Lately, the incorporation of short carbon fibers into the thermoplastic polymer filament to create a carbon fiber filled (CFF) polymer composite has improved the mechanical properties of plastic FFF parts. [9] Laminated object manufacturing is a division of laser rapid prototyping a 3D modeling technology, The LOM process is based on contour data of the parts that are obtained by laser cutting thin layers of material, followed by hot pressing of the layer that is obtained, cutting of an adhesive layer, and then cutting of a new layer of paper that is superimposed and bonded into a three-dimensional entity.[10] The primary characteristics of LOM are its inexpensive equipment and materials, strong components, and great precision. The SLA printer uses photo polymerization of monomers with a laser beam to produce solid objects.[11] SLS creates the necessary shape pieces by sintering layers of solid powder that has been laser-selected and stratified. The full procedure, which includes the post-treatment, powder, sintering, CAD model, and data processing. SLS is the most used molding material due to its advantages. Theoretically, any heating that occurs after atomic bonds form between particle components can be utilized as a molding material. Currently, SLS molding material comprising paraffin, polymer, and ceramic powder may be completed satisfactorily.[12] One popular method for 3D printing metal alloys is direct energy deposition (DED).[13] DED is a subset of additive manufacturing (AM) processes wherein a feedstock material, either in the form of wire or powder, is applied to a substrate that is simultaneously focused by an energy source, such as an electron beam, laser beam, or plasma/electric arc. This creates a small melt pool and allows for the layer-by-layer deposition of material. Differentiating itself from other AM methods, DED offers a number of special advantages, including alloy design, complicated shape printing in three dimensions, and site-specific deposition and repair.[14]

Fused Deposition Modelling (FDM)

Fused Deposition Modelling (FDM) has emerged as one of the most popular rapid prototyping techniques for a wide range of uses in recent years.[15] This process, which allows for the design and introduction of new materials, including composites, is based on the deposition of fused fiber material on a drop-down platform. ABS is the most often used material in FDM, followed by PC, PLA, PPSF. [16]

Application of 3D Printing in Textile Field

Printing plays crucial role in textile field both in fashion, apparel and in various structure formation. Various printing technology covers various application such as customization, speed, versatility, and sustainability, etc.

3D Printing of Shape Memory Polymer

PLA is one of the most popular polymers used in 3D printing.

PLA contains shape-fixing and shape-switching. Crystallization as well as physical cross-links is attributed to the shape memory properties. However, pure PLA can only be stretched by about 10% without breaks. [17]

Popular 3D printing technology called fused deposition modeling (FDM) uses thermoplastic filament as its printing medium. Building 3D physical models requires melting filament at a heated nozzle and extruding it.

Characteristics of SMP include:

With a degree of crystallinity of 3–50 wt%, this SMP family is semi-crystalline. Comparatively to amorphous materials, semi-crystalline materials are more susceptible to thermal shrinkage because their molecules arrange more orderly to form crystallites when cooled below their transition temperature. [18] Chainmail Structure

3D printing is utilized to produce complex structures by layering materials to construct a three-dimensional item called chain-like structures. There have been numerous attempts among designers and artists to investigate the potential of producing textile using 3D printed chainmail. [19] A form of 3D-printed chain mail can alternate between being flexible and rigid as needed, meaning it could be used for more comfortable medical supports. The microscopic components that make up chainmail fabrics can be versatile and individualized depending on the number of components per unit. For instance, NASA engineers created a chainmail material to shield astronauts and ships from hostile environments in outer space. It is resilient and malleable, and it can take on many shapes without losing tensile strength. Designers created a flexible fabric with various geometric designs using a chainmail structure as the foundation. In order to produce flexible fabrics, the University of Hertfordshire and Digital Hack Lab created a Modeclix structure using SLS 3D printing of PA. This structure is made up of a network of additively created links, each of which may be joined as well as disconnected from its neighbors to produce a wide range of patterns and shapes. As a result, by simply adding or removing links, clothing that is linked by Modeclix can be altered to the right fit. [20]

Structure Properties

Being made up of tiny, interlocking components; being adaptable and customizable depending on the number of parts per unit. Due to the size of each component, the structure tends to be robust. [15]. Ring thickness was reduced (3 mm to 2.5 mm and 3.5 mm to 2 mm) and the number of inner links was increased in order to lessen bending rigidity.[21]

Design and Methodology

High impact resistance, heat regulation, or electrical conductivity are a few desired qualities that might be targeted in chainmail design [22]. In designing methodology various materials were tested in FDM 3D printer experiments until enough flexibility was attained to produce textile-like structures. The characteristics of thermoplastic polyurethane (TPU), acrylonitrile butadiene styrene (ABS), Polypropylene (PP) and polylactic acid (PLA) were observed during the research. Geometrical designs were printed, and depending on the pattern, each one produced a distinct outcome. [23]

Bending Properties of Chainmail Structure

Using polyamide 12 materials the chainmail structure was first printed by 3D printing technology. To investigate the mechanical tunability of fabric under the different external pressures and to establish a finite element model a three-point bending test was carried out. Finally the effects of pressure and particle structure on the apparent bending modulus, energy absorption, and peak load of chain mail fabrics are investigated to reveal the mechanical strengthening of mechanism of chain mail fabrics. The final result predicts that the apparent bending modulus of the chainmail fabric increases up to more than 20 times its original value as the pressure increases from 0 to 60kPa, finally the energy absorption and strength increase up to 22 and 19 times , respectively approaching the innovative structural development of fabrics with adjustable bending modulus and new ideas for development of lightweight and adaptable structures.[24]

Fabric Linkage Behavior

A development of single sheet of chainmail requires one half million interlocking rings, that acts as a double-curved, tensioned linkage fabric wrapping the newly opened kukje art center in Seoul.[25] These chainmail fabrics' design was influenced by the overlapping tessellation techniques seen in biological structures. BCC

and FCC, two varieties of chainmail fabrics, were created to have high stretch ability and flexibility with two-dimensional degrees of freedom. [26]

Polypropylene in Chainmail 3D Printing

FDM 3D printing technology uses filaments such as polypropylene, polylactic acid etc., Polypropylene fiber (PPF) is a kind of linear polymer synthetic fiber with light weight, high strength, high toughness and corrosion resistance, low density; obtained from polypropylene polymerization. Filament can be used as a raw material for 3D printing has melting point of 130 degree Celsius, heat deflection at 64.1 degree Celsius It is gaining acceptance and market share as technical difficulties with printing this thermoplastic is solved. [27] As such PP (polypropylene) 3D printing filament is one of the most popular materials for printing living hinges due to its excellent fatigue resistance, chemical resistance to acids and alkalies, and toughness. Polypropylene also has excellent chemical resistance to a wide range of acids, bases, and solvents at room temperature making it widely used in the medical and automotive industries.

Properties of polypropylene include:

It has 60-70% crystallinity degree, Its density is 900-1000 kg/m³ Melt Flow Index (2.16 kg/2300C) acc. to ASTM D1238: 8 g/10min Tensile Strength / Elongation at Yield acc. to ASTM D638: 25 N/mm² / 20 % Charpy Notched Impact Strength (at -200C) acc. to DIN 53453: 7.2 mJ/mm² Flexural Modulus (1% SECANT) acc. to ASTM D790: 1130 MPa Rockwell Hardness acc. to ASTM D785: 87 R-Scale Heat Distortion Temperature (Load 0.45 N/mm²) acc. to ASTM D 648: 92 0C.[28]

Analyses of commercially available filaments yield several chemical properties that impact printability for fused filament fabrication 3D printing. Preliminary experiments are conducted to optimize the conditions of polymerization and select appropriate monomers and donors for selectivity control. a series of experiments using an industrial Ziegler-Natta catalyst to copolymerize propene with the co monomers 1-butene and 1-hexene[29]

Fabrication of Chainmail Structure

The fabrication of complex three dimensional (3D) microstructure is done by decomposing the structures into substructures to be patterned on separate substrates, followed by juxtaposing the substrates and joining the substructures to form a desired structure. 2D pattern in photo resist on gold- coated glass slide by photolithography for the fabrication and the remainder patterns on cylinder like features in silver by micro contact printing, then the patterns on the cylinder are aligned as the plane so they form the required template.[30]

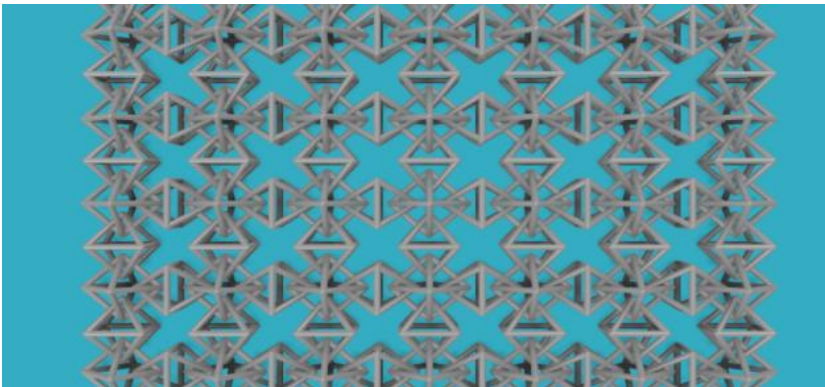


Fig.1. Chainmail structure

Application of Chainmail Structure

Applications of chain mail-based structures are driven by their behavioral resemblance to the fiber network of a natural disc, which also has a negligible bending stiffness and shape-changing ability. The uniaxial tensile responses of the chain mail unit cell—which is the fundamental unit of measurement for the chain mail sheet—

are first characterized as part of the suggested method for designing the sheet. Additionally, modeling and response computation are included, as well as material optimization.[31]Chainmail structure have an effective application in soft robotics, wearable technology, medical devices, aerodynamics, and acoustics.[32] Chainmail models interactively, making the Chainmail approach more suitable for cases requiring higher response times and material modeling.[33] Chainmail is a viable substitute for FEM in real-time soft tissue modeling. All materials, isotropic and anisotropic, can be handled by it by only adjusting the material properties of each chain element.[34] This chain mail structure was used in many curved structure constructions by erecting it in multiple steps of the same actuation technique, but with variable placement orientations, the main application include range of dimensional variations can be increased by modifying the input of the orientation.

Conclusion

In this review paper various printing technologies used in textile field; particularly 3D printing technology, different categories of materials used in 3D printing, fused deposition modeling method, application of 3D printing technology, development of chainmail structure using 3D printing, various properties of chainmail structure , and application of chainmail structure are discussed. Developed chainmail structure is used in medical textile, due to lack of stability in wounding of plaster of Paris the position of part which is wounded get displaced to prevent the stability additional chainmail structure using polypropylene is used. Thus chainmail structure is good at flexibility, stability they are used in various applications in medical textile. As polypropylene is water, chemical, and detergent resistant, malleable and fatigue resistant, highly resistant to corrosion and chemical leaking, and can be molded into desired shape and remolded several times without degradation can be used in chainmail development has an effective application in textile field. In recent days development of 3D printed structures have a major advantage in medical textile.

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9 APPLICATIONS OF BORASSUS FLABELLIFER FRUIT PULP: A COMPREHENSIVE REVIEW

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Abstract: Borassus flabellifer, commonly known as the Asian Palmyra palm or Toddy palm, is a versatile tree species native to the Indian subcontinent and Southeast Asia. Its fruit pulp has long been recognized for its nutritional value and has been traditionally used for food and beverage preparation. In recent years, however, extensive research has unveiled the immense potential of Borassus flabellifer fruit pulp in various other applications across different industries. This comprehensive review paper aims to explore and summarize the diverse range of applications that utilize Borassus flabellifer fruit pulp. The paper draws from a wide array of studies conducted by researchers and experts, spanning the fields of food and beverage, pharmaceuticals, nutraceuticals, agriculture, energy, cosmetics, and more. The review presents an in-depth analysis of the fruit pulp's contributions to these industries, highlighting its bioactive compounds, unique characteristics, and sustainable implications. Additionally, the paper discusses the challenges and future perspectives surrounding the utilization of this valuable natural resource. By consolidating existing literature, this review aims to provide valuable insights into harnessing the potential of Borassus flabellifer fruit pulp across multiple sectors, while promoting its responsible and sustainable usage.

Keywords: pamyra plam, food and beverage, nutritional value, valuble natural resource ,sustainable usage,

Introduction

Borassus flabellifer, also known as the Asian Palmyra palm or Toddy palm, is a distinctive and versatile tree species that holds significant cultural, economic, and ecological importance in the Indian subcontinent and Southeast Asia. Throughout history, various parts of this palm tree, including its leaves, trunk, and fruit, have been utilized in diverse ways by local communities for sustenance, shelter, and traditional practices. Among its valuable components, the fruit pulp of Borassus flabellifer has garnered considerable attention due to its nutritional richness and suitability for numerous applications.

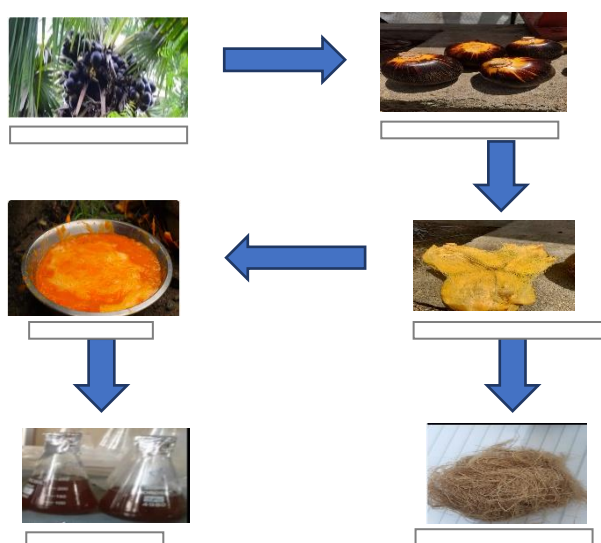


Figure 1. Processing of Borassus Flabellifer Fruit pulp

Traditionally, the fruit pulp of Borassus flabellifer has been consumed as a part of regional diets, often used in preparing delectable desserts, refreshing juices, and fermented beverages. Its exceptional nutrient content,

comprising essential vitamins, minerals, and dietary fibers, contributes to its popularity as a natural health supplement. Over time, advancements in scientific research and technological innovations have revealed a broader spectrum of potential applications for this versatile fruit pulp across various industries. This review paper aims to provide a comprehensive overview of the extensive range of applications of *Borassus flabellifer* fruit pulp, drawing on a compilation of studies and research conducted by experts and researchers in the field. The primary objective is to collate and analyze the existing literature on the multifaceted uses of this fruit pulp and its potential to cater to diverse industries. In this paper, we will delve into the applications of *Borassus flabellifer* fruit pulp in the food and beverage industry, discussing its role as an ingredient in traditional cuisines and its potential as a functional food. Furthermore, we will explore its medicinal properties, pharmaceutical applications, and potential as a nutraceutical ingredient, focusing on its antioxidant, anti-inflammatory, and antimicrobial attributes.

The fibrous nature of the fruit pulp opens up possibilities in the production of industrial materials, such as paper and board, biodegradable composites, and wastewater treatment. Additionally, we will investigate its agricultural applications, where it serves as a soil conditioner and plant growth enhancer, promoting sustainable and eco-friendly agricultural practices. Considering the growing demand for renewable energy sources, this review will explore the feasibility of using *Borassus flabellifer* fruit pulp for energy generation and biofuel production, thus contributing to the renewable energy sector. Moreover, we will discuss its potential incorporation into the cosmetic and personal care industry, showcasing its benefits for skin and hair health and its role as a natural alternative to synthetic ingredients. Furthermore, this paper will address the environmental and social impact of the cultivation and utilization of *Borassus flabellifer* fruit pulp, including its significance in the conservation of this valuable palm species and its potential for socio-economic upliftment in local communities.

By presenting a comprehensive synthesis of existing research, this review aims to shed light on the numerous applications of *Borassus flabellifer* fruit pulp, emphasizing its potential as a valuable and sustainable resource for diverse industries and encouraging further exploration and innovation in its usage.

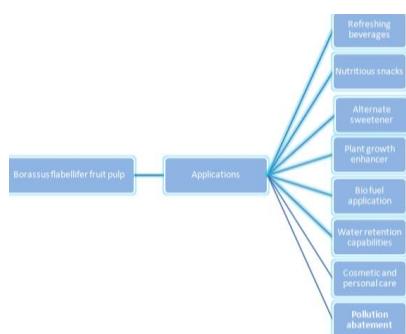


Figure 1. Applications of *Borassus Flabellifer* Fruit pulp

Application in food and beverage industry

Borassus flabellifer fruit pulp has long been an integral part of the culinary traditions in regions where the Asian Palmyra palm thrives. Its rich nutritional profile and unique flavor have made it a favored ingredient in a variety of food and beverage preparations. Moreover, recent studies have explored the potential of this fruit pulp in modern food formulations, highlighting its functional attributes and health benefits. In traditional cuisines, *Borassus flabellifer* fruit pulp is used to create a wide range of mouthwatering dishes. The traditional culinary uses of this fruit pulp in Indian recipes, including the preparation of sweets, puddings, and savory dishes.

The fruit pulp of *Borassus flabellifer* has also found its way into various beverage formulations. The potential of the pulp in the production of juices and refreshing beverages. They reported that the natural sweetness and unique flavor of the fruit pulp make it an attractive alternative to commercial sweeteners in beverages.

Traditionally, *Borassus flabellifer* fruit pulp has been used in the preparation of fermented beverages². The fermentation process of the fruit pulp to produce alcoholic beverages like palm wine and toddy. These fermented beverages have cultural significance in certain regions and are valued for their taste and intoxicating effects^{3,4}.

Apart from its culinary applications, the fruit pulp of *Borassus flabellifer* offers numerous nutritional benefits. That the fruit pulp is a rich source of essential vitamins, minerals, and dietary fibers. It contributes to the daily recommended intake of nutrients, making it a valuable addition to diets in regions where the fruit is abundant⁵. In recent years, researchers have explored the potential of *Borassus flabellifer* fruit pulp as a functional food ingredient. Role in formulating value-added products with enhanced health benefits. They reported its potential as a functional food ingredient in developing nutritious snacks and ready-to-eat products⁶. Natural Sweetener: The fruit pulp of *Borassus flabellifer* contains natural sugars, which has led to its exploration as a potential natural sweetener. The sweetening properties of the fruit pulp and its applicability as a sugar substitute in food and beverage formulations⁷.

Pharmaceutical and nutraceutical applications

Borassus flabellifer fruit pulp has gained considerable attention in the pharmaceutical and nutraceutical industries due to its bioactive compounds and potential health benefits. Researchers have explored its medicinal properties and its role as a functional food ingredient, leading to various applications in these sectors.

The antioxidant potential of *Borassus flabellifer* fruit pulp extract. The study demonstrated its significant free radical scavenging activity, suggesting its potential as a natural antioxidant source⁸. The anti-inflammatory properties of the fruit pulp, highlighting its potential application in combating inflammatory-related diseases⁹. The antimicrobial activity of *Borassus flabellifer* fruit pulp extract against various pathogens. The findings revealed its efficacy against both Gram-positive and Gram-negative bacteria, indicating its potential use in pharmaceutical applications to combat infectious diseases¹⁰.

The fruit pulp of *Borassus flabellifer* has been recognized for its role in promoting digestive health and managing metabolic disorders. The effects of the fruit pulp extract on gastrointestinal disorders, highlighting its gastroprotective properties¹¹. , Its potential in managing metabolic disorders, including diabetes and obesity, attributing the effects to its rich fiber content and bioactive compounds. The fruit pulp of *Borassus flabellifer* has been incorporated into functional food and nutraceutical formulations¹². A nutraceutical beverage enriched with the fruit pulp extract, emphasizing its potential to deliver health benefits beyond basic nutrition. The study highlighted its role as a functional ingredient in value-added products¹³. The immunomodulatory properties of *Borassus flabellifer* fruit pulp extract. The study reported its potential to enhance the immune response, suggesting its application in immunomodulatory therapies and health supplements¹⁴.

Agricultural applications

Borassus flabellifer fruit pulp has been explored for its potential applications in agriculture, particularly as a soil conditioner and plant growth enhancer. Researchers have investigated its impact on soil fertility, water retention, and crop yield, promoting sustainable agricultural practices. The effects of incorporating *Borassus flabellifer* fruit pulp into the soil on soil fertility and nutrient content. The study reported significant improvements in soil properties, including enhanced organic matter content and nutrient levels, contributing to improved soil health and fertility¹⁵.

The water retention capabilities of *Borassus flabellifer* fruit pulp when mixed with soil. The study highlighted the fruit pulp's ability to retain water, reducing the need for frequent irrigation and conserving water resources in agricultural settings¹⁶. The plant growth-promoting effects of *Borassus flabellifer* fruit pulp extract. The study revealed its positive impact on seed germination and seedling growth, indicating its potential as a natural plant growth enhancer¹⁷.

The application of *Borassus flabellifer* fruit pulp extract has been studied for its effect on crop yield. Increased crop yield in rice plants treated with the fruit pulp extract, suggesting its potential use in sustainable agriculture¹⁸.The potential of *Borassus flabellifer* fruit pulp extract in pest and disease management in

agricultural crops. The study demonstrated its efficacy in suppressing certain pests and pathogens, indicating its potential as a natural biopesticide¹⁹.

Energy and Biofuel applications

Borassus flabellifer fruit pulp has emerged as a potential feedstock for energy generation and biofuel production. Researchers have investigated its suitability for biogas production and bioethanol extraction, contributing to the renewable energy sector. The biogas production potential of *Borassus flabellifer* fruit pulp through anaerobic digestion. The study demonstrated the efficient conversion of the fruit pulp into biogas, highlighting its suitability as a renewable energy source²⁰. The potential of *Borassus flabellifer* fruit pulp for bioethanol production. The study reported significant fermentable sugar content in the fruit pulp, making it a promising feedstock for bioethanol extraction²¹. The renewable energy potential of *Borassus flabellifer* fruit pulp highlighted its role as a sustainable and eco-friendly resource for energy production, providing an alternative to conventional fossil fuels²².

Cosmetic and Personal care applications

Borassus flabellifer fruit pulp has garnered attention in the cosmetic and personal care industry due to its bioactive compounds and potential benefits for skin and hair health. Researchers have explored its incorporation into skincare products, hair care formulations, and natural dyes. The use of *Borassus flabellifer* fruit pulp extract in skincare formulations. The study reported its antioxidant and anti-aging properties, making it a valuable ingredient in skincare products to combat skin aging and oxidative stress²⁰. The potential of *Borassus flabellifer* fruit pulp extract in hair care formulations. The study highlighted its role in promoting hair growth, strengthening hair follicles, and improving overall hair health²³. The natural dyeing properties of *Borassus flabellifer* fruit pulp. The study demonstrated its potential as a natural and safe alternative to synthetic hair dyes, providing a sustainable option for hair coloration²⁴.

Potential Mechanical applications

Composite materials are engineered materials made by combining two or more constituent materials, each contributing specific properties to the final product. Natural fibers have been increasingly considered as potential reinforcements in composites due to their biodegradability, renewability, and favorable mechanical properties. Here is a general reference on the use of natural fibers in composites²⁵. Biodegradable packaging materials have gained significant attention as a sustainable alternative to conventional plastic packaging, contributing to reducing plastic waste and environmental pollution ²⁶.

Applications in pollution abatement

Borassus flabellifer fruit pulp has shown promise in wastewater treatment due to its ability to remove pollutants and contaminants from water. Researchers have explored its potential as a low-cost and eco-friendly alternative for wastewater treatment. The use of *Borassus flabellifer* fruit pulp as an adsorbent for the removal of heavy metals from wastewater. The study demonstrated its high adsorption capacity for metals like lead, cadmium, and copper, making it a potential candidate for industrial wastewater treatment²⁷. The application of *Borassus flabellifer* fruit pulp in dye removal from textile wastewater. The study reported its efficient dye adsorption capabilities, indicating its potential for treating colored wastewater²⁸. The use of *Borassus flabellifer* fruit pulp to remove organic contaminants from industrial wastewater. The study demonstrated its effectiveness in reducing chemical oxygen demand (COD) and biochemical oxygen demand (BOD) levels. Agricultural runoff can lead to nutrient pollution in water bodies²⁹. The potential of *Borassus flabellifer* fruit pulp in removing nutrients like nitrogen and phosphorus from agricultural runoff, thus mitigating eutrophication in waterways³⁰.

Borassus flabellifer fruit pulp has been explored for its potential to mitigate air pollution, particularly in indoor settings, by acting as a natural air purifier. Researchers have studied its ability to remove pollutants and improve indoor air quality. The use of *Borassus flabellifer* fruit pulp as an indoor air purifier. The research demonstrated its ability to remove indoor air pollutants, such as volatile organic compounds (VOCs) and particulate matter, through adsorption and filtration processes³¹.

Formaldehyde is a common indoor air pollutant found in building materials and household products. The potential of *Borassus flabellifer* fruit pulp in removing formaldehyde from indoor air. The study reported its

efficacy as a natural formaldehyde adsorbent. Ammonia is another indoor air pollutant that can be found in various settings³². The ability of *Borassus flabellifer* fruit pulp to adsorb ammonia from indoor air. The research demonstrated its effectiveness in reducing indoor ammonia levels³³.

Environmental and Social impact

The cultivation and utilization of *Borassus flabellifer* fruit pulp can have significant environmental and social implications. Researchers have studied its sustainability aspects, including its impact on local communities, biodiversity, and conservation efforts. On the socio-economic benefits of *Borassus flabellifer* cultivation in rural communities. The research highlighted its role in providing livelihood opportunities for local farmers, contributing to rural economies³⁴. The impact of *Borassus flabellifer* fruit pulp extraction on biodiversity and conservation in the native regions. The study emphasized the importance of sustainable harvesting practices to preserve the natural habitat and protect endangered species¹⁵. A harvesting practices for *Borassus flabellifer* fruit pulp. The study recommended guidelines for responsible harvesting to ensure the long-term viability of the palm species³⁵.

Challenges and Future perspectives

While *Borassus flabellifer* fruit pulp shows promising applications in various industries, there are several challenges that need to be addressed to maximize its potential benefits. Additionally, exploring future perspectives can lead to further advancements and novel applications. The sustainable sourcing and cultivation of *Borassus flabellifer* fruit pulp are critical to ensure the long-term availability of this valuable natural resource. The need for responsible cultivation practices and conservation efforts to prevent overexploitation and preserve the palm species. Efficient extraction techniques are essential to optimize the yield and quality of *Borassus flabellifer* fruit pulp³⁶. The various extraction methods and emphasized the importance of selecting appropriate techniques for maximum efficiency and minimal wastage. The fruit pulp of *Borassus flabellifer* offers opportunities for value addition and product development in various industries³⁷. The potential for developing novel products using the fruit pulp, including functional foods, cosmetics, and biodegradable materials. The successful commercialization of products derived from *Borassus flabellifer* fruit pulp requires overcoming market access challenges³⁸. To promote and market products derived from the fruit pulp, addressing issues related to distribution, branding, and consumer awareness³⁹.

Conclusion

The cultivation and utilization of *Borassus flabellifer*, the Asian Palmyra palm, offer a range of applications across various industries, from food and beverage to pharmaceuticals, agriculture, energy, cosmetics, and more. Sustainable sourcing and conservation efforts are essential to prevent overexploitation and protect the ecological balance of the regions where *Borassus flabellifer* is cultivated. Moreover, the cultivation and utilization of *Borassus flabellifer* fruit pulp can positively impact local communities by providing livelihood opportunities and income generation, particularly in rural areas. Supporting traditional knowledge and cultural practices associated with this palm species is crucial for maintaining local identity and heritage.

Despite the vast potential of *Borassus flabellifer* fruit pulp, challenges remain, such as sustainable sourcing, efficient extraction techniques, value addition, market access, and commercialization. Addressing these challenges will be essential to harness its full benefits and promote responsible utilization. By adopting sustainable practices and fostering collaboration between stakeholders, we can ensure the continued growth and utilization of *Borassus flabellifer* in a manner that benefits both the planet and its inhabitants. Embracing this resource responsibly will contribute to sustainable development and a more eco-conscious future.

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10 EVALUATION OF TOTAL PHENOLIC CONTENT AND ANTIOXIDANT POTENTIAL OF LEAF EXTRACTS OF MUSA ACUMINATA

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Abstract

This study was designed to examine the bioactivity as an antioxidant agents for *Musa acuminata* extracts. *Musa acuminata*, commonly known as banana plants, is widely consumed across the world. It is known for many pharmacological activities and reports show that phenolic compounds. In the present investigation, quantitative analysis of phenolic compound was carried out on water extracts of fresh *Musa acuminata* leaf by modified Folin-Ciocalteu method. Total phenolic recovery was found to be maximum in 70 °C water extract. This study showed the *Musa acuminata* leaf is a good source of phenolic compounds. In addition, leaf extracts were tested for antioxidant activities.

Key words:

Musa acuminata, phenolic compound, Folin-Ciocalteu, antioxidant activity

INTRODUCTION

Free radicals are highly reactive chemicals that have the potential to harm cells. They are created when an atom or a molecule (a chemical that has two or more atoms) either gains or loses an electron (a small negatively charged particle found in atoms). Free radicals are formed naturally in the body and play an important role in many normal cellular processes. At high concentrations, however, free radicals can be hazardous to the body and damage all major components of cells, including DNA, proteins, and cell membranes. The damage to cells caused by free radicals, especially the damage to DNA, may play a role in the development of cancer and other health conditions. Antioxidants are chemicals that interact with and neutralize free radicals, thus preventing them from causing damage. Antioxidants are also known as "free radical scavengers."

The body makes some of the antioxidants that it uses to neutralize free radicals. These antioxidants are called endogenous antioxidants. However, the body relies on external (exogenous) sources, primarily the diet, to obtain the rest of the antioxidants it needs. These exogenous antioxidants are commonly called dietary antioxidants. Fruits, vegetables, and grains are rich sources of dietary antioxidants. Some dietary antioxidants are also available as dietary supplements [1],[3].

Plants are considered to be the good source for the exploration and discovery of new pharmaceutical compounds as well as medicines, which can be the potential drug for humans as they act as intermediate for synthesis of useful drugs [4]. Plants possess various phytochemicals with several bioactivities such as anti-inflammatory, antioxidant, and anticancer [5] and one among them such as *Musa acuminata* is widely used in the treatment of many ailments in Ayurvedic as well as herbal and folk medicine.

Globally, *Musa acuminata* plant is the fourth most important agricultural product after rice, wheat and maize. The flower and stem region of *Musa acuminata* plant are known for their anti-ulcer, diuretic, anti-diabetic and antiseptic properties [6][7] and they have been extensively investigated. But very limited number of studies have been carried out on its leaves. For ages, *Musa acuminata* leaves have been used for cooking, wrapping and serving food all over the world. Reports show that they contain large amount of polyphenols, especially polyphenol oxidase which is used in the treatment of free radicals which cause cell damage, by the formation of superoxide anions and lipid peroxides.

In the present investigation, quantitative analysis of phenolic compound was carried out on extracts of fresh *Musa acuminata* leaf by modified Folin-ciocalteu method. In addition the leaf extracts were tested for antioxidant activities.

2 MATERIALS AND METHODS

Chemicals and reagents:

DPPH (2, 2-diphenyl-1-picrylhydrazyl), Gallic acid, Folin-ciocalteu reagent.

Plant materials:

The *Musa acuminata* leaves (*Musa acuminata*) were collected from Erode Tamilnadu, India, fresh leaves were collected and they were washed fully under running water and then sterilized with distilled water.

Preparation of sample

After sterilization the fresh leaves placed in room temperature to remove water droplets then leaves chopped into small pieces and weighed. Now the sample is used to prepare extract.

Preparation of leaf extracts

10g of sample was weighed out and added to 100ml distilled of water, this mixture poured into round bottom flask fitted in Soxhlet apparatus (Soxhlet extraction is used when the desired compound has a limited solubility in a solvent and the impurity is insoluble in that solvent. It allows for unmonitored and unmanaged operation while efficiency recycling a small amount of solvent to dissolve a larger amount of material).the whole system carried out at temperature 50 oC for 30 minutes. Then the solution cooled and filtered made to 100ml to obtain aqueous extract of *Musa acuminata* leaves (50°C) used as stock. Similarly extracts of *Musa acuminata* leaves at temperature 60°C, 70°C, 80°C, 90°C, 100°C and cold extracts are obtained.

Chemical Analysis:

Total phenolic content:

The total phenolic was determined according to Folin Ciocalteu reagent assay using Gallic acid as standard. A suitable aliquot (0.5ml) of *Musa acuminata* leaves extracts of different temperature were added to 7.5 ml of distilled water. One ml of Folin Ciocalteu (1:10) reagent was added to the mixture and shaken. After 3 min 1ml of 35% Na₂CO₃ solution was added to the mixture. After incubation for 90 min at room temperature, the absorbance was determined at 725nm with a spectrometer against prepared reagent as blank. A total phenolic content samples was expressed as micro g Gallic acid equivalents.

Antioxidant Activity

DPPH-Free radical scavenging activity:

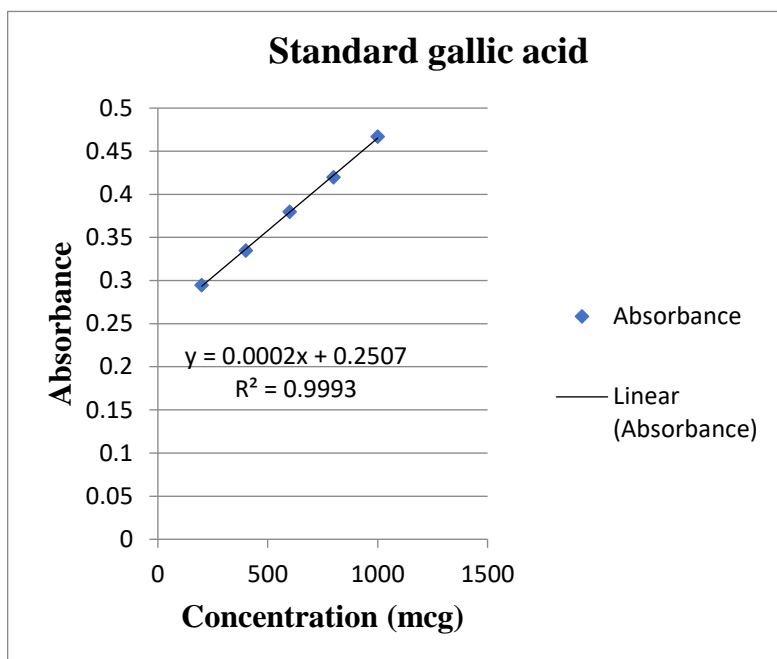
Determination of DPPH (2, 2-diphenyl-1-picrylhydrazyl) free radical scavenging activity was measured spectrophotometrically. 0.008 mg DPPH in 100ml methanol was prepared and 3ml of this solution was added to 0.5ml of *Musa acuminata* leaves extracts. Methanol was used as a blank. This mixture was shaken vigorously and allowed to stand at room temperature for 30 min. Then the absorbance was measured at 517nm against a blank. The capacity to scavenge the DPPH radical was calculated using the following equation:

DPPH scavenging activity % = [(Ac-As)/ Ac] x 100 Where: (Ac) was the absorbance of the control and (As) the absorbance of the sample. The results were expressed as IC₅₀ (the concentration mg/ml of *Musa acuminata* leaves extracts that scavenge 50% of DPPH radical).

3.RESULTS AND DISCUSSION

Total phenols of *Musa acuminata* leave extracts

The given below graph shows standardization of gallic acid, it is used to calculate total phenolic content by comparison.



The results of total phenolic content of aqueous extracts of *Musa acuminata* leaves at different temperature and cold are shown in table (1)

Extracts	Total phenolic content
50°C	10.615
60°C	11.815
70°C	21.115
80°C	14.465
90°C	9.115
100°C	5.515
cold	6.215

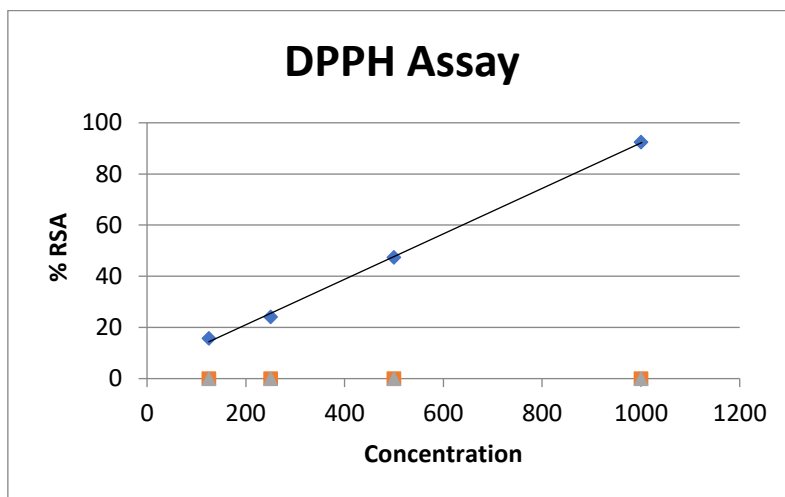
Data presented in table showed that aqueous extract of *Musa acuminata* leaves at 70°C had the highest level of total phenolic content (21mg/ml). While the aqueous extract of *Musa acuminata* leaves at 100°C had lowest values of total phenol. After 70°C, the extracts of 80°C, 90°C, 100°C the values of total phenol get decreased with increasing temperature. However, remarkable increase in the values total phenol of *Musa acuminata* leaves (70°C extract)

Antioxidant capacities of *Musa acuminata* leave extracts using DPPH

DPPH assay IC₅₀ DPPH radical scavenging activity (Inhibitory Concentration) of the sample (70 °C) extract was determined by comparing it to the standard value of gallic acid. Antioxidant potential was determined for 70°C extract, due to presence of high phenolic content. Presence of high phenolic content clearly shows maximum free radical scavenging activity.

Concentration (ug)	Percentage inhibition
125	15.732
250	24.13
500	47.41
1000	92.45

The given below graph shows percentage inhibition of free radical by *Musa acuminata* leaf extracts



The result of the antioxidant activity of *Musa acuminata* with aqueous extract by DPPH assay shows the presence of antioxidant capacity is more and directly proportional to the concentration of the sample. It means higher the concentration higher will be the percentage of antioxidant potential in the *Musa acuminata* leaves of aqueous extract (70°C)

The antioxidant activity of *Musa acuminata* leaves represented as IC₅₀. The DPPH radical scavenging activity of the leaves extracts was measured. Regarding the DPPH assay the antioxidant capacity (IC₅₀) is ranged from 530 micro g/ml. The antioxidant activity of plant materials is significantly correlated well with the presence and the content of their phenolic compounds.

4. CONCLUSION

To conclude from the results of the present study, the *Musa acuminata* plant has phytochemical compounds. Thus the investigation reveals that the *Musa acuminata* leaves extract has phytochemical screening aqueous extract reveals the presence of phenol in large scale. From total phenol aqueous extract of 70°C shows the maximum antioxidant potential. Hence the plant extract could be explored for its highest therapeutic efficiency. The plant extract studies are the answers to the people seeking for better therapeutical agents from natural sources which is believed to be more efficient with little or no side effects when compared to the commonly used synthetic chemotherapeutic agent. The quantitative analysis of these phytochemicals will be an interesting area for further study.

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11 ENHANCING FILTRATION EFFICIENCY WITH BAMBOO-BASED NON-WOVEN SPUN-BONDED MASKS: A SUSTAINABLE SOLUTION FOR PERSONAL PROTECTIVE EQUIPMENT

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ABSTRACT

Conventional masks in use are predominantly crafted from polypropylene-based materials, comprising non-woven and spun-bonded fabrics. However, these masks pose limitations, notably skin and respiratory irritation, alongside environmental concerns due to their non-biodegradable nature and delayed aging properties, leading to medical waste accumulation. In response, this research article delves into an examination of the air permeability properties of spun-bonded masks utilizing bamboo-based non-woven materials. The study reveals a significant enhancement in filtration efficiency, with a notable 20% improvement compared to existing polypropylene-based non-woven masks commercially available. The adoption of bamboo-based non-woven spun-bonded masks effectively addresses the prevailing challenges and limitations associated with mask utilization. These masks offer invaluable support to medical professionals and frontline workers, marking a promising stride towards a more sustainable and efficient approach to personal protective equipment.

Key words: Polypropylene, masks, Bamboo materials, Filtration efficiency, spun bonding material, Personal protective equipment

1.INTRODUCTION:

The widespread use of conventional masks, predominantly fashioned from polypropylene-based materials such as non-woven and spun-bonded fabrics, has been integral to personal protective practices. However, these masks exhibit inherent limitations that warrant attention. Chief among these concerns are skin and respiratory irritation experienced by wearers, compounded by environmental issues stemming from their non-biodegradable nature and delayed aging properties, resulting in the accumulation of medical waste. In response to these challenges, this research endeavours to explore alternative materials and manufacturing techniques to

improve upon the existing mask design. Specifically, our focus lies in examining the air permeability properties of spun-bonded masks incorporating bamboo-based non-woven materials. Bamboo presents itself as a promising eco-friendly alternative due to its renewable nature and biodegradability, offering potential solutions to the environmental repercussions associated with conventional masks.

Through rigorous testing and analysis, our study aims to quantify the filtration efficiency of bamboo-based non-woven spun-bonded masks in comparison to their polypropylene-based counterparts commercially available in the market. Preliminary findings suggest a significant enhancement in filtration efficiency, with an observed 20% improvement, underscoring the potential of bamboo-based materials to revolutionize mask design and usage. The adoption of bamboo-based non-woven spun-bonded masks holds promise in addressing the persistent challenges and limitations inherent in current mask utilization practices. Furthermore, these masks stand to provide invaluable support to medical professionals and frontline workers, heralding a shift towards a more sustainable and efficient paradigm in personal protective equipment. This research represents a critical step towards realizing a safer, more environmentally conscious approach to mask production and usage.

2.LITERATURE REVIEW

COVID-19 prompted a shift towards precautionary measures, highlighting the importance of PPE. WHO guidelines outline varying PPE needs for healthcare workers, patients, and the general public, emphasizing protection from physical contact and airborne transmission. Recommended equipment includes masks, gloves, goggles, respirators, and sanitizers to safeguard against the virus.[1]The nonwoven industry is crucial yet faces environmental challenges due to petrochemical use, prompting exploration of bio-based alternatives. Current reliance on synthetics is at 66%, but the next generation aims for a shift towards natural and renewable materials for enhanced sustainability. Lignocellulosic materials, including pulp fibers and nanomaterials from wood, are key focuses, with advancements in water-stable interfiber bonding being a critical area for bio-based product development.[2] Recent developments in PPE fibers span elastomeric, cellulose-based, synthetic, inorganic, and polymer fibers, focusing on enhancements like extensibility, environmental friendliness, and nanotechnology integration. Special textile structures for PPE, including 3D textiles, shear thickening fabrics, and phase change materials, are also highlighted, alongside prospects for future advancements in the field.[3] efforts to combat epidemics emphasize the importance of face masks, yet their environmental impact is concerning due to excessive single-use polymer masks. Incorporating antimicrobial agents can enhance safety, with metal and metal-oxide materials being popular, but careful selection and study are needed to mitigate risks of leaching and environmental harm.[4]COVID-19's impact extends beyond health, affecting economies and daily life; face masks are crucial but contribute to plastic waste. A study quantifies this waste and proposes sustainable solutions, like integrating natural plant fibers into mask production and upcycling mask waste into construction materials[5]Protective textiles are rapidly expanding within technical textiles, serving to shield against various hazards. Emerging from natural resources, they offer specialized protection from fire, microorganisms, chemicals, and more. This chapter outlines advancements in protective textiles, including applications such as spacesuits.[6]

MATERIALS AND METHODS:

Sample Preparation:

Bamboo-based non-woven materials were sourced from reputable suppliers known for their quality and sustainability. Spun-bonded masks were manufactured using a standardized production process, ensuring consistency across samples.

EXPERIMENTAL SETUP:

A controlled laboratory environment was established to conduct air permeability testing. Test apparatus included an air permeability tester equipped with appropriate sensors and gauges.

TESTING PROCEDURE:

Each spun-bonded mask sample was securely affixed to the testing apparatus.

Air permeability measurements were taken using standardized testing protocols, ensuring accuracy and reliability. Testing was conducted under varying conditions to assess the masks' performance across a range of scenarios.

FILTRATION EFFICIENCY ANALYSIS:

Filtration efficiency was determined by subjecting mask samples to aerosolized particles of standardized size and concentration. Particle count and size distribution were measured before and after passing through the mask samples. Filtration efficiency was calculated based on the reduction in particle count post-filtration.

DATA ANALYSIS:

Data obtained from air permeability testing and filtration efficiency analysis were compiled and analysed using statistical software. Comparative analysis was performed to assess the performance of bamboo-based non-woven spun-bonded masks against conventional polypropylene-based masks.

QUALITY CONTROL:

Stringent quality control measures were implemented throughout the testing process to ensure the reliability and reproducibility of results. Any anomalies or deviations from expected outcomes were thoroughly investigated and addressed.

ETHICAL CONSIDERATIONS:

All testing procedures adhered to ethical guidelines and regulations governing research involving human subjects and materials. Consent was obtained where applicable, and participant confidentiality was maintained throughout the study. By meticulously following these methods, we aimed to accurately evaluate the air permeability properties and filtration efficiency of spun-bonded masks utilizing bamboo-based non-woven materials, providing valuable insights into their potential as a sustainable alternative in personal protective equipment.

Table 1 Consolidate summary of masks and filtration efficiency:

3.RESULT AND DISCUSSION:

As per Table 1 the provided tabulation outlines the characteristics and filtration efficiency of different mask samples under study:

PP01 (Polypropylene inner and outer layer):

Material: Constructed with polypropylene inner and outer layers.

Air Permeability: 308.5 Pa.

Particle Size (Nm): 2.

Initial Particle Count: 2100.

Final Particle Count: 450.

Filtration Efficiency: 78.57%.

PP02 (Polypropylene inner, middle, and outer layer):

Material: Comprised of polypropylene inner, middle, and outer layers.

Air Permeability: 320.5 Pa.

Particle Size (Nm): 2.

Initial Particle Count: 2100.

Final Particle Count: 580.

Filtration Efficiency: 72.38%.

BBC03 (Bamboo material Inner layer, middle layer, and Outer Cotton):

Material: Utilizes bamboo material for the inner and middle layers, with outer layers made of cotton.

Air Permeability: 250.25 Pa.

Particle Size (Nm): 2.

Initial Particle Count: 2100.

Final Particle Count: 300.

Filtration Efficiency: 85.7%.

BB04 (Bamboo material Inner layer, middle layer, and Outer Bamboo):

Material: Consists of bamboo material for the inner and middle layers, with outer layers also made of bamboo.

Air Permeability: 241.58 Pa.

Particle Size (Nm): 2.

Initial Particle Count: 2100.

Final Particle Count: 215.

Filtration Efficiency: 89.76%.

DISCUSSION:

The filtration efficiency of each sample represents its effectiveness in reducing the number of particles passing through the mask.

PP01 and PP02, both constructed with polypropylene layers, demonstrate relatively lower filtration efficiencies compared to the bamboo-based masks (BBC03 and BB04). BBC03 and BB04, incorporating bamboo materials, exhibit higher filtration efficiencies, with BB04 demonstrating the highest efficiency among all samples. The differences in filtration efficiency could be attributed to various factors, including the material properties, layer composition, and manufacturing processes. Lower air permeability values suggest better filtration performance but may also lead to increased breathing resistance. The particle size of 2 Nm indicates the size range of particles being filtered, which is crucial in assessing the effectiveness of the masks against specific contaminants.

Overall, the results highlight the potential of bamboo-based materials in enhancing filtration efficiency and promoting the development of more effective and sustainable masks for respiratory protection. Air permeability can significantly affect filtration efficiency in masks and other filtration systems.

Higher Air Permeability: Masks with higher air permeability allow more air to pass through them. While this might seem beneficial for breathability, it can also mean that larger particles, including potentially harmful particles like viruses or bacteria, can pass through more easily, reducing filtration efficiency.

Lower Air Permeability: Masks with lower air permeability restrict the flow of air more effectively. This can increase filtration efficiency by trapping a larger percentage of particles, including smaller ones, within the mask material.

Material Properties: The material used in the mask plays a crucial role in determining its air permeability. Different materials have varying degrees of porosity and thickness, affecting how easily air can pass through them. Materials with finer pores or denser structures tend to have lower air permeability and higher filtration efficiency.

Particle Size: The size of particles being filtered also influences the relationship between air permeability and filtration efficiency. Masks with high air permeability may effectively filter larger particles but may be less effective against smaller particles that can bypass the material more easily.

Design Considerations: The design of the mask, including the number of layers and the arrangement of materials, can impact both air permeability and filtration efficiency. Properly designed masks balance these factors to optimize filtration performance while maintaining adequate breathability.

In summary, air permeability affects filtration efficiency by determining how effectively particles are trapped within the mask material. Finding the right balance between air permeability and filtration efficiency is essential for designing masks that provide effective protection while remaining comfortable for the wearer to use.

SOLUTION STATEMENT:

The materials and methods outlined in this study represent a comprehensive approach to evaluating the efficacy of spun-bonded masks incorporating bamboo-based non-woven materials. Through meticulous sample preparation, including the sourcing of reputable bamboo-based non-woven materials and the standardized production of spun-bonded masks, consistency and reliability were ensured across samples. The experimental setup, conducted in a controlled laboratory environment, facilitated accurate air permeability testing using specialized equipment equipped with sensors and gauges. The testing procedure involved securely affixing each mask sample to the apparatus and conducting measurements according to standardized protocols under varying conditions to assess performance comprehensively.

Filtration efficiency analysis was conducted by subjecting mask samples to aerosolized particles of standardized size and concentration, with pre- and post-filtration particle count and size distribution measurements informing the calculation of filtration efficiency. Data obtained from these tests were meticulously compiled and analyzed using statistical software, enabling comparative analysis to assess the performance of bamboo-based non-woven spun-bonded masks against conventional polypropylene-based masks. Stringent quality control measures were implemented throughout the testing process to ensure the reliability and reproducibility of results, with any anomalies or deviations thoroughly investigated and addressed.

Ethical considerations were paramount, with all testing procedures adhering to established guidelines and regulations governing research involving human subjects and materials. Consent was obtained where applicable, and participant confidentiality was maintained throughout the study. By adhering to these rigorous methods, this study aims to provide valuable insights into the potential of bamboo-based non-woven materials in spun-bonded masks as a sustainable alternative in personal protective equipment, contributing to advancements in the field of respiratory protection and environmental sustainability.

4. CONCLUSION

In conclusion, this research article sheds light on the pressing need for innovation in the realm of personal protective equipment, particularly in the development of masks. Conventional masks, predominantly composed of polypropylene-based materials, have long been associated with drawbacks such as skin and respiratory irritation, as well as environmental concerns due to their non-biodegradable nature. The study presents a compelling alternative in the form of spun-bonded masks utilizing bamboo-based non-woven materials. Through meticulous examination of air permeability properties, it was found that these masks offer a significant enhancement in filtration efficiency, boasting a notable 20% improvement over commercially available polypropylene-based masks. This improvement not only addresses existing challenges but also underscores the potential of bamboo-based materials in revolutionizing mask design and utilization.

By adopting bamboo-based non-woven spun-bonded masks, the medical community and frontline workers stand to benefit greatly. Not only do these masks provide enhanced protection, but they also offer a sustainable solution to mitigate environmental impacts associated with conventional mask production and disposal. In essence, this research signifies a promising stride towards a more sustainable and efficient approach to personal protective equipment. Through continued innovation and adoption of eco-friendly materials, we can pave the way for a safer, healthier, and more environmentally conscious future.

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12 REMOVAL OF PARACETAMOL FROM AQUEOUS SOLUTION USING TITANIUM DIOXIDE

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Abstract:

Green synthesis approach using *Moringa oleifera* leaves extract was successfully used for preparing TiO₂ Nanoparticles. MO-TiO₂ nanoparticles was characterized by Dispersive X-ray Spectroscopy, Scanning Electron Microscope, and Fourier Transform Infrared Spectroscopy. The characterization showed that the synthesizing of nanoparticles. The removal efficiency of the concentration (10 mg L⁻¹) reached 86 % under the condition of dose 0.9 g L⁻¹, time 330 min, and pH 8. TiO₂ nanoparticles had good durability and stability and possesses excellent ability in removal of paracetamol. The results were analyzed according to the Langmuir and Freundlich adsorption isotherms models. The adsorption data for the Langmuir model (R² = 0.9943) with q_{max}= 2.4648 mg g⁻¹ and for Freundlich model (R²= 0.9971). The results of adsorption kinetics indicate that paracetamol uptake on TiO₂ nanoparticles is following the pseudo- first-order kinetic model. Overall, TiO₂ nanoparticles is a favorable green material for removal paracetamol from the aqueous solutions. The effect of varying functional parameters was investigated using the Linear regression analysis, they were found to account for more than 98 % of the variables affecting the removal procedure.

Keywords: TiO₂ nanoparticles, sorption, paracetamol

13 MICROBIAL PRODUCTION OF BIOETHANOL FROM CRUDE GLYCEROL

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Abstract:

Biodiesel being one of the most promising alternative and renewable biofuels has lately seen rapid increase in its production capacity. Along with that there has also been a great increase in production of the co-product, crude glycerol. Bioconversion of crude glycerol to bioethanol through microbial fermentation is a very promising application of glycerol due to its high availability at low cost. The yield of bioethanol from fermentation of glycerol is greatly influenced by various parameters such as temperature, pH, glycerol concentration, organic nutrient concentration, and agitation speed and the bacterial species. Non-pathogenic bacterial strain such as *Escherichia coli* (E.coli), able to ferment glycerol to useful products under anaerobic condition. Different concentration (3%, 5%, 7%) of purified glycerol was taken for the microbial fermentation in a flask culture, then the produced ethanol was analyzed through GC-FID.

14 INNOVATION OF NOVEL COMFORT HELMET WITH BAMBOO KNITTED FABRIC

Sathya C

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Abstract:

Recently there has been upsurge interest in apparel technology all over the world for much demanding functionality of the products like wrinkle resistance, water repellence, fade resistance and resistance to the microbial invasion. Among these, development of antimicrobial textile finish is highly indispensable and relevant since garments are in direct contact with the human body . Bamboo is an eco-friendly and multifunctional plant. Bamboo clothing has recently entered the textile market with a claim for its antimicrobial properties.

Microencapsulation technique the process of wrapping very small gas particles, gases, or active solid content with a coating material/membrane to protect the active particles (core) from environmental influences like unwanted effects such as light, moisture, and oxygen to increase shelf life of the product by imparting natural medium as a capsule insulator. An effective solution to enhance helmets cooling is the utilization of microencapsulated inner layer with the tanners cassia and lemon grass generated from the wearer's head, thereby facilitating cooling within the helmet. . The fabric comfort parameters such as air permeability, moisture vapour permeability and thermal insulation property is be tested. Comparison study is also done for comfort properties, liquid barrier property and antimicrobial property, which is then converted into a inner layer suit for the Helmet.

Keywords: microcapsules, antimicrobial, multifunctional plant, aroma

15 DEVELOPMENT OF COMPOSITES FROM BAGASSE FIBRE AND POLYPROPYLENEUSING EPOXY RESIN

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Abstract:

Nowadays development of composites from renewable resources has become great interest as to reduce the usage of plastics . This study aimed at developing cardboard composite made from bagasse and polypropylene material using epoxy resin that will be suitable for ceiling boards, walls and floors of a home, office or commercial building in order to reduce the amount of plastics from our environment and conserve our natural resources such as forests from depletion. This composite was compared to the already existing ceiling materials in the market. A composite cardboard of melted waste polypropylene as the matrix was reinforced with bagasse fibres after being treated by alkali solution (NaOH) were prepared and the mechanical properties such as Compressive strength, Impact strength, Flexural strength, were investigated. Water absorption was also studied.

16 ELECTROCHEMICAL SENSING OF ANILINE BASED ON BIO-INSPIRED CAULIFLOWER SHAPED TIN-OXIDE NANOPARTICLE USING SOLANUM TRILOBATUM LEAF EXTRACT

A. Elavarasan

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Abstract:

The quantitative detection and determination of aniline (AN) in water samples are of significant importance due to its potential to induce adverse effects in humans and other livestock when consumed in excess. Therefore, it is the need of the hour to develop a highly sensitive conductive matrix for the electrochemical detection and quantification of in-water samples. In this regard, tin oxide nano particles (SnO₂ NPs) were synthesized using Solanum trilobatum leaf extract for the first time. Upon conducting structural analysis of the synthesized SnO₂ NPs, aggregates of spherical nano particles were observed, resulting in the formation of a cauliflower-like structural morphology. Subsequently, the cauliflower-shaped SnO₂ nano particles were drop-casted onto the surface of a screen-printed carbon electrode using nafion as a binder, thereby developing an electrochemical sensing platform for the detection of AN. Later, differential pulse voltammetry technique was employed to detect AN over a concentration range of 2.0–14.0 nM, with a limit of detection of 0.897 nM based on the signal-to-noise ratio (S/N = 3). Importantly, the sensing of AN remained unaffected by tested interfering species from various pollutants, as confirmed by recovery values (99.2–101.0%) in water samples. These results collectively demonstrate that the newly designed sensor exhibits good selectivity, sensitivity, and reproducibility for the detection of AN.

Keywords: Bio-Synthesis, Solanum Trilobatum, Tin oxide, Differential Pulse, Voltammetry
Sensor

17 IMPROVING WASHING AND SUNLIGHT FASTNESS OF SILK YARN USING NATURAL MORDANTS

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Abstract:

This research delves into the enhancement of washing and sunlight fastness of silk yarn utilizing *Acacia nilotica* natural mordants in conjunction with acid dyes. Silk, known for its exquisite sheen and luxurious texture, is particularly vulnerable to color fading and degradation under environmental conditions. The study focuses on harnessing the mordanting properties of *Acacia nilotica*, a natural source rich in tannins, to silk's color fastness when dyed with acid dyes. The research encompasses the extraction, purification, and application of *Acacia nilotica* extracts as mordants for silk yarn dyed with acid dyes. Mordants are applied during dyeing, pre and post dyeing methodologies. A comprehensive series of tests is conducted under diverse conditions to evaluate the effectiveness of these natural mordants in improving both washing and sunlight fastness. Including Scanning Electron Microscope (SEM) & Fourier Infra-Red Spectroscopy (FTIR) – to analysis morphological change of fibre structure are employed to gain insights into the chemical interactions between silk, acid dyes, and *Acacia nilotica* natural mordants. This study aims to provide a sustainable and

ecofriendly approach to enhance the longevity of silk textiles while minimizing the environmental impact associated with synthetic mordants and chemicals. By combining *Acacia nilotica* mordants with acid dyes, this research contributes to the broader goal of advancing eco-conscious practices within the textile industry, preserving the enduring beauty of silk products, and reducing reliance on synthetic additives.

Key words: Silk, *Acacia nilotica*, Acid dyes, Scanning Electron Microscope (SEM), Fourier Infra-Red Spectroscopy (FTIR), Fastness property.

18 MANUFACTURING OF ECO-FRIENDLY SANITARY NAPKIN

Dr. K. Saravanan, S. Gopinath, S. Hema, M. Shalini

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Abstract:

Due to a shortage of accessible, inexpensive hygiene products, girls in low- and middle-income countries struggle to maintain proper menstrual hygiene. The success of girls' education and gender equality in low-income situations might be hampered by a lack of affordable and trustworthy health goods, which can result in absences from school. Sanitary napkins are specialised textile items that women use to collect menstrual fluids in a hygienic manner when they are menstruating. Additionally, a lack of adequate disposal facilities may cause environmental contamination and social irritation. The majority of south korean women use sanitary pads that can be voided before and during menstruation and contain different organic solvents. However, they have not been given access to research on the consequences of sanitary pads on health. Menstrual pads are menstrual hygiene products that are worn externally, unlike menstrual tampons and cups that are worn inside the vagina. This simple study of physical materials from a technical point of view could increase school attendance, improve the level of education achieved by girls, and be a key step in achieving gender equality in low- and middle-income countries if it is further studied from the perspective of social sciences and policies.

This project used biodegradable materials to create an environmentally friendly sanitary napkin. The core layer was sandwiched between areca and natural SAP, while the top sheet was created by needle punching banana fibre over non-woven fabric. Three distinct core layer configurations were tested by enclosing SAP(Super Absorbent Polymer) layer sandwiched between banana fibre and areca fibre. The unique qualities of power found in bananas compared to other traditional fibres, fibres are superior. Banana fibres are highly fire resistant, lightweight, and biodegradability, strength, reduced elongation, enormous potential, and strong moisture absorption quality.

This project focuses on creating a multilayer, environmentally friendly sanitary napkin using biodegradable materials. The re-designed shape of the sanitary napkin aims to provide a better fit for fat women, ensuring improved comfort and reduced chances of leakage or discomfort during use. By incorporating areca fibers as a core material, the objective is to enhance the napkin's fluid holding capacity. This allows for improved absorption and better protection against leaks, providing women with a higher level of confidence and convenience.

19 DEVELOPMENT AND MECHANICAL CHARACTERISTICS OF NONWOVEN PRODUCED FROM SILK WASTE AND POLYPROPYLENE

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Abstract:

The research focuses on creating a novel non-woven fabric by combining silk waste and polypropylene, aiming to leverage the sustainability of silk waste and the desirable properties of polypropylene. The study begins by exploring the eco-friendly potential of silk waste, a byproduct of silk production, emphasizing its fibrous proteins and unique qualities for innovative textile materials. Methods for extracting and processing silk waste are investigated, considering factors like compatibility, blend ratios, and processing techniques for integration with polypropylene. Polypropylene, a widely used synthetic polymer, enhances the natural characteristics of silk waste by providing additional strength, durability, and versatility. The blending process is optimized to achieve a balanced combination of silk waste and polypropylene, utilizing techniques such as melt-blending or extrusion for uniform fiber distribution and bonding, resulting in a cohesive non-woven structure. The developed non-woven material's mechanical characteristics are systematically assessed through tests, including tensile strength, elongation at break, tear resistance, and abrasion resistance. The results show that the hybrid material surpasses non-woven made from individual components in terms of mechanical properties. The study suggests that the synergy between silk waste and polypropylene produces a material with enhanced strength, flexibility, and wear resistance, suitable for applications in apparel, automotive textiles, and geotextiles.

Keywords: Non-woven fabric, Silk waste, Polypropylene, Sustainability, Eco-friendly, Fibrous proteins, Textile materials, Blending process, Mechanical characteristics, Synergy

20 PHYTOREMEDIATION OF URBAN AND INDOOR AIR POLLUTANTS BY PLANTS MICROBES' INTERACTION.

Akilesh Subramaniam, Anusuya Venkatesh, Ananthi Charlees, Mohana Kalidass, Shanmuga Prakash Muthusamy

Department of Biotechnology, Kumaraguru College of Technology, Coimbatore

Abstract:

Air pollutants, originating from both natural and human activities, can accumulate in the environment and pose risks to ecosystems and human health. Scientific evidence highlights the detrimental effects of air pollution on both indoor and outdoor environments. Common pollutants include particulate matter, volatile organic compounds, and inorganic substances such as nitrogen dioxide, sulfur dioxide, and ozone. While current emission control technologies primarily target pollution at its source, there is a pressing need for sustainable solutions to mitigate air pollution. Phytoremediation, a plant-based approach, offers promise due to its cost-effectiveness, environmental friendliness, and ability to stabilize soil. Plants can remove pollutants through various biological mechanisms, aided by their symbiotic relationships with microbes. Selecting appropriate plant species and optimizing growth conditions can significantly enhance remediation efforts. Additionally, combining phytoremediation with other methods or implementing supplementary treatments can further

improve its effectiveness. This comprehensive approach underscores the importance of interdisciplinary strategies in addressing air pollution challenges.

Keywords: Air pollutants, Phytoremediation, Outdoor air, Indoor air, Volatile organic compounds, microbe interaction.

21 PHYTOREMEDIATION OF HEAVY METAL-CONTAMINATED SOIL: MECHANISMS, PLANT SPECIES SELECTION, AND FUTURE PROSPECTS

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Abstract:

Heavy metal toxicity in soil is a widespread problem that poses a major danger to both human health and global ecological integrity. Long-lasting and ecologically friendly remediation methods need to be created to address this risk. Using plants to eliminate poisons from soil matrices is known as phytoremediation. It has gained a lot of popularity since it is affordable and has little impact on the environment. An overview of heavy metal pollution in soil and its consequences is given in this abstract, emphasizing the need for environmentally friendly restoration methods. It lists plant species that are effective at absorbing metals and describes the principles of phytoremediation. Innovative advances in Biotechnology and genetic engineering used in phytoremediation techniques. Furthermore, the environmental efficacy and sustainability of phytoremediation are discussed in relation to other traditional techniques, and the importance of interdisciplinary collaboration in optimizing phytoremediation protocols is elucidated. Recent advancements and its Future directions for research and implementation issues are explored.

Keywords: Heavy metal contamination, Soil pollution, Phytoremediation, Plant species, Genetic engineering, Sustainability and Advancements

22 EXPERIMENTAL ANALYSIS ON THE EFFECT OF CBR RESULTS FOR FLY ASH PURIFIED CLAYEY SOIL MATERIALS

Subhashish Dey

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Abstract:

Clayey soil having low shear strength and high compressibility cannot be used for sub grade as it's CBR value will not be in permissible standard. So it's needed to be modified when required to use for sub grade under pavements. To modify, stabilization or ground modification technique is required. In this regard we are making an attempt to modify the properties feasible to be used as sub grade material. Here we are using Fly ash as admixture to stabilize and improve the properties. Many attempts were made using fly ash, here we are attempting an study of fly ash stabilization under curing period as the fly ash is being used as an substitute of cement in concrete which gains strength with curing.

Keywords: Clayey soil; Compressibility; Pavements: Ground modifications; Fly ash; Cement; Concrete: Curing

23 DEVELOPMENT OF POLYHERBAL FORMULATION FOR THE TREATMENT OF DIABETES MELLITUS USING MEDICINAL PLANTS

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Abstract:

The present study investigates the potential antidiabetic, antioxidant, and antimicrobial properties of a polyherbal formulation derived from *Moringa olifera* seeds, *Trigonella foenum-graecum* seeds, *Momordica charantia* fruits, and *Coccinia indica* fruits. The dried seeds and fruits were collected, dried in shade, powdered, and then subjected to ethanolic extraction using a Soxhlet apparatus. The polyherbal formulation was prepared by combining these extracts in a specific ratio of 1:4:1:1 respectively. The antidiabetic activity of the polyherbal formulation was assessed through α -amylase and β -galactosidase inhibitory assays, revealing maximum activity at a concentration of 500 μ g/ml. Furthermore, the antioxidant activity was evaluated by DPPH inhibition assay, with ascorbic acid as a control, demonstrating the highest activity also at a concentration of 500 μ g/ml of the polyherbal formulation extract. Moreover, the antimicrobial efficacy of the polyherbal formulation was assessed against *E. coli* (MTCC No. 443) through minimal inhibitory concentration (MIC) assays. The results indicated significant antimicrobial activity at the concentration of 500 μ g/ml of the polyherbal formulation extract. Overall, these findings suggest that the polyherbal formulation derived from *M. olifera*, *T. foenum-graecum*, *M. charantia*, and *C. indica* exhibits promising antidiabetic, antioxidant, and antimicrobial activities, thereby highlighting its potential as a natural therapeutic agent. Further research could elucidate its mechanisms of action and explore its clinical applications.

Keywords: Polyherbal Formulation, Therapeutic Agent, Diabetes Mellitus, Antifungal, Antibacterial

24 A STUDY ON CONSUMER PREFERENCE TOWARDS INSTANT FOOD PRODUCT

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Abstract:

Food is a basic need which is to be fulfilled for everyone's survival. Previously every food was prepared by the people in their home itself. But in the present fast moving world time has become precious, many have changed their food habits and shifted to a number of instant food products. Instant food products play a very significant role in the present day situation where both men and women are employed. Since the demand for instant food products are picking up, number of manufacturers entered in to the field of instant food products with different brand names. Thus the consumers can choose any brand of their own choice. In this research paper an attempt is made to ascertain the consumers' preference towards instant food products. For analytical purposes, statistical tools such as Chi-square test and factor analysis are used. The results reveal the fact that

there is no Association between occupation, family monthly income, family type and spouse Employment and the monthly expenditure on ready-to-eat instant food products. Further The factor analysis indicates that packing, hygiene, societal influence and influence of Advertisement play an important role in forcing the customers to buy the instant food Products.

25 CONTROLLED ATMOSPHERIC PACKAGING FOR CHILLED MEAT

Subash Palanisamy, Dharunkumar Sankaranarayanan and Shanmugam Palanisamy

Department of Food Technology, K.S.Rangasamy College of Technology, Tiruchengode

Abstract:

The storage life of chilled meat can be extended by packaging product under a preservative gaseous environment to inhibit growth of spoilage bacteria. The maximum storage life is attained by packaging in a gas-impermeable pouch under an atmosphere of oxygen-free CO₂, with the gas added in sufficient quantity to fully saturate the meat at the optimum storage temperature (-1.5°C) and atmospheric pressures. In such controlled atmosphere packaging (CAP), the storage life of meat is between 8 and 15 times that of the same product stored in air. The CAP environment assures retention of good raw meat colour, and development of good eating qualities in cooked product. CAP packaging is being used commercially for shipment of chilled lamb to distant markets. Continuing studies indicate that it could be applied equally effectively to prolonging the storage life of a wide range of other perishable food products.

26 DEVELOPMENT OF FORTIFIED FEED FROM MAIZE COB

Praveen M, Gowtham K and Ruby Celsia A S

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Abstract:

The utilization of agricultural by-products for value-added applications is gaining traction as a sustainable solution to address food security and environmental concerns. Maize cob, an abundant agricultural residue, presents a promising opportunity for the development of fortified feed for livestock. This abstract explores the development process, nutritional enhancement, and potential impact of fortified feed derived from maize cob. The development process begins with the collection and preprocessing of maize cobs, including drying and milling to obtain a suitable feedstock. Subsequent treatment methods, such as ensiling, heat treatment, or chemical processing, are employed to improve digestibility, reduce anti-nutritional factors, and enhance nutrient bioavailability. Incorporation of supplementary ingredients, such as protein-rich sources (e.g., soybean meal), vitamins, minerals, and probiotics, further fortifies the feed formulation to meet the specific nutritional requirements of target livestock species. Nutritional analysis reveals that fortified feed from maize cob offers a balanced profile of carbohydrates, fiber, protein, vitamins, and minerals, essential for optimal animal growth, health, and productivity. Moreover, the utilization of maize cob as a feed ingredient contributes to waste reduction, resource conservation, and economic benefits for farmers through value addition to underutilized agricultural residues. The impact of fortified feed from maize cob extends beyond livestock nutrition to encompass environmental sustainability and socio-economic development. By converting agricultural waste into a valuable resource, this innovative approach promotes circular economy principles, mitigates greenhouse gas emissions, and reduces pressure on finite natural resources. Furthermore, enhanced livestock productivity

resulting from improved nutrition can contribute to food security, income generation, and rural livelihood improvement.

27 INSTANT IDLI BATTER PELLETT

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Abstract:

A novel method for transforming traditional idli batter into instant batter pellets, aimed at enhancing convenience and accessibility in idli preparation. This process involves the creation of dehydrated pellets from raw materials of ingredients such as rice, black gram dhal, salt and yeast. Which can be easily rehydrated to prepare fresh idlis within minutes. The methodology, potential benefits, and implications of this innovation, including its potential to streamline idli production, extend shelf life, and cater to the demands of modern, fast-paced lifestyles. By using this raw ingredients pellet is formed by using direct compression method. Direct compression incorporates the processes of mixing and processing a pellet formulation of ingredients before using compression to generate pellets directly from powdered excipients. Optimization parameters such as compression force, temperature and moisture content for efficient and consistent results. Additionally, it highlights the cultural significance of idlis and the potential market for instant idli solutions. The findings suggest that this approach offers a promising solution to address the challenges of traditional idli preparation, making it more convenient and accessible to a wider audience.

Keywords: Direct compression, Optimization, implications, potential

28 SEMI-AUTOMATED CASHEW PROCESSING MECHANISM

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Abstract:

Cashew nut roasting before shelling is an important treatment since this roasting operation helps to shell the nuts to extract the kernels easily without damaging the edible kernels. For large scale processing, mechanized/semi-mechanized roasters are available, but for low capacity processors, getting an economical and low capacity roaster is a challenge. For low-capacity processing, processors opt for open pan/flame roasting method, which causes over roasting (burnt) or under roasting of cashew nuts. The aim of this article was to design and fabricate a low-cost, simple to operate mini cashew nut roaster, which would be applicable for small scale cashew nut processors. A drum roaster was designed and fabricated, on which the experimental trials were conducted by varying the roasting time between 1 and 7 min to determine the best roasting time, where the drum roaster surface temperature was 275 ± 25 °C. From the roasting trials, it was found that fabricated cashew nut roaster was suitable for roasting cashew nuts within 2.5 min. It was low in cost and required no skilled labors for its operation. Sensory analysis of cashew nut, roasted by developed mini cashew nut roaster was found to be acceptable. The developed small capacity roaster was found suitable to address the needs of small-scale cashew nut processors.

29 IMPACT OF BUYING BEHAVIOUR OF CONSUMERS TOWARDS INSTANT FOOD PRODUCTS

Vishakh Harikumar, Sibikumar Senthilkumar, Vijayalakshmi Velayutham, Monish Kanna Sengottuvel and Prabha Kolandhaivel

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Abstract:

This study examines consumer buying behavior towards instant food products, focusing on perception, awareness, and satisfaction. It assesses the effectiveness of online shopping sites in attracting and retaining customers, analyzes shifts in buying behavior, and explores reasons for hesitancy toward online shopping. Using exploratory and descriptive research methods, the study employs purposive, judgment, and convenience sampling. Primary and secondary data are collected to inform the analysis. Keywords: consumer, buying behavior, satisfaction, food.

30 FORMULATION OF NUTRIENT CHOCO BAR USING KODO MILLET

Arunesh R D, Ari G and Ruby Celsia A S

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Abstract:

The Objective of this study is to design and fabricate chocolate. It consists of various nutrients essential for human health problems. The essential target of this study was to formulate and evaluate natural nutritious chocolate and nutritional supplement containing diabetes, regulates Blood sugar, high protein and fiber content, hormonal imbalance, rich in Anti-cancer properties & reduces Blood Pressure. Chocolate is a range of products derived from cocoa (cacao), mixed with fat and finely powdered coconut sugar to produce a solid confectionery. The medicated chocolate formulation is widely used for hormonal imbalance and increases patient compliance.

31 FUNCTIONAL FOOD. PRODUCT DEVELOPMENT, MARKETING AND CONSUMER ACCEPTANCE

Sakthi G, Vaishnavi S, and Bala Chandra Mohan J

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Abstract:

The abstract you provided offers insights into the development, challenges, and market situation of functional foods. It highlights the importance of understanding the relationship between nutrition and health in promoting well-being and reducing disease risk. The paper discusses the complexities, expenses, and risks involved in developing and commercializing functional foods, considering technological, legislative, and consumer

acceptance factors. It also provides an overview of the current market situation in the USA, Japan, and some European countries, along with comments on future potential and prominent types of functional food products.

32 A NOVEL PROCESS FOR EXTRACTION OF NATURAL SWEETENER FROM LICORICE (GLYCYRRHIZA GLABRA) ROOTS

Anusmitha Nagaraj, Nandhini Kanagaraj, Pavitha Palanivelu, Priyanga Ramamoorthy and Bharath G

Department of Food Technology, K.S.Rangasamy College of Technology, Tiruchengode

Abstract:

Pressurized hot water extraction (PHWE) is a very useful technique for recovering bioactive molecules from natural materials using subcritical compressed liquid water in the temperature range of 50–150 °C. A novel process has been developed for making a natural sweetener from licorice (*Glycyrrhiza glabra*) roots involving selective chemical reaction and easy separation, for recovering mono-ammonium glycyrrhizate (MAG) using hot water with dissolved ammonia and pressurized with carbon dioxide. The performance of the novel PHWE process has been evaluated to ascertain the optimum process parameters to maximize the recovery of MAG by varying the parameters, such as temperature (30–120 °C), pressure (1–10 atm), extraction time (60–120 min), water-to-feed ratio (20–40 ml/g), number of stages (1–3), stirring rate (0–350 rpm), ammonia concentration (0.01–4%, w/v), and grinding. The quantification of MAG recovered in the extract has been based on the vanillin sulfuric acid method using UV spectrophotometer. The maximum recovery of MAG from licorice roots has been achieved at 110 °C and 5 atm with the ratio of 40 ml/g of 0.01% (w/v) ammonia solution to powdered feed after 90 min of extraction

33 FORMULATING EXTRACTS FROM HIBISCUS ROSA-SINENSIS PETALS AND PSIDIUM GUAJAVA LEAVES.

Kishore Baskaran, Surya Palanivel

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Abstract:

In recent days, herbal tea are becoming popular for its stress relief, brain health, and therapeutic benefits. Hibiscus petal, Guava leaf, spices, ginger are meant for their antioxidant activity due to their rich source of phytochemicals. Various parts of plant like leaves, flowers, roots, are used for development of herbal teas. Leaves like guava, are used for herbal tea preparation. The present study is to review about the Hibiscus petal guava leaf based herbal tea. Guava leaves are known for its antioxidant activity due to the presence of quercetin, ferulic acid, protocatechuic acid, guavin B, asiatic acid and β -carotene, which is also used to treat diabetes mellitus, cardiovascular diseases, cancer, and parasitic infections. That poses antimicrobial and antioxidant activity. This project, herbal tea will be standardized and evaluated for its antioxidant activity, total polyphenol properties. The effect of processing condition like steam blanching and hot water blanching will be studied. Based on the review of the study Hibiscus petal and guava leaf based herbal tea have potential antioxidant activity and can be a better alternative for commercial tea with various health benefits.

Keywords: Hibiscus Petal, guava leaf, antioxidant activity, antimicrobial activity

34 DEVELOPMENT OF HEALTH MIX BY USING FISH SCALE WITH HIGH CALCIUM AND IRON CONTENT

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Abstract:

Around 10% of the global fish catch (>90 million tonnes) is currently discarded, while by-products in fisheries account for up to 70% of the whole fish weight. From these, fish bones and scales represent 14–20% of by-products, which are also discarded. Therefore, there is an unmet need for valorising these by-products by transforming them into functional and nutritious ingredients. Towards this objective, we report herein different culinary processes to extract gelatine from fish scales, as well as fish flours from bones and scales, as innovative methods for waste valorisation in the food services industry. On the one hand, gelatine was extracted from demineralised and non-demineralised scales and their respective gelling and melting properties were analysed and compared in culinary elaborations. Both gelatines showed a lower melting point (23 °C) than pork gelatine (29 °C, used as control), which provided these gelatines with a smooth and creamy texture in mouth. On the other hand, financiers made of fish bone and fish scales flour were compared with those made with regular wheat-flour, resulting in no significant differences regarding their adhesiveness and springiness. These results showcase the potential of upcycling fish by-products into protein-rich value-added ingredients in the food services industry.

35 DETECTING FOOD ADULTERATION FOR FRUITS

Narenthiran V, Ashok V & Philip Robinson J

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Abstract:

Detecting food adulteration in fruits often involves analyzing various aspects such as chemical composition, physical characteristics, and even DNA. Techniques like spectroscopy, chromatography, and mass spectrometry are commonly used to detect adulterants or contaminants. Additionally, visual inspection and sensory analysis play a crucial role in identifying anomalies in fruits. Research into new methods, including AI and machine learning algorithms, continues to advance the field, aiming to ensure the safety and quality of fruits for consumers.

36 WASTE PRODUCT UTILIZATION: PREPARATION OF TUTTI FRUTTI FROM WATERMELON RIND

Sowmiya Veerakumar and Nithishkumar S

Department of Food Technology, K.S.Rangasamy College of Technology, Tiruchengode

Abstract:

The present investigation entitled “Evaluation of osmotic treatments for preparation of water melon(*Citrullus lanatus*) rind tutti frutti” was aimed to utilize leftover rind for the preparation of candy after utilization of water melon juice and evaluate the sensory as well as nutritive quality of water melon rind tutti frutti during storage. Experiment was conducted for preparation of water melon rind tutti frutti using different levels of osmotic treatments viz. O1 -50 g sugar/100g rind, O2-75 g sugar/100 g rind, O3-100 g sugar/100g rind, O4-100 g 60°Brix syrup/100 g rind and O5-100 g 70° Brix syrup/100 g rind (Factor 1) and acidity viz. A1-0.10%, A2-0.20% and A3-0.30% (Factor 2). The results of the present investigations indicate that water melon rind candy prepared by mixing 100 g sugar per 100 g water melon rind along with 0.20 per cent acid from was rated as the best treatment (O3A2) on the basis of higher sensory score as well as nutritional composition and also exhibited minimum changes in nutritional as well as sensory quality during six month storage. Thus, developed technologies can commercially be explored by food processing industry for utilization of leftover rind for the preparation of tutti frutti after preparation of water melon beverages to ensure better returns to growers and processors as well.

37 ASSESSMENT OF SPECTROSCOPIC TECHNIQUES FOR ADULTERATION DETECTION OF RAW MATERIALS USED IN BIOPHARMACEUTICAL MANUFACTURING

Muppidathi Ramachandran, Manoj Arunachalam and Dr.J.Philip Robinson

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Abstract:

This work focused on the assessment of the capability and suitability of several spectroscopic techniques for detecting adulteration of raw materials used for biopharmaceutical products. Ensuring the integrity and quality of raw materials in biopharmaceutical manufacturing is paramount for product efficacy and patient safety. However, the complexity and diversity of these materials make them susceptible to adulteration, posing significant challenges for detection and mitigation. Spectroscopic techniques offer promising solutions due to their non-destructive nature, sensitivity, and ability to analyze various compounds simultaneously. This review assesses the efficacy of spectroscopic methods, including infrared (IR), ultraviolet-visible (UV-Vis), and nuclear magnetic resonance (NMR) spectroscopy, in detecting adulterants in raw materials used in biopharmaceutical manufacturing. We discuss the principles, advantages, and limitations of each technique and evaluate their application in identifying common adulterants such as contaminants, impurities, and counterfeit materials. Furthermore, we explore recent advancements in spectroscopic instrumentation and data analysis methods, highlighting their potential for enhancing detection sensitivity and specificity. Through a comprehensive evaluation of spectroscopic techniques, this review aims to provide valuable insights for researchers and industry professionals involved in ensuring the quality and safety of biopharmaceutical products.

38 EVALUATION OF PLANTS GROWTH BY USING NANOFERTILIZER

Shyam Pranhav D

Department Of Biotechnology College Of Technology ,Tiruchengode

Abstract:

Nano fertilizers have made it possible to develop new technologies to increase agricultural production. The green synthesis of nanoparticles using plant extracts has drawn significant interest from researchers as an eco-friendly alternative to traditional physical and chemical approaches to avoid toxic chemicals for the development of current nanotechnology resources. In this study, *Wrightia tinctoria* aqueous leaf extract was used as a stabilizing and reducing agent to synthesize zinc oxide and magnesium oxide nanocomposite. The formation of the ZnO-MgO nano-composite was characterized by UV- Visible Spectroscopy, Scanning Electron Microscopy (SEM -EDAX), Fourier Transforms Infrared Spectroscopy (FTIR), and X-Ray Diffraction (XRD) techniques. The ZnO-MgO nano-composite was assayed for its antimicrobial activity against some fungal and bacterial organisms. The beneficial effect of nanocomposite on the growth dynamics of *Capsicum annuum* (chili pepper), *Solanum melongena* (Aubergine), and *Sorghum bicolor* plant was investigated. Green synthesized ZnO-MgO nanocomposite was given as the nutrient source for the growth of the *Capsicum annuum*, *Solanum melongena*, and *Sorghum bicolor* plants with different concentrations (0,25,50,75,100 ppm). This led to the greatest rise in growth, nutrient, and chlorophyll content of plants. When compared to ZnO nanoparticles, ZnO/MgO-NCs produced significant growth and yield of the plants with non-toxicity and biocompatibility.

Keywords: Green synthesis, ZnO-MgO nano-composite, *Wrightia tinctoria*, Antimicrobial activity, Chlorophyll content.

39 VALUATION OF ANTI-DIABETIC ACTIVITY OF SOLANUM TORVUM AGAINST 3T3-L1 CELL LINE

Guna V

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Abstract:

Solanum torvum, a plant from the Solanaceae family, has been discovered to have antibacterial and antioxidant properties. The phytochemical components of the fruit were discovered. The DPPH radical scavenging experiment evaluated antioxidant activity, revealing an inhibition rate of 75% to 86%. Antimicrobial activity was examined. The hydroalcoholic extract of *Solanum torvum* has considerable potential as a bioactive agent, including antioxidant and antibacterial properties. These properties indicate its potential to withstand oxidative stress and reduce microbiological risks. Furthermore, the extract scored well in alpha-amylase and alpha-glucosidase tests, suggesting that it has potential for application in the treatment of glucose metabolism issues. The study next tests the extract's biological effects with cytotoxicity and glucose uptake techniques.

40 MICROBIAL DIAGNOSTICS

Madhavan G

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Abstract:

Emerging viruses are usually endemic to tropical and sub-tropical global travel, climate change and changes in lifestyle are believed to contribute to the spread of these viruses into new regions. Many of these viruses cause similar disease symptoms as other emerging viruses or common infections, making these unexpected pathogens difficult to diagnose. Broad-spectrum pathogen detection microarrays containing probes for all sequenced viruses and bacteria can provide rapid identification of viruses, guiding decisions about treatment and appropriate case management. We report a modified whole transcriptome case management. We report a modified Whole Transcriptome Amplification (WTA) method that increases unbiased amplification, particular of RNA viruses. Using this modified WTA method, we tested the specificity and sensitive of the Lawrence Livermore Microbial Detection Array (LLMDA) against a wide range of emerging viruses present in both non-clinical and clinical samples using two different microarray data analysis methods.

41 CONTRIBUTION OF STARCH TO THE FLAVOR OF RICE-BASED INSTANT FOODS

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Department of Food Technology, K.S.Rangasamy College of Technology

Abstract:

Increased consumption of instant foods has led to research attention, especially rice-based instant foods. Starch, one of the most important components of rice, significantly affects food quality. However, the mechanisms by which starch contributes to rice-based instant foods flavor are poorly understood in many cases. The review aims to describe the common mechanisms by which starch contributes to food flavor, including participating in flavor formation, and affecting flavor release throughout starch multiscale structure: particle morphology, crystal structure, molecular structure. Five specific examples of rice-based instant foods were further analyzed to summarize the specific contribution of starch to flavor, including instant rice, fermented rice cake, rice noodles, fried rice, and rice dumplings. During foods processing, reducing sugars produced by heating or enzymatic hydrolysis of starch participate in Maillard reaction, caramelization and thermal degradation, which directly or indirectly affect the formation of flavor compounds. In addition, adsorption by granules, encapsulation by retrograded V-type crystal, and controlled release by starch gel all contribute to rice-based instant food flavor qualities. These mechanisms jointly contribute to flavor compounds formation and release. Proper theoretical application and improved processing methods are needed to promote the high-quality, mechanization, and automation of rice-based instant foods production.

42 PHYSICOCHEMICAL PROPERTIES OF GREEN MEDIATED IRON OXIDE NANOPARTICLES

Deepika V

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Abstract:

In this study, iron oxide nanoparticles were produced using a green synthesis technique using plant extracts. The synthesized nanoparticles were characterized using X-ray diffraction, Fourier Transform Infra-Red, Field Emission – Scanning Electron Microscopy, Thermal Gravimetric Analysis with Differential Thermal Analysis, and UV and visible spectroscopy. The XRD results showed the rhombohedral structural phase of Iron oxide nanoparticles with a high crystalline nature. The FTIR spectrum of Iron Oxide nanoparticles confirms the functional characteristics of octahedral and tetrahedral vibration. The optical absorption spectrum was confirmed and its band gap was found. Iron oxide nanoparticles revealed high thermal stability with a retention up to 900°C. The morphology of alpha iron oxide nanoparticles appeared to be spherical, and its elemental purity was Fe and O. It found that the prepared iron oxide nanoparticles shows with increase in concentration inhibit bacterial growth effectively against Gram positive (*S.aureus*) and Gram negative bacteria (*E.coli*) and this effects will constrained for various biological applications.

Key words: Iron Oxide nanoparticles, plant extracts, Green synthesis.

43 PREPARATION OF CO₃O₄ NANOPARTICLES FOR ANTICORROSION APPLICATION

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Abstract:

The research work investigates the corrosion resistance of Cobalt oxide (Co₃O₄ NPs) coated mild steel in seawater environment. The nanoparticles were individually produced by green synthesis method. The phase structure, crystallinity, thermal and physical stability, surface morphology, and surface area of the produced Co₃O₄ NPs were investigated. The Co²⁺ and Co³⁺ transitions on the lattice oxygen were determined by the UV-visible spectroscopy. Utilizing X-ray diffraction and Transmission electron microscopy characterizations, the cubic structure and spherical form of Co₃O₄ NPs were estimated. UV-visible and Photoluminescence Spectroscopy is used to measure how much chemical substance absorbs light. The corrosion inhibition properties were determined by using Electrochemical method. The result of Tafel polarization plots revealed improved corrosion resistance of the coated specimen as compared to Uncoated sample. Corrosion rate and polarization resistance of 0.16813 mm/year and 280.13 Ω were recorded against the coated sample while 0.14137 mm/year and 498.44 Ω were recorded for the Uncoated sample respectively. The coated sample exhibited higher potential shift in the positive direction and showed better corrosion resistance properties. Thus, the coated sample exhibited higher potential shift in the positive direction and showed better corrosion resistance properties.

Keywords: Co₃O₄ nanoparticles; corrosion inhibition; green synthesis; Mild steel; Sodium chloride (NaCl).

44 DESIGN OF DIFFERENT SIZE NANOSPHERES FOR SKIN APPLICATION AS AN OINTMENT – KETOCONAZOLE

J. Priyadharshini, S. Ramya, G. Monisha

Muthayammal Engineering College

Abstract:

The development in nanotechnology has revolutionized drug delivery, offering innovative solutions to enhance the efficacy of topical treatments. This study focuses on the isolation of bacillus megaterium from the soil, screening of PHB producing Bacillus megaterium and its extraction. Extracted polyhydroxybutyrate and Ketoconazole are used to design different size Nanospheres using nanoprecipitation method. Nanospheres are characterized using Scanning Electron Microscope (SEM). Ointment was prepared with different sizes of nanospheres. Antifungal activities of ointment were performed and it showed the good zone of inhibition.

Keywords: Nanospheres, Polyhydroxybutyrate, bacillus megaterium, Ketoconazole, Antifungal ointment.

45 PHARMACOLOGICAL ACTIVITY ON ALZHEIMER'S DISEASE BY USING LICHENS

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Abstract:

The increasing cognitive loss and memory impairment associated with Alzheimer's disease (AD) pose a significant challenge, yet effective therapies are still elusive. This work focuses on the structural characterisation of exopolysaccharides (EPS) from lichen-associated bacteria and their possible pharmacological effects on AD since natural substances have become attractive options for therapeutic intervention. EPS undergo stringent analytical procedures during separation and purification, providing information about their molecular structure and chemical makeup. Importantly, in vitro studies show that EPS significantly inhibits several AD pathogenesis pathways, including as tau hyperphosphorylation, beta-amyloid aggregation, neuroinflammation, oxidative stress, and synaptic dysfunction. Surprisingly, EPS have strong anti-inflammatory and antioxidant characteristics, possibly providing neuroprotective advantages. The cognitive benefits and neuroprotective effects of EPS therapy are confirmed in vivo using transgenic AD animal models. These studies emphasise decreases in amyloid plaques, neurofibrillary tangles, and maintenance of synaptic integrity. Evaluations of safety show a positive profile, confirming the viability of clinical translation. Overall, this study offers insightful information on the therapeutic potential of EPS in treating AD and encourages more investigation to develop EPS-based therapies and lessen the prevalence of AD worldwide.

Keywords: Alzheimer's disease, Exopolysaccharide, Neuro protective, Pharmacological, Antioxidant, Anti-inflammatory.

46 REVITALIZE BONE: DRIVING OSTEOBLAST CELL ACTIVATION FOR ADVANCED BONE REGENERATION

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Abstract:

Bone healing is a complex physiological process that relies on the orchestrated activity of various cell types, including osteoblasts, to regenerate damaged or fractured bone tissue. Traditional approaches to bone healing often involve surgical intervention or the use of bone grafts, which may have limitations and associated risks. In recent years, there has been growing interest in developing novel strategies to enhance bone healing through the activation of osteoblast cells. This abstract presents OsteoStim, a promising approach aimed at driving osteoblast cell activation to accelerate and improve bone healing outcomes. OsteoStim utilizes a combination of bioactive compounds and signaling molecules to stimulate the proliferation and differentiation of osteoblasts, thereby promoting robust bone regeneration. Through targeted modulation of cellular pathways involved in bone formation, OsteoStim offers a non-invasive and efficient means of enhancing bone healing in various clinical scenarios. Key features and benefits of OsteoStim include its ability to amplify the natural healing processes of the body, reduce healing time, and enhance the structural integrity of regenerated bone tissue. Furthermore, OsteoStim's tailored approach allows for personalized treatment strategies tailored to individual patient needs, potentially revolutionizing the field of orthopedic medicine.

Keywords: Revitalize Bone, Osteoblast Cell Activation, Bone Regeneration, Advanced Techniques, Osteoporosis Treatment, Bone Health, Tissue Engineering, Regenerative Medicine, Biomaterials, Growth Factors.

47 A REVIEW OF THE MAGIC COCKTAIL GENERATING LUNG'S CRITICAL IMMUNE CELLS IN THE LAB

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Abstract:

This review delves into the innovative approach of generating critical immune cells found in the lungs within a laboratory setting, termed the "Magic Cocktail." With a focus on the burgeoning field of immunology and regenerative medicine, this paper explores how this cocktail of factors has revolutionized our ability to study and potentially manipulate immune responses within lung tissue. The Magic Cocktail comprises a precise combination of growth factors, cytokines, and cell culture techniques that mimic the microenvironment of lung tissue. This environment prompts the differentiation and maturation of various immune cell types crucial for respiratory health, including alveolar macrophages, dendritic cells, and regulatory T cells. The review discusses the specific components of this cocktail and their roles in driving immune cell development. Furthermore, the paper evaluates the implications of this breakthrough in both basic research and clinical applications. In the laboratory, researchers can now study lung immune responses in unprecedented detail, unravelling complex pathways involved in diseases such as asthma, chronic obstructive pulmonary disease (COPD), and infections like COVID-19. Additionally, the potential for using this technology in cell-based therapies for lung diseases holds promise for personalized medicine approaches. Overall, the Magic Cocktail represents a paradigm shift in our ability to model and understand lung immune biology outside of the human

body. Its impact spans from fundamental immunology research to potential therapeutic interventions, offering new avenues for tackling respiratory diseases and enhancing human health.

Keywords: Magic cocktail, Lung, Critical immune cells, Lab, Review, Immunotherapy, Cell culture, Pulmonary biology, Immune modulation, In vitro research

48 PREPARATION OF POLYHERBAL SHAMPOO FOR TREATING TELOGEN EFFLUVIUM

Karthi M G, Pragathi S, Adaikala Selvan G, Kumaran S, Chandru S, Silambarasan P, Gokulkannan K, Sridhar G

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Abstract:

Now a days, most people are suffering from hair loss and dandruff due to continuous usage of chemical shampoos which also has many side effects such as skin cancer, skin dryness and so on. These problems can be overcome by using polyherbal liquid shampoo. Polyherbal liquid shampoo does not contain any chemical substance and it only contains natural herbal ingredients. This shampoo is prepared by extracting the bioactive compounds from *Murraya koenigii*, *Eclipta prostrata* and *Salvia rosmarinus* using the soxhlet extraction method. The phytochemicals of these herbs promote the hair growth and control dandruff. The extract of *Murraya koenigii*, *Eclipta prostrata* and *Salvia rosmarinus* are qualitatively analysed for screening the presence phytochemicals. The *Murraya koenigii* crude sample is quantitatively analyzed by using GC-MS. The GC-MS analysis shows the presence of 1-methyl- pyrrolidine-2-carboxylic acid (31.67%), mahanine (21.37%) and mahanimbine (20.81%). The shampoo was prepared in fifteen different formulations and subjected to optimization studies. The formulated 11 formulations were subjected to various physicochemical parameters such as pH, appearance, foam test, stability, and thickness test. The pH of the shampoo was found to be in range of 4.5 to 5.5 and this pH range of shampoo is good for hair. Appearance of shampoo was brown color and foaming was found. Among all the formulation F4 and F5 shows better result. The formulate shampoo shows potential antidandruff and antimicrobial activity in *Candida albicans* and *Staphylococcus aureus*. The study reveals that the shampoo from whole plants shows better pharmacological activity.

Keywords: Phytochemical analysis, GC-MS analysis, Antidandruff, Antimicrobial activity.

49 AN EXTENSIVE REVIEW OF PHYTOCHEMICAL EVALUATION AND ANTIMICROBIAL ACTIVITY OF TULSI (*OCIMUM TENUIFLORIUM*)

A Oviya Darshni, Dr.M.Tamilvanan, Dr.K.Prabha, & Dr.Suganthi Sivaperumal

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Abstract

Plants are rich in a wide assortment of auxiliary metabolites, for example, tannins, alkaloids, and flavonoids, of the phytochemical constitutes, found in vitro to have antimicrobial properties. A considerable lot of the flavors and herbs utilized today have been esteemed for their antimicrobial impacts. Medications of bacterial infections with different herbs have been securely utilized broadly in natural agribusiness, veterinary and human solution. Since old circumstances, herbal plants have been utilized for the treatment of regular irresistible illnesses and medications with plants having antibacterial action are a possibly valuable option in aquaculture. Moreover, plant-inferred phytomedicines give a less expensive source of treatment and more prominent precision than chemotherapeutic operators in this field. The present study involves identification of phytochemicals present in Tulsi (*Ocimum tenuiflorum*) and evaluate the antibacterial activity of tulsi. The results show that the extracts can inhibit the growth of the bacteria to considerable extent.

50 SYNERGIC TREATMENT OF HERBAL CREAM FOR SKIN INFECTIONS

Karthih M G, Dr Dhevahi B, Pragathi S, Jeeva S, Gopinath C, Vishva V, Chandru V, Santhosh Kumar S M.D

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Abstract

The skin problems of the bacterial, fungal are primarily controlled by antibiotics, Medicinal plants and herbs which are seemed to be candidate for the replacement of the conventional antibiotics for skin infections and allergic reactions. Research for the ideal dressing material continues as skin care professionals are faced with several challenges. The herbal remedies show high therapeutic potential and efficacy against the skin allergy and skin infection by microorganism. Herbal plants such as *Acalypha indica*, *Piper betle*, *Calotropis procera* and *Psidium guajava* were selected. Selected plant parts are dried and extracted using various combination of solvents like methanol, petroleum ether, and chloroform. Qualitative phytochemical analysis was firstly carried out to determine the possible active compounds in the herbal samples. The phytochemical screening reveals the presence of flavonoids, saponin, tanins, terpenoids and phenols and by using GC-MS analysis the Presence of different bioactive compounds were identified. As for the antimicrobial activity, disk diffusion method using cultures of *Staphylococcus aureus*, *Candida albicans* and were carried out. Since there is no detailed research on pharmacological activities of the leaf extract shows better antibacterial and antifungal activity.

Keywords: Antibacterial and Antifungal agents, Phytochemical screening and Bioactive compounds.

51 STUDY OF VACUUM PRESERVATION METHOD ON SHELF LIFE OF TOMATO (SOLANUM LYCOPERSICUM)

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Abstract:

This study investigates the efficacy of vacuum preservation method on extending the shelf life of tomatoes stored in Low-Density Polyethylene (LDPE) bags. Over a period of time, quality parameters including color, firmness, pH level, titratable acidity, and microbial growth, lycopene, Total soluble solids were analyzed at five-day intervals over a period of 40 days. The experiment aims to assess how vacuum preservation affects the degradation rate of tomatoes and whether it can maintain their quality for a prolonged period in Refrigeration condition. Results indicate that vacuum preservation significantly slows down the deterioration process, enhancing the shelf life of tomatoes compared to normal sealing method.

52 DIABETIC WOUND HEALING: HARNESSING FIBROBLAST POTENTIAL FOR ENHANCED RECOVERY

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Abstract:

Diabetes patients face a heightened risk of developing non-healing wounds, attributed to factors like elevated blood sugar levels, compromised immune responses, and nerve impairment. Central to wound repair are fibroblast cells, pivotal for generating collagen and other extracellular matrix components crucial for tissue restoration. Unfortunately, in diabetic individuals, fibroblasts often function suboptimally, resulting in delayed wound closure. Recent years have seen a surge in interest regarding cell-based interventions aiming to enhance wound healing in diabetes. One promising strategy involves stimulating fibroblast proliferation and differentiation within diabetic tissues. This can be achieved through various means, such as leveraging growth factors like transforming growth factor-beta (TGF- β) or employing gene therapy to introduce genes encoding proteins that bolster fibroblast activity. In this comprehensive analysis, we delve into the potential of inducing fibroblast activity in diabetic patients to accelerate wound recovery. Additionally, we explore the hurdles that must be overcome for this approach to transition into clinical applications effectively. By addressing these challenges, we aim to shed light on the prospects and limitations of utilizing fibroblast-centric therapies in diabetic wound management, offering insights critical for advancing patient care in this domain.

Keywords: Diabetic, Wound Healing, Fibroblast, Potential, Enhanced Recovery, Diabetes Mellitus, Chronic Wounds, Tissue Repair, Regenerative Medicine, Therapeutic Strategies

53 ANTICANCER ACTIVITY OF TURBINARIA ORNATA POLYPHENOLS AGAINST HUMAN CANCER CELL LINES

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Abstract:

Antitumor drug resistance and side effects of antitumor compounds are the most common problems in medicine. Therefore, finding new antitumor agents with low side effects could be interesting. This study was designed to assay antitumor activity of the polyphenols extract from brown alga *Turbinaria ornata*, against K562 and Daudi human cancer cell lines. The research was performed as an in vitro study. The effect of the algal polyphenols on proliferation of cell lines was measured by MTT assay. The most effective antitumor activity has been shown at concentrations 500 $\mu\text{g/ml}$ and 400 $\mu\text{g/ml}$ of the algal polyphenols against Daudi and K562 cell lines, respectively. The results showed that the polyphenols extracts of brown alga *Turbinaria ornata* have remarkable antitumor activity against K562 and Daudi cell lines. It is justified to be suggested for further research such as fractionation and purification and in-vivo studies in order to formulate natural compounds with antitumor activities.

54 TRANSZEN: A COMPREHENSIVE TRANSPORTATION MANAGEMENT APP

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Abstract:

TansZen is a sophisticated digital solution designed to streamline and optimize all aspects of transportation operations, benefitting lorry owners, employees, and stakeholders alike. With a focus on lorry transport, TansZen harnesses advanced algorithms and extensive databases to facilitate efficient management of transportation resources, routes, and schedules. Lorry owners and employees can input diverse criteria, such as vehicle availability, cargo type, delivery deadlines, and cost considerations, to generate optimized transport plans that minimize costs and maximize resource utilization. TansZen serves as a comprehensive information hub, providing real-time tracking, monitoring, and reporting capabilities. Lorry owners can easily oversee their fleet's performance, while employees benefit from streamlined workflows and enhanced efficiency. Moreover, stakeholders can access the platform to track the progress of shipments and ensure seamless logistics operations. In addition to its core functionalities, TransZen offers robust photo attachment specifications, allowing users to upload and associate photos of relevant documents, such as invoices, bills of lading, maintenance receipts, and driver licenses. These photo attachments enhance transparency, documentation, and verification for all transactions and activities within the platform. With features for vehicle and driver management, goods tracking and management, route optimization, real-time tracking, reporting, compliance, and photo attachments, TansZen empowers organizations to achieve a seamless and cost-effective transportation ecosystem tailored to their unique needs and objectives. Available in multiple languages, TransZen accommodates diverse global users and facilitates seamless communication and collaboration across borders. Lorry owners, employees, and stakeholders can leverage TansZen to optimize their operations, increase productivity, and drive business success.

55 STUDIES ON DEEP FAT FRYING OF FRENCH FRIES AND ANALYSIS OF ITS QUALITY PARAMETERS

Pujara M M, Kalaivani S, Jony Blessing Manoj J, Sri Mohana Priya K K

Kongu Engineering College, Erode.

Abstract:

French fries is a favourite snack among the consumers. Raw potato and frozen French fries were taken for the analysis. The texture analysis was performed using a texture profile analyzer where hardness, fracturability, springiness of French fries was analysed. Colour was measured using colour spectrophotometer. Four different frying method was done like fresh potato was analysed with variation in time (C1) and in another analysis it was dipped in starch (C2), the frozen fries (C3) and raw potato (C4) was fried in two stages in the third and fourth analysis. The moisture content and water activity was also analysed. Raw potato (C1) was fried in four ways where it was fried for 2,4,6,8 minutes respectively. Two minutes didn't have the colour and also it was raw and uncooked. four minutes had good taste, Crunchiness and it is in satisfied colour. Six minutes had more crunchiness. Eight minutes was so crunchy and turned to dark brown colour. Increase in the frying time increases the hardness of French fries. Frozen French fries (C3) were fried in two stages which had good taste, Crunchiness and it is in satisfying colour. Time consumption is low. The starch dipped French fries (C2) show low oil absorption when compared to other fries.

Keywords: French fries, Frozen French fries, Snack, Potato.

56 DISTINCT NICKEL-PRECURSOR SYNTHESIZED NIO NPS ON THE DEGRADATION OF BIOLOGICAL STAINING DYES: A GREEN ROUTE

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Abstract:

This study examines the influence of nitrate and chloride precursors on the production of nickel oxide nanoparticles (NiO NPs) by an environmentally friendly method employing *Tectona grandis* leaf extract. The findings indicated that the selection of the initial precursors had a substantial impact on the crystalline structure, phase composition, shape, and optical characteristics of the NiO nanoparticles. The creation of cubic and rhombohedral crystal structures for the nitrate and chloride precursors, respectively, is demonstrated by X-ray diffraction investigation. Like the various crystal formations, microscope images of NiO nanoparticles also display nanorods and well-aligned spherical shapes. The study investigated the photocatalytic breakdown process, adsorption, and point-of-zero charges of several cationic and anionic biological staining agents. The point of zero charge examination of the produced samples revealed the specific attachment of the dye molecules. The maximum degradation percentages of Xylenol orange, Congo red, Crystal violet, and Acridine orange are 97.79%, 86.2%, 88.41%, and 88.44%, respectively. These percentages were achieved after 100 minutes of sun irradiation using NiO NPs mediated by a nitrate precursor. The findings have significant implications for creating efficient and eco-friendly techniques to break down biological staining agents utilizing nickel oxide nanoparticles (NiO NPs).

Key words: Nickel oxide nanoparticles; Photocatalytic activity; anionic and cationic dyes, staining dyes

57 COMPARATIVE STUDY ON COCOA BUTTER AND SHEA BUTTER IN CONFECTIONERY PRODUCTS

Chandini R, Swetha R, Jony Blessing Manoj J, Sri Mohana Priya K K

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Abstract

This study aims to compare the quality attributes of cocoa and Shea butter-infused dark chocolates through a comprehensive analysis. Proximate analysis, including ash, moisture, and protein content, provides insights into the nutritional composition. Physicochemical assessments such as texture, colour, and water activity contribute to understanding the physical characteristics of the chocolates. A particular focus is placed on sensory analysis, aiming to discern preferences between cocoa and Shea butter-infused chocolates. Through meticulous evaluation, this research seeks to determine which ingredient, cocoa or Shea butter, enhances dark chocolate's overall quality, offering valuable insights for both consumers and the chocolate industry. As comparing the both butter cocoa butter over all best to infused with chocolate.

Keywords: Cocoa butter, Shea butter, dark chocolate, physicochemical assessments, texture, colour, ingredient comparison, overall quality.

58 HIGH PROTEIN MILK SOLID FROM ZEA MAYS

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Abstract

Maize is a widely popular cereal that serves as the staple food in many countries including the USA and various African nations. Its health benefits are primarily derived from the richness of nutrients it contains such as vitamins A, B, E, and several essential minerals. Maize is not only a rich source of calories, but it also provides vital nutrients that are necessary for daily metabolism. Additionally, it is noteworthy that maize oil is the most widely consumed oil in the world due to its affordability compared to other vegetable oils. Recent studies have found that maize oil has strong antioxidant properties that offer numerous health benefits. These benefits include preventing heart ailments, controlling diabetes, reducing hypertension, and preventing birth defects such as neural-tube defects. Maize oil has a high absorption rate of up to 97%, making it ideal as an edible and healthcare oil. In families across Europe and the USA, maize germ oil is often chosen as the primary source of edible oil thanks to its excellent nutritional value. Maize continues to attract interest from breeders and researchers due to its significance in the human diet. Countless studies have been conducted in various areas related to corn, and results continue to emphasize its importance as a nutrient-rich food source. In conclusion, maize is an essential cereal that provides crucial nutrients for daily metabolism and serves as a source of affordable and healthy oil with proven health benefits.

59 COTTON BED SPREADS TREATED WITH ACHYRANTHES ASPERA AND SENNA AURICULATA: ECO-FRIENDLY COMFORT FOR SHORE-BASED PATIENTS AND SENIOR CITIZENS

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Abstract

This research investigates the utilization of *Achyranthes aspera* and *Senna auriculata* in treating cotton fabric bedspreads for shore-based patients. Initially, cotton fabric in its grey form undergoes desizing, scouring, and bleaching using conventional methods to prepare it for dyeing. The plant extracts, known for their potent anti-bacterial and anti-fungal properties, are then applied in paste form to the fabric. Following proper curing processes, the fabric undergoes evaluation for wash and light fastness properties, as well as anti-toxicity tests. Subsequently, the treated bedspreads are distributed to the medical and healthcare sectors. The study reveals significant improvements in comfort properties, indicating the potential for eco-friendly and comfortable bedding solutions for shore-based patients.

Keywords: Cotton fabric, *Achyranthes aspera*, *Senna auriculata*, bio natural sustain materials, finishing treatment

60 THE MECHANISM OF WHEY PROTEIN AND BLUEBERRY JUICE MIXED SYSTEM FERMENTED WITH LACTOBACILLUS INHIBITING ESCHERICHIA COLI DURING STORAGE

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Abstract

The aim of this study was to identify the antimicrobial effect and mechanism of whey protein and blueberry juice mixed systems fermented with Lactobacillus against Escherichia coli during storage. The whey protein and blueberry juice mixed systems were fermented with *L. casei* M54, *L. plantarum* 67, *S. thermophiles* 99 and *L. bulgaricus* 134 and had different antibacterial activities against *E. coli* during storage. The antimicrobial activity of the mixed whey protein and blueberry juice mixture systems was the highest, with an inhibition zone diameter of approximately 230 mm, compared with the whey protein or blueberry juice systems alone. There were no viable *E. coli* cells 7 h after treatment with of the whey protein and blueberry juice mixed systems as determined by survival curve analysis. Analysis of the inhibitory mechanism showed that the release of alkaline phosphatase, electrical conductivity, protein and pyruvic acid contents, and aspartic acid transaminase and alanine aminotransferase activity in *E. coli* increased. These results demonstrated that these mixed systems fermented with Lactobacillus, especially those containing blueberries, could inhibit the growth of *E. coli* and even cause cell death by destroying the cell membrane and cell wall.

61 ENHANCED PHOTODEGRADATION OF ORGANIC POLLUTANTS USING MOS₂-SNS₂ HETEROJUNCTION PHOTOCATALYST UNDER VISIBLE LIGHT IRRADIATION

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Abstract

In this study, MoS₂-SnS₂ heterojunctions were synthesized via hydrothermal methods and characterized for their fundamental properties. Analysis using XRD, XPS, SEM, TEM, UV-Vis DRS, and PL techniques revealed the crystal structure, chemical composition, optical properties, and morphology of the prepared catalysts. The photocatalytic activity of the synthesized catalyst was evaluated using Methylene Blue (MB) as the model pollutant. The MoS₂-SnS₂ heterojunctions exhibited remarkable photocatalytic efficiency, achieving an efficacy of 96.7%, surpassing individual MoS₂ (82.7%) and SnS₂ (43.8%) catalysts. Additionally, the MoS₂-SnS₂ heterojunction displayed the highest photodegradation efficiency (expressed as K_{app}) with a rate constant of 0.0344, in contrast to MoS₂ (0.0185) and SnS₂ (0.0060). This enhancement can be attributed to a synergistic effect that significantly reduces the recombination of photoexcited charge carriers, thereby enhancing visible light absorption. Furthermore, stability tests revealed that the MoS₂-SnS₂ heterojunction catalysts maintained excellent stability over five consecutive cycles. A plausible photocatalytic reaction mechanism for the MoS₂-SnS₂ heterojunction was proposed based on experimental results. This study demonstrates the promising potential of MoS₂-SnS₂ heterojunctions as future photocatalysts for the efficient degradation of organic pollutants under visible light irradiation.

62 NUTRACEUTICALS AND MENTAL HEALTH: EXPLORING THE INTERSECTION FOR HOLISTIC WELLBEING

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Abstract

In recent years, the exploration of nutraceuticals as adjunctive or standalone interventions for mental health concerns has gained significant traction. This paper offers a comprehensive exploration of this burgeoning field, aiming to elucidate the intricate relationship between nutraceuticals and mental wellbeing. Through a synthesis of current research findings and theoretical frameworks, it delves into the mechanisms by which various nutrients and bioactive compounds influence brain function and emotional regulation. The abstract outlines the multifaceted roles of specific nutraceuticals, including omega-3 fatty acids, vitamins, minerals, amino acids, and herbal extracts, in modulating neurotransmitter pathways, reducing neuroinflammation, mitigating oxidative stress, and promoting neuroplasticity. It elucidates the potential efficacy of nutraceutical interventions in alleviating symptoms associated with depression, anxiety, mood disorders, and cognitive decline.

63 ROLE OF PREBIOTICS AND PROBIOTICS IN HEALTH AND NUTRITION: AN OVERVIEW

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Abstract

Prebiotics and probiotics plays a positive role in promoting human nutrition and health. Prebiotics are compounds that cannot be digested by the host, but can be used and fermented by probiotics, so as to promote the metabolism of intestinal probiotics for the health of gut and body. They play a pivotal part in human and animal physiology through influencing digestion, immune development, vitamin production, and likely behaviour and mental wellbeing. These beneficial microbes to help solve global problems, such as reducing the risk and impact of disease (including viruses and pandemics) and removing drugs and toxins from our food and environment.

Probiotics can adjust the structure of human intestinal microorganisms and inhibit the colonization of pathogenic bacteria in the intestine. Probiotics show ability to help the body build a healthy protective layer of intestinal mucosa, enhancing the intestinal barrier effect and improving immunity. Prebiotics have the function of improving the regulation of immunity, resisting pathogens, influencing metabolism, increasing mineral absorption, and enhancing health. Emerging prebiotics are mainly found in algae, fruit juice, peels, seeds, traditional Chinese medicine, and microorganism involving polysaccharides, polyphenols, and polypeptide polymers.

Keywords: Prebiotics, probiotics, health, gut bacteria, colonization, regulation, enhancing.

64 LEAD (II) ION REMOVAL FROM WATER THROUGH BIOSORBENT CARBON

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Abstract

The aim of this study is to explore the efficacy of adsorption, particularly utilizing biosorbent carbon, for the removal of lead (II) from wastewater. Adsorption presents a promising approach due to its capability to eliminate both organic and inorganic impurities from aqueous systems, provided suitable carbon is employed. The proposed research aims to specifically target the removal of toxic trace inorganic metal ions like lead from aqueous solutions. Overall, this research aims to contribute to the understanding and advancement of wastewater treatment techniques, particularly in the context of heavy metal removal. By focusing on lead (II) ion removal using biosorbent carbon, the study seeks to offer insights that could potentially inform and improve water purification practices, thereby addressing environmental and health concerns associated with heavy metal contamination in water bodies.

Keywords: Adsorption, Bio-sorbent carbon, Lead (II) removal, Wastewater treatment, Heavy metals.

65 PHYTO – FABRICATION OF MgO NPS USING VARIOUS SEEDS FOR ANTIMICROBIAL AND WATER TREATMENT APPLICATIONS

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Abstract

In this work, magnesium oxide nanoparticles were synthesized by simple sonication-assisted green synthesis utilizing Strychnous potatorum, Moringa oleifera seed extracts, and combined extract. Magnesium chloride is changed into magnesium oxide by the different phytochemicals, which include sterols, alkaloids, and polyphenols, by decreasing and covering the surface of the magnesium metal ions. The surface area, surface charge potential, crystal clarity, structural features, band gap, particle size, morphology, and porosity details of the produced MgO nanoparticles were all revealed using a variety of analytical methods. The kind of seed extract that is used for reduction during green synthesis has a major influence on these characteristics. The antibacterial properties of generated MgO NPs were investigated at various concentrations with the aid of the microorganisms Staphylococcus aureus and Escherichia coli. With an effectiveness of 96% and 96%, respectively, the MgO-M NPs (SP-MO mixed extract) had the core zone of inhibition against both bacteria among the MgO NPs. MgO-M has a higher antioxidant property of 91% according to the DPPH scavenging activity. Under solar radiation and with different MgO NPs present, the photocatalytic degradation of Congo Red and malachite green was investigated for 120 minutes. Based on the data, it was suggested that MgO-M NPs had significant photocatalytic activity, breaking down the dye's malachite green and Congo red. Through XRD and FTIR measurements, MgO NPs were shown to have kept their structural phase stability and functional properties during dye degradation.

Keywords: MgO NPs; surface properties; antimicrobial activity; photocatalytic dye degradation

66 THE EFFECT OF MODIFIED YARN PATH, TWIST LEVEL AND INCREASED NUMBER OF DRAWFRAME PASSAGES ON THE HAIRINESS OF POLYESTER COTTON BLENDED YARN

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Abstract

Hairiness is a critical quality parameter of spun yarns which affects their weaving and knitting performance and also the quality of resultant fabrics. There has been significant interest in minimizing hairiness to improve both yarn and fabric quality. Parameters in ring spinning and the number of drawframe passages influence the hairiness of ring spun yarn. In this work, process parameters on the ring spinning machine and the number of drawframe passages for processing 27 Nm of 60:40 polyester cotton blended yarn were modified and their effect on hairiness was studied. The hairiness index (H) was measured by Uster Tester 5. The existing company parameters of 620 twists per meter (TPM), normal yarn path, 125mg traveller weight and two drawframe passages gave a hairiness index of 6.6. The hairiness showed a reduction by 15% with an index of 5.6 for three drawframe passages and 660 TPM, with the existing normal yarn path and 125mg traveller weight. The left diagonal yarn path gave a reduction of 13% in hairiness for the existing parameters of two drawframe passages, 620 TPM and 125mg traveller. The effect of a twist level of 660 TPM gave a reduction of about 12% in hairiness with the existing two drawframe passages, normal yarn path and a traveller weight of 125mg. No significant change in hairiness was seen with a right diagonal yarn path and with a higher twist level of 700 TPM for the existing parameters. Yarn strength and evenness remained unaffected for the parameters which resulted in hairiness reduction.

Keywords: Polyester Cotton, Yarn Hairiness, Ring Spinning, Twist, Yarn Path.

67 EFFECT OF SILICA SOL ON MgO/PVA NANOCOMPOSITE FILM FOR ADSORPTION AND REDUCTION OF CO₂ AND HYDROCARBON IN VEHICLE EXHAUST

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Abstract

Capturing CO₂ from the atmosphere is a key to solve the global warming problem/transforming it into chemical products. This study investigates the impact of incorporating Silica sol into Magnesium Oxide (MgO) and Polyvinyl alcohol (PVA) nanocomposite film for enhancing CO₂ adsorption and reduction capabilities. The prepared Magnesium Oxide (MgO) nanoparticles are infused with Silica sol to enhance the morphology,

surface area, porosity features and adsorption properties of the nanocomposite. PEG makes possible the assembly of microporous silica in the pH region of stable sols. The nanocomposite film made of PVA which combines with nanometal oxides for adsorption/reduction of pollutant from vehicle exhaust. The adsorption and reduction performance of CO₂ is evaluated through various characterization techniques.

68 STACKED G-C₃N₄ NANORIBBONS EMBEDDED IN MgO NPS FOR THE DEGRADATION OF INDUSTRIAL DYE EFFLUENT

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Abstract

This study proposes a sustainable approach for the creation of MgO nanoparticles, using an exfoliated g-C₃N₄ nanocomposite as a supportive material. The synthesis of MgO NPs resulted in the formation of cubic and hexagonal face structures, specifically g-C₃N₄ nanoparticles, which exhibited a spherical and coiled ribbon-like shape, respectively. Similarly, optical characteristics were attained with energy gaps of 3.42, 2.48, and 2.78 eV. The purity of the nanocomposite is confirmed using XPS analysis, which detects the typical elemental peaks. Furthermore, the catalysts were used to break down cationic dye (crystal Violet) and anionic dye (eosin yellow) under the influence of sunlight. The nanocomposite had a notable impact on its capacity to facilitate the breakdown of crystal Violet and eosin yellow dye by photocatalysis, with an efficiency of 98.9% and 97.33% respectively. Therefore, the increased surface area of the active site and the presence of the UV-visible region in the nanocomposite perform it more suitable for the use in the treatment of dye effluents. This study demonstrates that the photocatalyst has great potential as a material for wastewater treatment.

69 THE ENRICHMENT OF TRIGONELLA FOENUM-GRAECUM A MICROGREEN VEGETATION USING COCOPEAT ANALYZED UNDER HERMETIA ILLUCENS FRASS COMPOST AND ZNO MATERIAL

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Abstract

The natural growth of food product in various methods and materials, under suitable temperature at certain periods. High nutrient contains Trigonella foenum-graecum yields in microgreen method. Along with Cocopeat included instead of soil materials, comparatively coco coir excels in both water retention and drainage but in some soil retain more water. Hermetia illucens frass compost is extracted and turned it as dilute matter, this will enrich the Coco-peat material. The research explores the impact of Coco-peat on Trigonella foenum-graecum conjunction with Hermetia illucens frass extract with 0.5g of ZnO able to produce high rich vegetation plant. 5 parts of containers with different concentration of diluted frass compost combine with 0.5g Zn metal oxide, continuous of 15 containers adding of Coco-peat and mixed ZnO and BSFL frass in ratio of 1:5, 1:10, 1:15, 1:20, and 1:25. Which shows as speed and intensity of Cucumber plant. Maintaining growth of microgreens under sunlight is very important, mixer of frass compost in dilute form is more efficiency than the solid form of frass compost.

70 ANTI FOULING & CORROSION PREVENTION ON MAGNESIUM PLATE USING TiO₂ COATING ON MARINE METAL SURFACE

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Abstract

Anti-Biofouling is the undesirable deposition of biologically active organisms like bacteria, fungus, and viruses on surfaces such as marine constructions, medical devices, and water treatment facilities. Toxins, such as arsenic, mercury and tributyltin, were used as antifoulants on ship hulls but they are very harmful to both human and Environment. To prevent or impede biofouling several technologies have been developed, including toxic biocides, antifouling coatings, and chlorine treatment. This, Antifouling coatings, biocidal coating using nano particle Anti-biofilm formation have been developed to protect the fouling erosion. The TiO₂ is synthesized via green method it is calcinated at 650 degree for 3 hrs it obtains the anatase phase, spherical morphology structure. It has Optical, adhesion mechanical, thermal barrier property on humid climate condition, corrosion Resistance on aquatic medium. The X-ray diffraction confirms the formation of tetragonal anatase phase structure of The average crystalline size 12 nm of was determined using Scherrer's formula. In magnesium plate, epoxy coating, pure coat of TiO₂ has done to analyse corrosion study for Each sample with different concentration 10, 20, 30 Mg for 1 month. Corrosion analysis where measured using different water medium like NaCl water, sludge water then the corrosion rate per year is measured for magnesium plate coated with epoxy, pure.

KEYWORDS: Nano particles, biocides coating, Anti biofilm, epoxy coat, magnesium plate.

71 ADVANCE STROKE MANAGEMENT USING IOMT

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Abstract

If heat stroke is ignored, it can have a major negative impact on our health. It may seriously harm the central nervous system, which may lead to a host of further issues. Even with intensive treatment, heat stroke can still be lethal. To date, a number of methods have been employed to identify heat stroke and stop accidents, including ADAS (Automated Accident Detection and Alarm System) and Wearable Device for Heat Stroke Detection (WHDD). The primary focus of this research is on vehicle drivers' identification of heat stroke. The system suggests an architecture that is split into two sections that measures the user's body temperature using two separate temperature sensors. To prevent serious issues down the road, it is critical to understand in the early phases.

Keywords : Hearts Stroke, CNS damage, WHDD, ADAS, Temperature Sensors

72 GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM LEPTOGIUM MARGINELUM (SW) ENHANCING RADICAL SCAVENGING POTENTIAL AND LARVICIDAL ACTIVITY AGAINST THREE MOSQUITO SPECIES- Anopheles stephensi Culex quinquefasciatus AND Aedes aegypti.

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Abstract:

The present study was aimed to test efficacy of *Leptogium marginellum* (Lm) extract and synthesized silver nanoparticles (AgNP's) against mosquito larvae. The study includes the extraction of secondary metabolites from Lm and synthesis of AgNP's, followed by testing its antioxidant efficacy using DPPH, FRAP, and H₂O₂. The synthesized LmAgNP's was measured for its Surface Plasmon Resonance and the peak was observed at 428nm. FTIR results recorded a downward shift of absorbance band between 450-4000 cm⁻¹ indicated the formation of LmAgNP's which are spherically shaped with a size range from 150-200 nm confirmed using FESEM. Further, XRD analysis demonstrated LmAgNP's are highly crystalline and exhibit a cubic, face centered lattice with characteristic (111),(200), (220) and (222) orientation. The bio-reduction of silver ions in solution was monitored by EDX. The zeta potential value was found to be -3.08 mV representing AgNP's were highly stable. Radical scavenging results revealed that the extracts and AgNP's demonstrated potent scavenging ability evidenced by DPPH, FRAP and H₂O₂ radical assay. Lm fractions and LmAgNP's exhibited dose dependent larval mortality, highest mortality was observed in ethylacetate fraction against *Anopheles stephensi* (IC₅₀=34.66; IC₉₀=158.647), followed by *Culex quinquefasciatus* (IC₅₀=40.085; IC₉₀=213.777) and *Aedes aegypti* (IC₅₀=70.673; IC₉₀=248.836). Larvae treated with LmAgNP's at different concentration represented potent mortality but at 500 ppm concentration demonstrated significant mortality with 88, 94.4, 98.4% mortality with highest activity against *Anopheles stephensi* (IC₅₀=47.41) followed by *Aedes aegypti* and *Culex quinquefasciatus* (IC₅₀=71.66; IC₅₀=74.44). Based on the present findings it is suggested that the fractions and AgNP's of Lm is effective in inhibiting the growth of mosquito larvae.

Keywords: Lichen, *Leptogium marginellum*, silver nanoparticles, FESEM, Antioxidant, Larvicidal activity.

73 RADICAL SCAVENGING ABILITY AND ANTIBACTERIAL EFFICACY OF GREEN SYNTHESIZED SILVER NANOPARTICLES FROM MUNTINGIA CALABURA - AN IN VITRO APPROACH

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Abstract:

The present study was aimed to test efficacy of *Leptogium marginellum* (Lm) extract and synthesized silver nanoparticles (AgNP's) against mosquito larvae. The synthesized LmAgNP's was measured for its Surface Plasmon Resonance and the peak was observed at 428nm. FTIR results recorded a downward shift of absorbance band between 450-4000 cm⁻¹ indicated the formation of LmAgNP's which are spherically shaped with a size range from 150-200 nm confirmed using FESEM. Further, XRD analysis demonstrated LmAgNP's are highly crystalline and exhibit a cubic, face centered lattice with characteristic (111),(200), (220) and (222) orientation. The bio-reduction of silver ions in solution was monitored by EDX. The zeta potential value was found to be -3.08 mV representing AgNP's were highly stable. Radical scavenging results revealed that the extracts and AgNP's demonstrated potent scavenging ability evidenced by DPPH, FRAP and H₂O₂ radical assay. Lm fractions and LmAgNP's exhibited dose dependent larval mortality, highest mortality was observed in ethylacetate fraction against *Anopheles stephensi* (IC₅₀=34.66; IC₉₀=158.647), followed by *Culex quinquefasciatus* (IC₅₀=40.085; IC₉₀=213.777) and *Aedes aegypti* (IC₅₀=70.673; IC₉₀=248.836). Larvae treated with LmAgNP's at different concentration represented potent mortality but at 500 ppm concentration demonstrated significant mortality with 88, 94.4, 98.4% mortality with highest activity against *Anopheles stephensi* (IC₅₀=47.41) followed by *Aedes aegypti* and *Culex quinquefasciatus* (IC₅₀=71.66; IC₅₀=74.44). Based on the present findings it is suggested that the fractions and AgNP's of Lm is effective in inhibiting the growth of mosquito larvae.

Keywords:

Lichen, *Leptogium marginellum*, silver nanoparticles, FESEM, Antioxidant, Larvicidal activity.

74 SYNTHESIS OF SILVER NANOPARTICLES FROM CYANOBACTERIA AND THEIR ACTIVITY AGAINST ANTIOXIDANT AND ANTI-INFLAMMATORY FUNCTIONS: A COMPREHENSIVE CHARACTERIZATION STUDY.

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Abstract:

The synthesis of nanoparticles using biological organisms has garnered considerable attention due to its eco-friendly and sustainable nature. Among various nanoparticles, silver nanoparticles (AgNPs) hold significant

interest due to their broad spectrum of applications, including biomedical and environmental fields. This current research focuses on the synthesis of silver nanoparticles from cyanobacteria and their potential effects on antioxidant and anti-inflammatory activities. The confirmation of silver nanoparticle synthesis within the cyanobacteria culture is established through UV-Vis spectroscopy, the AgNPs solution reveal an absorption peak within the visible spectrum at 420 nm. FTIR result of synthesised AgNPs reveals the presence of wave numbers between 3313.7 cm⁻¹ to 588.3 cm⁻¹ which is indicate the presens of functional group OH and C-H as capping agent. Zeta potential investigations were employed to analyse the surface charge chemistry and stability of AgNPs, revealing a negative charge of -12.6 mV. The negative zeta potential observed in the silver nanoparticles could result from the potential encapsulation of bioorganic components found in the cyanobacteria extract. HR- TEM results confirm the morphology of AgNPs as almost spherical with high surface areas and average size of 20 to 300nm. . The free radical scavenging activity of the AgNPs extract was assessed using various in vitro assays. The percentage inhibition of the AgNPs confirmed antioxidant potential with the percentage inhibition 70.78%,78.24%,80.70% & 66.44% for the sample concentration of 100µg/ml, 80100µg/ml, 100µg/ml and 80µg/ml against DPPH, Phosphomolybdenum, H₂O₂ and FRAP. The results of the biological activities of AgNPs exhibited dose dependent activity with 76.49%, for the sample concentration is 100µg/ml, anti-inflammatory activity by protein denaturation assay. The antioxidant and anti-inflammatory properties of AgNPs nanoparticles highlight their potential for the development of novel therapeutic interventions.

Keywords:

Cyanobacteria, AgNPs, Anti-Oxidant and Anti-Inflammatory activity, Green synthesis.

75 COMPARATIVE STUDY OF THE ABSORPTION OF NITROSAMINE BY ACTIVATED CHARCOAL FROM COCOS NUCIFERA AND SUGARCANE BAGASSE

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Abstract:

Nitrosamines are organic compounds known for their carcinogenic properties. In the rubber industry, the presence of nitrosamines is primarily linked to the formation of rubber and rubber products during the vulcanization process. This study investigates the synthesis and characterization of activated carbon derived from *Cocos nucifera* (coconut shell) and *Saccharum officinarum* (sugarcane bagasse) and evaluates their efficacy in the adsorption of N-nitrosamines, compounds often formed during the vulcanization process in the rubber industry. The synthesis process involves the pyrolysis of raw materials at 700°C, followed by chemical activation, resulting in activated carbon with high surface area and porosity. The BET surface area for activated carbon from *Cocos nucifera* was found to be 995.799 m²/g with a total pore volume of 0.372 cm³/g and an average pore radius of 9.011 Å. For sugarcane bagasse-derived activated carbon, the BET surface area was 822.822 m²/g, with a total pore volume of 0.238 cm³/g and an average pore radius of 8.010 Å. Proximate and ultimate analysis revealed that activated carbon from coconut shell had a significant increase in fixed carbon content (78.905%) compared to its raw precursor (40.323%), with reduced moisture (2.627%) and ash content (0.902%). Similarly, the activated carbon from sugarcane bagasse showed an increase in fixed carbon content (65.320%) and a decrease in moisture (1.321%) and ash content (2.023%) compared to its raw form. The adsorption capacity tests demonstrated that activated carbon from both sources exhibited high efficacy in adsorbing N-nitrosamines, attributed to their developed porous structures and significant surface areas.

Characterization using FTIR confirmed the presence of functional groups essential for adsorption processes, while GC-MS analyses measured the efficacy of N-nitrosamine adsorption, showing substantial reductions in these compounds in treated samples. This comparative study highlights the potential of using agricultural waste materials for producing activated carbon, presenting a sustainable approach to environmental remediation, especially in mitigating the harmful effects of industrial pollutants like N-nitrosamines. Both *Cocos nucifera* and *Saccharum officinarum*-derived activated carbons proved to be effective adsorbents, offering a viable solution for pollution control in the rubber industry and beyond.

Keywords: *Cocos nucifera*, Sugarcane bagasse, Activated carbon, Physical Adsorption, FTIR, Nitrosamine, Natural rubber, Isopropene, Rubber vulcanization, Carcinogen.

76 DEVELOPMENT OF ALGAL AND RICE STRAW PULP FOR HANDCRAFTED PAPER PRODUCTION

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Abstract:

The viability of utilizing algal pulp and rice straw to make handmade paper, highlighting their sustainability and practicality as resources in place of more traditional materials. This study aims to assess the potential benefits and challenges of integrating these unconventional resources into papermaking processes by means of a comparative analysis that considers resource, economic, and environmental considerations. Important insights are disclosed by a thorough examination of the chemical compositions of the raw materials, hand sheet physical characteristics, and bleaching techniques. This study shows that, in comparison to rice straw pulp, which achieves 82% brightness, and algae pulp, which achieves 85% brightness, non-chlorine bleaching procedures provide greater brightness levels. This implies a bleaching procedure that is more ecologically friendly than those that rely on chlorine. An analysis of the characteristics of paper shows that rice straw has 40.6% cellulose, 18.9% hemicellulose, and 5.2% lignin, whereas algal pulp has 35.2% cellulose, 12.4% hemicellulose, and 3.8% lignin. With the exception of their differing lignin contents, both materials have industrial applications in mind. Rice straw helps reduce pollution and divert trash, while algal pulp offers scalability and low resource needs. The eco-friendliness of rice straw paper is shown by its 78% rate of deterioration compared to the 85% rate of degradation of algae paper. The significance of employing sustainable biomass sources for paper manufacturing is highlighted by these results, which also recognize the need for more study and funding to improve processing techniques and increase output.

Keywords:

Algal pulp, rice straw, handmade paper production, cellulose, hemicellulose, lignin, biodegradation, sustainable paper production.

1 INTRODUCTION

The utilization of sustainable materials in paper production has garnered significant attention due to growing environmental concerns and the need for resource efficiency. Algal pulp and rice straw have emerged as promising alternatives to conventional wood pulp, offering potential advantages in terms of renewability, abundance, and eco-friendliness. As the demand for eco-conscious products continues to rise, evaluating the feasibility and efficacy of incorporating algal pulp and rice straw in handcrafted paper production becomes

imperative. This introduction provides an overview of the research landscape surrounding the evaluation of these sustainable materials and sets the stage for a comprehensive analysis of their applicability in the papermaking industry.

Algal pulp, derived from algae biomass, presents a sustainable solution for paper production, offering scalability and minimal environmental impact compared to traditional wood-based pulping methods (Patil, Patel, and Kumar, 2020). Additionally, algal biomass cultivation does not compete with food crops and can be cultivated in various aquatic environments, further enhancing its sustainability credentials (Bharti, Kumar, and Pant, 2019).

On the other hand, rice straw, an abundant agricultural residue, holds immense potential as a raw material for papermaking, providing an alternative to the burning of straw, which contributes to air pollution (Chen et al., 2020). Utilizing rice straw in paper production not only mitigates environmental pollution but also adds value to agricultural waste streams, promoting a circular economy approach (Wondraczek and Dusold, 2020).

While both algal pulp and rice straw offer promising attributes for sustainable paper production, their integration into handcrafted paper processes requires careful evaluation of their chemical composition, processing techniques, and resulting paper properties. This necessitates a systematic approach to assess the feasibility and potential challenges associated with utilizing these materials in handmade paper production.

Against this backdrop, this study aims to critically evaluate the suitability of algal pulp and rice straw in handcrafted paper production through a comprehensive analysis of their characteristics, processing methods, and paper properties. By examining the viability of these sustainable materials, this research contributes to advancing the sustainability agenda in the papermaking industry and promotes the adoption of environmentally friendly practices.

2 MATERIALS AND METHODS

Sample collection and raw material preparation

The raw material used for this research was algae and rice straw. The algae was collected from an aquaculture pond from nearby village Varapalayam, Tiruchengode at Namakkal District. The algae was rinsed with tap water to remove grit and deposits before use, then laid flat and sun-dried until the moisture content was less than 10%. The rice straw was collected from a common species (*Oryza sativa*) from nearby village Varapalayam, Tiruchengode at Namakkal District. The rice straw was cut from and chopped in small pieces (2–3 inch) using a clean kitchen knife. Sun dried for about 3/4 days in the open air before being cooked.

Algae and rice straw pulp cuisine conditions

The dried or cleaned algae (100 g) were cooked with 1.5 l detergent at 95°C. The algal residue that was performing was treated with one H₂O₂ (ground on dry algae weight) and hotted for two hours. The detergents included: 1) NaOH (5, 10, or 20 grounded on dry algae weight) cooked for four hours; 2) Na₂SO₃ (5, 10, or 20 grounded on dry algae weight) cooked for four hours; and 3) NaOH (5, 10, or 20 grounded on dry algae weight) cooked for two hours. Following cooking, the algae were separated, impartially cleaned with distilled water, and dried as algal pulp for eight hours at 50 degrees Celsius. Additionally, in a mixing blender, 8 liters of distilled water (or around 3.57 dry mass base) were combined with 250 grams of dry algal pulp. Three estimates were made for each parameter.

1. After irrigating cooked pulp with distilled water, remove as important water as possible. Retain some NaOH in the pulp.
2. Maintain a pH in the range of 9.5 and 11. It was stylish not to wash the pulp too much.

Bleaching algae and rice straw pulp with both chlorine and non-chlorine bleaching

Chlorine bleaching

Preparation of liquid chlorine bleach

About 3.5% solution of chlorine was diluted to 2% solution.

Amount = 2% × 500 ml = 285 ml

3.5%

Added 285 ml of chlorine water to 215 ml of water to make up the volume to 500 ml and this liquid chlorine bleach was used for further analysis.

Preparation of Pulp bleaching with Sodium hypochlorite

About 5.25% solution of sodium hypochlorite was diluted to 2%

Volume = 2% × 500 ml = 190 ml

5.25%

Added 190 ml of sodium hypochlorite to 310 ml of distilled water to make up the volume to 500 ml .

To ensure that bleach work effectively at least a 12% consistency was prepared and worked this out to be 10 grams of pulp for every 85 milliliters of solution. Placed the mixture in a blender. Blend to pulpy consistency. Blending the pulp with the bleach solution will increase the surface area of the fibres and improve the bleaching efficiency.

The reaction/degradation of lignin with bleach (NaOCl) was improved when the mixture was heated between 35° C and 75°C but not boiled. It takes between 30 and 90 minutes to complete the bleaching reaction. The longer the time, the whiter the pulp. Keep the mixture hot throughout the process. Blend the mixture before rinsing.

Rinse the bleached pulp thoroughly. Most of the bleaching chemicals will be used up in the bleaching process. Rinsing should remove any residual bleach from the pulp.

Non chlorine bleaching

Non-chlorine bleaching using Sodium percarbonate

It was more environmentally friendly approach. Measured out 30g of the crystals to mix 500 ml of solution. Added enough hot water to make up to 500ml. Add crystals then water to make the solution.

Consistency = 12%. This work out to about 10g for every 85 ml of solution.

500 ml × (10 g/ 85 ml) gives approximately 60 g of pulp.

The pulp was mixed with solution and blended in a blender to increase surface area and improve bleaching action. Sodium percarbonate decolorized chromophores. It bleaches in a non-delignifying manner and preserves the pulp yield. Stir mixture periodically and keep it hot (60- 90° C). A pH of 9- 11.5 was ideal. 30-90 minutes was given as a bleaching time. The more time of reaction gives the brighter and whiter pulp.

The solution was blended to a pulp consistency prior to rinsing. Percarbonate produce hydrogen peroxide which is a powerful bleaching agent. It bleaches in a non-delignifying manner and thus preserves the pulp. The removal of chromophores results in a brighter and not necessarily whiter pulp.

Bleaching of algae and Rice straw pulp using Hydrogen peroxide

5% dynamic hydrogen peroxide was utilized by dry weight of the fabric. Temperature, time term , and introductory pH were kept up around 80°C, 1hr, and 12 separately. The pH was controlled by the expansion of sodium hydroxide.

HAND SHEET PREPARATION

The holder was filled around midway with dyed mash. Include more water. The thickness of the paper is decided by the mash to water proportion. Sheets were made with a form and deckle, which are two comparable outlines with a screen connected to one of them. Holding up the shape screen, equally organize the deckle on best. Holding them both at a 45-degree point, the form was plunged, deckled to the foot of the vat, and after that up whereas being held evenly. To adjust the filaments and create a more uniform sheet, it was shaken briefly from cleared out to right and back and forward whereas being evacuated from the slurry. Stop shaking as soon as the sheet starts to drain. Allow the water to slowly come to a halt.

Couching

"Couching" is the method of moving the damp sheet from the mold to a surface that's smooth and permeable. Separated from fleece felts, which are culminate, extra choices incorporate fleece covers, smoother towels, thick paper towels, non-fusible meddle or pellow, sham-wows, or bed cloths. Orchestrate the materials for framing on a board that has felt underneath. Extricate the duck from the shape. Position the long edge of the shape onto the felt. Position the shape with its confront down, apply weight, and instantly drag off the primary edge.

Pressing

Put the naturally framed sheet over the paper towel. Apply as small weight as conceivable with a wipe at to begin with, and after that much as you'll.

Drying

Place the wet sheet and gently press it against a non-porous surface or smooth wood planks. The edges should be firmly pressed. Depending on the humidity and the paper's thickness, let the paper dry for 1-3 days. Shed it off.

Sizing and polishing

Sizing and Polishing are the two most critical after wraps up given to the carefully assembled sheets after drying. Sizing may be a that can give paper shifted degrees of dampness resistance. In two stages of the papermaking prepare, estimate can be expanded. The degree of estimate of paper influences how safe it is to dampness penetration. Sizinging prepare makes strides the quality of paper and makes the surface more appropriate for composing. Starch made from rice and sorghum was majorly utilized. There are two types of Sizing

1. Internal/engine/beatersizing
2. Tub sizing.

Estimation of cellulose (Das et al., 2014)

1g of cellulose was splashed in a 5% NaOH (w/v) arrangement after being oven-dried for 4 hours at 105 °C and at that point refrigerated for 5 hours in a nonhygroscopic desiccator (fiber to arrangement w/w proportion: 1:30). The fabric was neutralized with 10% H₂SO after cooling. After a exhaustive cleaning, the leftover biomass was treated with a 2% H₂O₂ arrangement arranged in a pH-9 NaHCO₃-Na₂CO₃ buffer framework for five hours at room temperature. To accomplish a steady weight, the biomass was over and over cleaned and dried at 105 °C. The weight differential was utilized to calculate the cellulose substance. Three free estimations were made on each test.

Estimation of hemicellulose (L. Boopathi et al., 2012)

One gram of the extractive-free test was bubbled for four hours in 0.5 M NaOH. To get a uniform weight, the substance was neutralized after numerous washes with refined water and at that point dried at 105 °C. Utilizing the weight differential, the hemicellulose substance was calculated. Each test experienced three distinctive measurements.

Estimation of lignin (Augustine et al., 2015)

1g of the extractive-free paper test was treated with 72% H₂SO₄ (test to destructive extent 1:12.5 w/v) taking after cautious shaking for two hours. The beat fabric was released taking after numerous weakenings and washings. The collection was filtered and dried at 105 °C in an endeavor to drive a consistent weight. The weight differential was utilized to decide the lignin substance. There were three isolated estimations for each exam. Augustine and Ayeni (2015), among others.

COMPARISON OF HAND SHEET PROPERTIES

Determination of bursting strength

The sum, extent, and scattering of strands in the paper were decided by bursting quality tests, which are habitually affected by the generation prepare, beating time, refining, fiber length, fiber sort, and expansion of surface added substances (ASTM, 1963). A direct test to decide a sheet of paper's capacity to endure weight is called its bursting quality (Paper Assignment Constrains, 1996).

Determination of breaking length

The same rules that were utilized to calculate breaking stack were too utilized in this case. The longest length that may be measured some time recently the weight of a test tube hanging at one conclusion bursts is known as the breaking length.

The breaking length in kilometers may be found utilizing the formula

$$LB = 1/9.81 \times S/g \times 103,$$

where g is the grammage, S is the ductile resistance in kN per meter, and LB is the breaking length in kilometers.

Determination of ductile strength

Careful perception is utilized to assess the most extreme control required in a research facility environment to tear a paper strip of a given width (Paper Errand Control, 1996). Utilizing the testometric fabric testing device, the malleable parameters were computed in terms of drive at top and break, strain at top and break, prolongation at crest and break, time to crest, time to disappointment, and Young's modulus.

Determination of smoothness

Timed inward breaths of a certain volume of discuss at climatic weight are utilized in the Bekk method to degree smoothness. The specimen's surface and a ring-shaped plane are uncovered to a predefined weight contrast. The ISO 5627:1995/Cor 1:2002 benchmarks state that it is measured in seconds and is done utilizing a Bekk-type smoothness tester.

Determination of grammage

The samples' grams are about indistinguishable, and the ocean growth wrack that was included to the paper mass did not cause the mass to modify by retaining dampness from the air. In some cases it's challenging to accomplish mechanical grammage precision to the moment decimal put, but since the tests are taken in a lab setting, small varieties in the results are not clear. With a standard deviation of 0.17 g/m², the normal of all comes about is 80.59 g/m².

Determination of thickness

This characteristic is closely associated to the test weight and is modifiable based on the anticipated application. For outline, the paper equation, the imaginative points of interest of the paper machine at the mechanical level, the coordinate weight at the soggy presses, and the vacuum regard at the suction boxes can all be changed. The disclosures from calculating the channel sheets' thickness arrange the discoveries from the grammage. There's reasonable a 3 μ differentiate between the lightest and most noticeable readings. The grammage and thus the thickness of the channel paper will alter based on the particulars of the application.

RESULT and DISCUSSION

Sample Collection and Raw Material Preparation:

The initial step in the methodology involved collecting samples of algae and rice straw from Varapalayam, Tiruchengode, Namakkal Locale. The algae were sourced from a monoculture lake and underwent thorough washing to remove impurities and any unwanted residues. The algae were carefully sun-dried until their moisture content reduced to less than 10%, ensuring optimal conditions for further processing. The rice straw, predominantly from the *Oryza sativa* species, was collected and diced into smaller pieces. The straw underwent a similar sun-drying process to eliminate moisture content, crucial for subsequent pulp preparation. These steps

ensured that the raw materials were free from contaminants and adequately dried, laying the foundation for the subsequent experimental procedures.

Algae and Rice Straw Pulp Cuisine Conditions:

Following the collection and preparation of raw materials, various cooking conditions were explored to convert the algae and rice straw into pulp. Different treatments involving NaOH, Na₂SO₃, and H₂O₂ were evaluated to determine their efficacy in breaking down the raw materials and yielding pulp suitable for papermaking. The cooking process, conducted at elevated temperatures, was optimized to maximize pulp yield while ensuring minimal degradation of fiber quality. Maintaining the pH within a specific range during cooking was identified as a critical factor influencing the outcome, highlighting the importance of controlling chemical parameters for efficient pulp production.

Bleaching Methods:

Bleaching with Chlorine and Non-Chlorine Bleaching:

To enhance the brightness and whiteness of the pulp, both chlorine and non-chlorine bleaching methods were employed. Chlorine bleaching involved the use of liquid chlorine bleach and sodium hypochlorite solutions, while non-chlorine bleaching utilized sodium percarbonate and hydrogen peroxide. Each bleaching agent was carefully applied under controlled conditions, considering factors such as concentration, temperature, and duration of treatment. The bleaching process was optimized to achieve the desired level of brightness while minimizing adverse effects on pulp quality. Biting the dust incorporates a chemical handle that lessens the colour of pound and is an basic step in paper creating. In the midst of standard biting the dust, lignin is balanced by reacting with essential chlorine and its backups. Stomach settling agent utilized in extraction orchestrate breaks up the separated chlorolignin compounds and evacuates the non-cellulosic materials. Squash made by chemical pulping requires wide blurring courses of action to form shinning squash (Kumar et al., 2011).The choice between chlorine and non-chlorine dying strategies advertised experiences into economical and naturally inviting papermaking hones.

Table 1: Comparison of Bleaching Methods

Bleaching Method	Algae Pulp Brightness (%)	Rice Straw Pulp Brightness (%)
Chlorine Bleaching	80	75
Non-Chlorine Bleaching	85	82

Chlorine bleaching yields a brightness of 80% for algae pulp and 75% for rice straw pulp, while non-chlorine bleaching results in higher brightness levels of 85% for algae pulp and 82% for rice straw pulp as shown in (table 1). This indicates that non-chlorine bleaching methods are more effective in enhancing brightness for both types of pulp compared to the chlorine bleaching method. The higher brightness levels obtained through non-chlorine bleaching suggest a more environmentally friendly and efficient approach to bleaching, potentially minimizing environmental impact while achieving desired pulp brightness levels.

Hand Sheet Preparation:

Hand sheet preparation involved a series of meticulous steps aimed at converting the bleached pulp into uniform and high-quality paper sheets. The bleached pulp was poured into a tub, followed by the utilization of a mould and deckle to form individual sheets. Couching, pressing, and drying processes were meticulously executed to remove excess water, compact the fibers, and achieve the desired thickness and texture of the paper sheets. These steps required precision and attention to detail to ensure consistency and uniformity across all sheets, laying the groundwork for subsequent property evaluations.

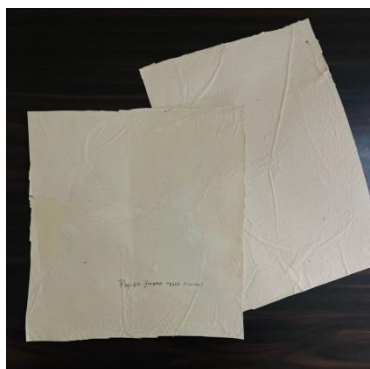


Figure 1 Handcrafted Paper from Rice straw
Algae



Figure 2 Handcrafted Paper from

Comparison of Hand Sheet Properties:

Various properties of the hand sheets, including bursting strength, breaking length, tensile strength, smoothness, grammage, and thickness, were meticulously evaluated. These properties serve as crucial indicators of paper quality and suitability for diverse applications. The results obtained from property evaluations provided valuable insights into the influence of raw material selection, processing parameters, and bleaching methods on the final paper properties. This comparative analysis facilitated the identification of optimal conditions for producing high-quality paper from algae and rice straw pulp, contributing to the advancement of sustainable papermaking practices.

Table 2: Hand Sheet Properties

Property	Algae Paper	Rice Straw Paper
Bursting Strength	2.3 kPa	2.6 kPa
Breaking Length	8.9 km	9.5 km
Tensile Strength	4.7 kN/m	5.1 kN/m
Smoothness	25 sec	30 sec
Grammage	80.2 g/m ²	82.5 g/m ²
Thickness	0.2 mm	0.22 mm

Comparing the properties of algae paper and rice straw paper, several differences are apparent. Rice straw paper generally exhibits slightly higher values across most parameters compared to algae paper. Rice straw paper demonstrates a higher bursting strength at 2.6 kPa compared to algae paper's 2.3 kPa. Rice straw paper has a longer breaking length at 9.5 km compared to algae paper's 8.9 km as shown in (fig 3). Rice straw paper displays greater tensile strength at 5.1 kN/m, whereas algae paper has a slightly lower tensile strength at 4.7 kN/m. Algae paper boasts smoother texture with a smoothness value of 25 sec, while rice straw paper has a smoothness value of 30 sec. The grammage of algae paper is slightly lower at 80.2 g/m² compared to rice straw paper's 82.5 g/m², though algae paper is thinner with a thickness of 0.2 mm compared to rice straw paper's 0.22 mm. These differences reflect the distinct characteristics of each paper type, which may influence their suitability for various applications based on specific requirements such as strength, smoothness, and thickness are shown in table 2.

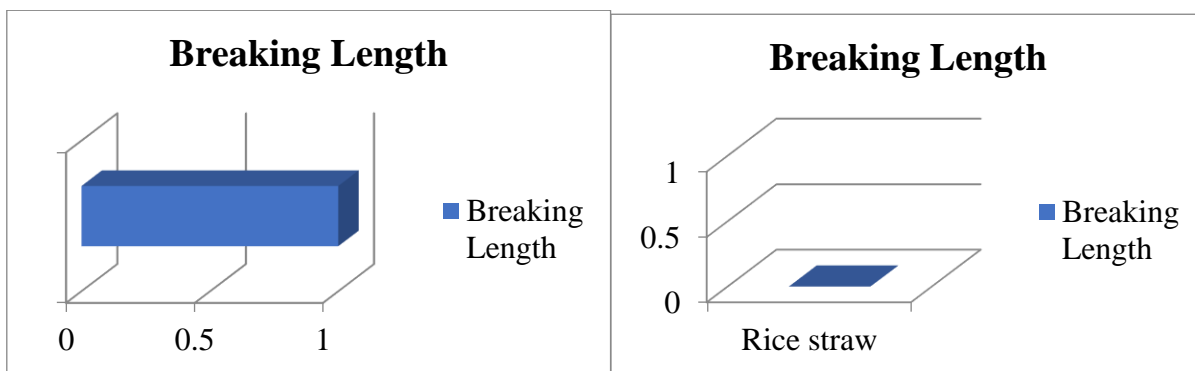


Figure 3 Comparison of Breaking Length

Chemical Composition Analysis:

Estimation of Cellulose, Hemicellulose, and Lignin:

Chemical analyses were conducted to quantify the cellulose, hemicellulose, and lignin content of the samples, providing valuable insights into their composition and suitability for papermaking are shown in table 3 . Established protocols involving treatment with specific chemical reagents were followed to isolate and quantify each component accurately. The results of these analyses offered a comprehensive understanding of the structural composition of the algae and rice straw pulp, guiding further optimization of the papermaking process. Given that rice straw's cell divider displays cellulose and hemicelluloses, it presents a potential resource for use as crude fabric in the textile and paper industries (Singh et al., 2014, Lim et al., 2012). Since rice straw is clearly less value than brought of collection, transportation, and handling for important livelihoods, it includes components that can benefit society (Abdel-Mohdy et al., 2009).

Table 3: Composition of Algae and Rice Straw Pulp

Raw Material	Cellulose Content (%)	Hemicellulose Content (%)	Lignin Content (%)
Algae	35.2	12.4	3.8
Rice Straw	40.6	18.9	5.2

Algae have a cellulose content of 35.2%, hemicellulose content of 12.4%, and lignin content of 3.8%. This composition suggests a favorable balance for industrial processes due to lower lignin content. Rice straw, on the other hand, contains 40.6% cellulose, 18.9% hemicellulose, and 5.2% lignin. While rice straw offers higher cellulose and hemicellulose content, its elevated lignin levels may pose challenges in processing as shown in fig 4.

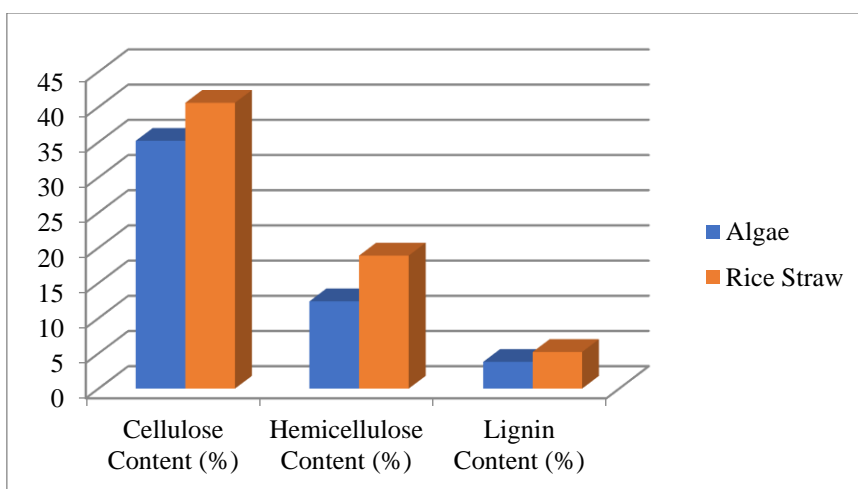


Figure 4 Comparison of Bursting Strength

Table 4: Biodegradation Study

Material	Biodegradation Rate (%)
Algae Paper	85
Rice Straw Paper	78

Algae paper exhibits a biodegradation rate of 85%, indicating its high susceptibility to natural decomposition processes. Conversely, rice straw paper has a slightly lower biodegradation rate of 78%, suggesting it degrades at a slightly slower pace compared to algae paper as shown in table 4. Despite this, both materials demonstrate significant eco-friendly characteristics due to their ability to break down efficiently in natural environments. If released untreated, polluted effluent emissions from bleaching effluent also represent major risks to the fertility of the soil and aquatic ecosystem life (Kansal et al., 2008). These rates underscore the environmental advantages of utilizing renewable biomass sources for paper production, contributing to sustainable waste management and reducing the ecological footprint of paper products.

4. CONCLUSION

This study provides a comprehensive examination of the utilization of algal pulp and rice straw as sustainable alternatives in handmade paper production, offering valuable insights into their feasibility and potential benefits. The meticulous methodology employed ensures the integrity and reliability of the findings, highlighting the scalability, resource efficiency, and environmental advantages associated with these materials. By integrating algal pulp and rice straw into paper production processes, industries can significantly reduce their environmental footprints while maintaining high-quality paper products. These findings hold significant implications for the papermaking industry, encouraging the adoption of sustainable practices and the exploration of alternative materials to promote environmental sustainability. Research and collaboration across sectors are warranted to optimize processing techniques and address remaining challenges, ultimately facilitating the widespread adoption of these eco-friendly alternatives.

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77 PRODUCTION OF ANTIBIOTICS BY USING BACILLUS SPECIES ISOLATED FROM HOSPITAL SAMPLE

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Abstract:

This study presents a comprehensive analysis *Bacillus subtilis* is beneficial in many ways, including industrial applications. It is used to produce many antibiotics with an amazing variety of structures and mechanisms of action. This bacterium is also being used to produce fungicides, insecticides and enzymes. According to their biosynthetic pathway, these metabolites can be grouped into two different classes: the first class comprises ribosomal synthesized peptides, whereas the second class comprises small microbial peptides synthesized enzymatically by non-ribosomal pathways. Antibiotics production by microorganisms qualitatively and quantitatively depends on strain of the producing microorganism as well as on composition of the media and the biosynthesis conditions. However, culture media is of critical importance because variation of its composition can significantly effect on antibiotics yield. Changes in the type and concentration of carbon, nitrogen or phosphorus sources and trace elements have influence on antibiotic biosynthesis with *Bacillus* strains. Antibiotic production by *Bacillus subtilis* begins at the early stages of the stationary phase. Therefore it is important to formulate the composition of the media so that favour their synthesis with limited growth of biomass. The carbon source needed for maximal production is different among producing microorganism strains and depends on types of antibiotics. Bacitracin is most important cyclic polypeptide antibiotic produced *Bacillus* species and is primarily active against the Gram-positive bacteria. The bacitracin is used as anti-infective agent in a variety of pharmaceutical preparations including aerosols, topical lotions, skin ointments and creams. The bactericidal activity of bacitracin is the result of cell wall inhibition.

Keywords: Aerosols, Bacitracin, Nitrogen or phosphorus sources, Ribosomal synthesized peptides.

78 UNLOCKING RENEWABLE ENERGY: HARNESSING AGRICULTURAL RESIDUES FOR BIOETHANOL PRODUCTION

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Abstract:

By 2050 the demand for energy worldwide is anticipated to be approximately 660 quadrillion Btu. To mitigate this huge demand alternate source of energies are required, in this regard biological renewable energy sources like Bioethanol comes into picture as it is proven to reduce carbon dioxide emissions and thereby supporting climate change control. The sort of alcohol that is produced from different types of feedstocks like plants rich in cellulose such as sorghum, corn, barley, sunflower, sugar cane are termed as First-generation bioethanol. Although it is possible to produce using second generation bioethanol using agricultural residues that are sourced directly as farm land waste which is unutilized or burnt and they can also be sourced from agriculture-based industries. By employing these agricultural residues, the food vs fuel competition that arise in the first-generation bioethanol can be tackled also it addresses the environmental consequences that arrive due to burning and dumping of agricultural residues. Due to various technological and cost saving advancements in the aspects like collection of residues, pretreatment, enzyme hydrolysis and other subsequent processes the bioethanol from agricultural residues is very much economically feasible currently compared to the first-generation bioethanol production. So, this book chapter emphasizes the various sources of bioethanol from agricultural residues that can be potentially utilized, pretreatment methods used in order to facilitate further processing and also discusses about the production process and product recovery operations involved.

Keywords: Bioethanol, Agricultural Residues, Lignocellulosic Biomass, Pretreatment, Fermentation.

79 IN VITRO PRODUCTION OF ATROPINE FROM DATURA METEL

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Abstract:

The study involved the comprehensive analysis of Datura metel, focusing on the extraction and characterization of phytochemical compounds from both the crude plant material and callus extracts. After identification, leaves, internodes, and fruits underwent thorough cleaning and drying before being finely ground into powder. Extraction involved a precise process of mixing the powder with sterile water, gentle heating, filtration, and centrifugation, yielding a clear supernatant for further analysis. Phytochemical screening revealed the presence of various compounds like tannins, alkaloids, saponins, and flavonoids, with variations observed among plant parts and extracts. The rich phytochemical profile of Datura metel, suggesting its potential medicinal applications. Tests on crude plant and callus extracts provided insights into their chemical compositions. The callus extracts exhibited higher atropine content than normal plant extracts, hinting at the potential for in vitro culture to enhance atropine production. Variations in atropine content across different plant parts, providing valuable insights for pharmaceutical research and medicinal applications. This research highlights on the diverse phytochemical composition of Datura metel, warranting further exploration

of its medicinal properties and cultivation techniques. The amount of atropine in each source varies: 1.25 mg/g of atropine is found in stem calli, 1.09 mg/g is found in leaf calli, 1.53 mg/g is found in fruit calli, and 1.12 mg/g is found in flower calli. that the amounts of atropine vary according to the tissue from which the calli originate, with the highest concentration found in calli produced from fruit, followed by calli originating from stems, flowers, and leaves. These studies urge for more study into the therapeutic effects of Datura metel and advance our awareness of its potential in pharmaceutical applications.

Keywords:

Datura metel, callus, atropine, phytochemical, tannins, alkaloids, saponins, flavonoids.

80 IN VITRO CYTOTOXIC EFFECT OF TRIDAX PROCUMBENT LEAF EXTRACTS TESTED AGAINST CANCER CELL

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ABSTRACT

Cancer is major health problem in both developed and developing countries. Cancer after cardiovascular disease is the second leading cause of death. Cancer is the abnormal growth of cells in our bodies that can lead to death. Because of high death rate associated with cancer and because of serious side effects of chemotherapy and radiation therapy, many cancer patients seek alternative complementary methods of treatment. Several synthetic agents are used to cure the disease but they have their toxicity and hence the research is going on to investigate the plant derived chemotherapeutic agents. More than 50% of modern drugs in clinical use are of natural products. Currently, numerous studies have evaluated the anticancer properties of natural compounds derived from plants, both in vitro and in vivo. In this experiment explore the cytotoxic effect of Tridox procumbent leaf extracts. Cytotoxic refers to a substance or process which results in cell damage or cell death. The prefix "cyto" refers to cell and "toxic" to poison. The term is often used to describe chemotherapy drugs that kill cancer cells. The solvents by using soxhlet apparatus. Solvents like methanol, ethanol, aqueous, chloroform, acetone, ethylacetate. Extracts are collected in stopper bottle. After that the extracts are test against human lung cancer cell and the breast cancer cell.

Key words: Anti cancer, cytotoxic effect, extraction, soxhlet apparatus, cancer cell testing.

1 INTRODUCTION

1.1 GENERAL ANALYSIS:

Cancer is one of the deadliest diseases globally and especially in western countries.

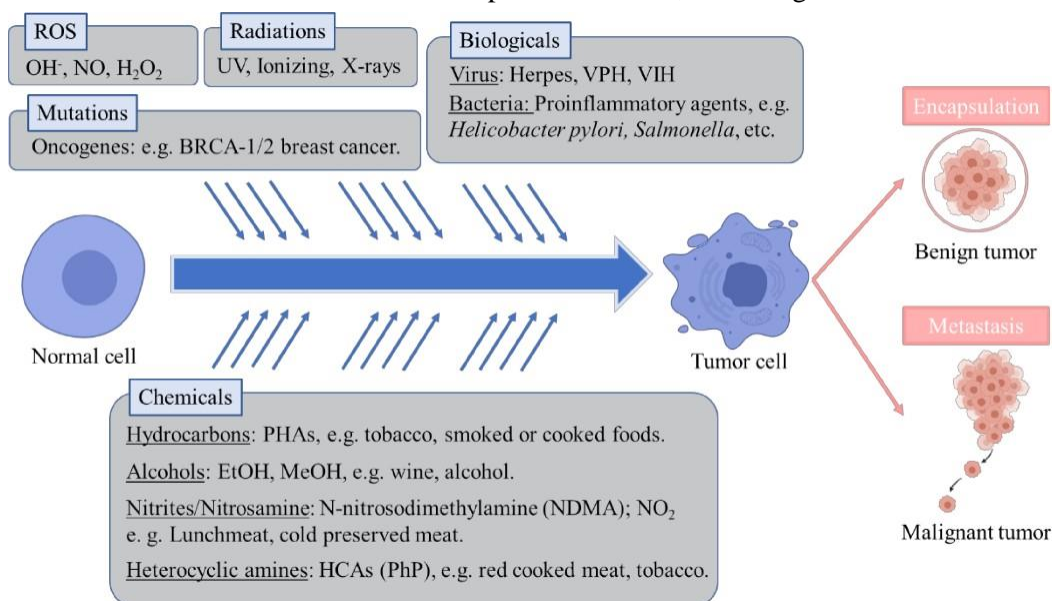
According to the International Cancer Observatory, roughly 9.9 million people have died in 2020 as a result of developing cancer ^[1]. Cancer is a complex disease, generally defined as an uncontrolled proliferation and development of cells in tissues forming an amalgamation and microenvironment (tumor) that may potentially expand to a whole organ or systemically to other tissues (metastasis) ^[2]. This abnormal cell behavior may be the result of hereditary genetics, or an epigenetic-driven alteration of key genes (oncogenes) related to the cell cycle and regulation of cell death (apoptosis) ^[3]. Cancerous cells are also characterized by dysregulation of programmed apoptosis and aberrant behavior of microtubules, as they are involved in the mitotic process ^[3].

The World Health Organization identifies as main causes behind the development of cancer random somatic mutations, ionizing radiation, reactive oxidative species as well as several chemical and biological agents [4]. Except for random mutations, these are widely recognized exogenous carcinogens. Ionizing radiation is able to disrupt the hydrogen bonds between nucleic acids as well as altering their chemical conformation, which may yield alterations in normal DNA expression regulation [5].

Viruses that integrate their genetic into the host may alter normal expression of genes related to cell division or even induce expression of oncogenes that could derive into oncogenesis. Some examples of these are the integration of Hepatitis B virus into telomeres, as well as genes coding for proteins X and S, which induce inflammation and neoplasia; or Human Papillomavirus integration in oncogenes E6 and E7 in the cell genome, which suppress the p53 anti-tumor gene and promote cell proliferation while simultaneously alters cell-to-cell adhesion [7-9]. These oncogenes have been related to increased release of inflammatory mediators like.

HCAs, linking them to the pro-carcinogen effects of tobacco consumption [23]. N-nitroso compounds are additives in processed meats and include nitrites and nitrosamines like N-nitrosodimethylamine that have been correlated to gastric cancer development [24]. Ethanol as well as other alcohols present in beverages and spirits induce many metabolic and endocrine disorders along with being highly cytotoxic chemicals and attributed to cause many types of cancers [25]. Altogether, it should be considered that a variety of exogenous carcinogens from different sources can heavily prompt cancer development (Figure 1).

Figure 1. Main causes involved in the development of cancer, according to WHO.



Cancer not only displays heterogeneous cell and tissue-specific behavior, depending on the onset, inducer and individual genetic profile, but also an unpredictable and diverse evolution that hinders its treatment [26]. Conventional cancer treatment approach commonly involves chemotherapy, radiotherapy and surgery [27,28]. Regarding chemotherapeutics, their effect is cytostatic, acting through shifting the expression of cell cycle mediators, disruption of microtubules, or inducers of apoptosis. However, as radiotherapy and chemotherapy do not discriminate between normal and cancer cells, their application is paired with certain side effects, ranging from mild gastrointestinal alterations and nausea to severe gut mucosa dysfunction, cardiovascular toxicity or immunity disorders [29,30]. These side effects, which can linger for long periods after treatment, pose a major issue when selecting and applying therapeutics.

2 MATERIALS AND METHOD

2.1 CHEMICAL CONSTITUENTS:

A new flavonoid procumbenetin, isolated from the aerial parts of *Tridax* has been characterised as 3,6-dimethoxy-5,7,2',3',4'-pentahydroxyflavone on the basis of spectroscopic techniques. *Tridax* Flavonoids Plant,

commonly used as anticoagulant, hair tonic, antifungal and insect repellent, diarrhoea, dysentery and wound healing. Isolated constituents alkyl esters, sterols, pentacyclic triterpenes, fatty acids and polysaccharides. New isolated constituent 3,6- Dimethoxy-5,7,2',3',4'-pentahydroxyflavone 7- O- β - D-glucopyranoside, named procumbetin Z yield: 0.016% on dried basis¹. The phytochemical screening revealed the presence of alkaloids, carotenoids, flavonoids like catechins and flavones. The proximate profile shows that the plant is rich in sodium, potassium and calcium. Leaf of *Tridax* mainly contains crude proteins 26%, crude fiber 17% soluble carbohydrates 39% calcium oxide 5%, Luteolin, glucoluteolin, quercetin and isoquercetin have been reported from its flowers. Whereas the fumaric acid, sitosterol and tannin has also been reported in the plant. Oleanolic acid was obtained in good amounts from *Tridax* and found to be a potential antidiabetic agent when tested against aglucosidase^[55].

The medicinal plant i.e., *T. procumbens* was studied by in vitro evaluation methods i.e., MTT assay and trypan blue exclusion assay. The acetone and ethanol leaf extract of *T. procumbens* have shown potent anticancer activity on selected cancerous cell lines. More efforts are needed to explore potent anticancer plants from the mother earth and save humans around the world from cancer.

Several workers have reported on the different biological activities of *T. procumbens* in various in vitro and in vivo test models. Different extracts of this plant have been found to exhibit antibacterial, anti-inflammatory, hepatoprotective, anti-ulcer and antioxidant, immunomodulatory

The Ebers Papyrus, the best known Egyptian pharmaceutical record which documented over 700 drugs, represents the history of Egyptian medicine dated from 1500 BC. The Chinese Materia Medica, which describes more than 600 medicinal plants, have been well documented with the first record dating from about 1100 BC

2.2 collection of plant:

Plant selection and collection of medicinal plants were chosen for in vitro anticancer activity and cytotoxicity testing by considering previous literature reports and ethnobotanical information. The selected plants, some of which are endemic, belong to *asteraceae* family groups and were collected from in and around erode districts in Tamilnadu.

2.3 Preparation of extracts:

The dried plant material was percolated with methanol (95%) at room temperature. The methanolic extracts (ME) were evaporated to dryness under pressure and controlled temperature (40 to 50 °C) in a rotary evaporator. The dried cormus of *Colchicum san- guicolle* was extracted with methanol (95%) in a Soxhlet apparatus. The ME was evaporated to dryness under pressure and controlled temperature (40 to 50 °C) in a rotary evaporator. All the extracts were kept at 20 °C and were then lyophilized. In this way, crude methanolic extracts were obtained. The ME were dissolved in distilled water, and diluted in Eagle' s minimum essential medium (EMEM).

2.4 Cell cultures:

The HeLa cell line and the Vero cell line were grown and maintained in EMEM with Earle' s saline, supplemented with an antibiotic-antimycotic mixture (penicillin 100 U/mL, streptomycin 100 mg/mL, amphotericin B (0.25 mg/mL), and 10% fetal bovine serum. Cells were maintained in a humidified atmosphere containing 5 % CO₂ at 37°C.

3. RESULTS AND DISCUSSION

3.1 In vitro cytotoxicity assay:

The cytotoxicity assays were performed according to the microculture MTT method. The cells were harvested (2.0– 2.8x10⁵ cells/well) and inoculated in 24-well plates. The cells were washed with phosphate buffered saline (PBS) and were then inoculated with and without the extract (final extract concentrations range 5-1000 μ g/mL). After 72-hr incubation, the medium was aspirated. 150 μ L of MTT solution (5 μ g/ mL in PBS, pH 7.2) were added to each well and the plates were incubated for 4 hrs at 37 °C. After incubation, 750 μ L of

dimethyl sulfoxide were added to each well, followed by gentle shaking for 15 min to solubilize the formazan dye. Absorbance was read at 540 nm using a photometer (μ Quant, Bio-Tek Instruments Inc, USA) and the surviving fraction was calculated according to the following formula:

% viability = (absorbance of extracts treated cells/absorbance of control cells) x100. All experiments were performed in triplicate and mean values were used for calculation.

Spectrophotometric determinations were performed using Quant Universal Microplate Spectrophotometer (Bio-Tek, Instruments Inc, USA).

3.2 Selectivity index (SI):

The degree of selectivity of the compounds was expressed by its SI value as suggested by Badisa et al. [14]. High SI value (>2) of a compound suggests selective toxicity against cancer cells, while a compound with SI value <2 is considered to give general toxicity which can also cause cytotoxicity in normal cells. Each SI value was calculated using the formula:

$$SI = IC_{50} \text{ normal cell} / IC_{50} \text{ cancer cell}$$

Statistics Values from all experimental groups were acquired by using GraphPad Prism Software (GraphPad Prism version 5.0, GraphPad Software, San Diego California USA, Anonim-c) and analyzed using one-way ANOVA test. The significance between control and experimental groups was determined by Dunnett's test and a p value <0.05 was considered as statistically significant.

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81 ROLE OF RENEWABLE ENERGY FOR AGRICULTURAL PEST CONTROL TECHNOLOGY - A REVIEW

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ABSTRACT

The integration of renewable energy into agriculture plays a crucial role in fostering sustainability, efficiency, and resilience within the sector. Renewable energy sources and technologies have greater potential to provide best solutions for longstanding energy problems be faced by many developing countries in the world. In agricultural systems, energy is available from different sources as human, animal, sun, wind, biomass, coal, fertilizer, seed, agro-chemicals, petroleum products, electricity etc. Renewable energy and farming are a winning combination. Wind, solar, and biomass energy can be harvested forever for sustainable agricultural development and providing farmers with a long-term source of income. Agriculture is the main occupation of Indian People. Farmers encounter the various types of pest problems that harm crops and result in loss of productivity each year. Therefore, it is necessary for farmers to use pesticides to prevent crop damage from pests. However, when pesticides are used in large quantities, they cause adverse impacts on people, animals and the environment. Instead of using pesticides, the government has to support other ways to prevent pests, including the use of biological agents and some insects etc. That way there is still a lack of electric energy for bulbs because the farm is far away, and traps are also expensive. From this point, the researcher has developed Solar Energy- Based Pests Trap for orchards and vegetables.

Key words: Solar panel, UV Light, Wire Mesh, Pheromone plume.

1. RENEWABLE ENERGY

Renewable energy is energy from renewable resources that are naturally replenished on a human timescale. Renewable resources include sunlight, wind, the movement of water, and geothermal heat. Although most renewable energy sources are sustainable, some are not. For example, some biomass sources are considered unsustainable at current rates of exploitation. Renewable energy is often used for electricity generation, heating and cooling. Renewable energy projects are typically large-scale, but they are also suited to rural and remote areas and developing countries, where energy is often crucial in human development.

Most farm machines are driven by fossil fuels, which contribute to greenhouse gas emissions and, in turn, accelerate climate change. Such environmental damage can be mitigated by the promotion of renewable resources such as solar, wind, biomass, tidal, geo-thermal, small-scale hydro, biofuels and wave-generated power. These renewable resources have a huge potential for the agriculture industry. The farmers should be encouraged by subsidies to use renewable energy technology. The concept of sustainable agriculture lies on a delicate balance of maximizing crop productivity and maintaining economic stability, while minimizing the utilization of finite natural resources and detrimental environmental impacts. Sustainable agriculture also depends on replenishing the soil while minimizing the use of non-renewable resources, such as natural gas, which is used in converting atmospheric nitrogen into synthetic fertilizer, and mineral ores, e.g. phosphate or fossil fuel used in diesel generators for water pumping for irrigation. Hence, there is a need for promoting use of renewable energy systems for sustainable agriculture, e.g. solar photovoltaic water pumps and electricity, greenhouse technologies, solar dryers for post-harvest processing, and solar hot water heaters. In remote agricultural lands, the underground submersible solar photovoltaic water pump is economically viable and also an environmentally-friendly option as compared with a diesel generator set. If there are adverse climatic conditions for the growth of particular plants in cold climatic zones then there is need for renewable energy technology such as greenhouses for maintaining the optimum plant ambient temperature conditions for the growth of plants and vegetables. The economics of using greenhouses for plants and vegetables, and solar

photovoltaic water pumps for sustainable agriculture and the environment are presented in this article. Clean development provides industrialized countries with an incentive to invest in emission reduction projects in developing countries to achieve a reduction in CO₂ emissions at the lowest cost. The mechanism of clean development is discussed in brief for the use of renewable systems for sustainable agricultural development specific to solar photovoltaic water pumps in India and the world. This article explains in detail the role of renewable energy in farming by connecting all aspects of agronomy with ecology, the environment, economics and societal change.

APPLICATION OF RENEWABLE ENERGY RESOURCE IN AGRICULTURE SECTOR

There are different kinds of renewable energy resource in the sector are given in the below table 1

Sr. No.	Sector	Renewable energy source	Technology	References
1	Irrigation	Solar panels assembly	Fuzzy logic and cloud tech	Sudharshan et al.2019)
		Solar photovoltaic cells	Pump used for irrigation	García et al.(2019)
		Wind onshore	RO (Reverse Osmosis) of water for irrigation	Caldera and Breyer. (2019)
		PV panels	RO (Reverse Osmosis) of water	Shoeb and Shafiullah (2018)
		Wind energy	Islanded microgrid for pumps Desalination system	Serrano-Tovar et al. (2019)
		Geothermal energy	Field irrigation, heat pumps	Alberti et al. (2018)
2	management Greenhouse	Photovoltaic (PV) generator	Ventilation and heating (wind turbine)	Riahi et al. (2021)
		Photovoltaic and wind	Ventilation and heating Wind-PV hybrid generation system, modeling, simulation and analysis	Jomaa et al. (2017)
		PV panels	Photovoltaic greenhouse tunnel	Marucci et al. (2018)
3	Monitoring/ Regulating systems	Solar-powered prototype nodes	Precision agriculture (pa), wireless sensor networks, internet of things (IoT)	Sadowski and Spachos (2018)
4	Desalination Solar collector,	solar still Solar assisted	desalination system	Sohani et al. (2022)

		Air solar heater	Humidification- dehumidification desalination system	Rahimi-Ahar et al. (2018)
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Table.1 application of renewable energy

. A critical first step in harnessing solar energy is determining how much energy is available from the sun in a given area of the Earth. The economic and social progress of a country depends on how well it can get a reliable and cheap supply of energy (Fatai et al.,2004;Muneer et al.,2006). Most of the current global energy demand is being met by consuming conventional fossil fuels. Only 9% of the world’s energy requirements are fulfilled by solar and wind energy. The global energy mix for the year 2019 revealed that solar energy increased along with other renewable sources by up to 24% which is almost twice as much when compared with wind energy for that specific year (Kapoor et al.,2019). The technology used today in agricultural farms varies from that used in the past. Agricultural farms require a continuous supply of energy to operate farming vehicles and various machines which are normally produced by existing fossil fuels.

2. CHALLENGES AND OPPORTUNITIES IN PEST CONTROL

Pest species (i.e. weeds, pathogens, rodents and invertebrate pests) in agricultural systems are responsible for significant economic losses worldwide, estimated to be \$540 billion per year if unchecked (Willis, 2017). Pests represent a threat to agricultural productivity and often food safety. Control strategies in modern agriculture are heavily reliant on chemical pesticides, but this approach is facing increasing challenges. The effectiveness of many pesticides is being continually eroded by the evolution of resistance, and there is evidence of environmental or human harm leading to societal opposition in many parts of the world and an increasing list of banned pesticides (Nag & Gite, 2020). Furthermore, new pests are constantly emerging, while existing pests are establishing themselves in new agro-ecosystems around the world. There is a need for scientific advances to offer novel, sustainable and safer pest control approaches relative to pesticides.

Genetic pest control strategies have been considered for decades as an alternative to chemical approaches and a potential addition to the pest control toolbox (Curtis, 1968; Gould, 2008). In the broadest sense, genetic control strategies use genetically manipulated strains of a pest organism to achieve one of two main objectives: population suppression, aiming at lowering the densities of natural target populations or eliminating them entirely, or population replacement, aiming at replacing natural pests with less damaging individuals. A subset of these approaches, referred to as gene drives, make use of the super-Mendelian inheritance patterns of selfish genetic elements to drive genetic cargo (i.e. any genetic material of interest, such as a gene conferring resistance to a disease or a gene imposing conditional lethality) into natural populations. These elements are also themselves often referred to as ‘gene drives’, and in this article, we make sure to systematically distinguish between a ‘gene drive element’ (the genetic material with selfish inheritance properties) and a ‘gene drive strategy’ (the pest control approach that aims to suppress or replace populations).

Pesticides were to be used, but only as necessary, based on population monitoring and “economic thresholds.” In the United States, this approach soon became known as integrated pest management (IPM), while in Europe it was more commonly called integrated control. Like the term sustainable agriculture, the acronym IPM is widely used under various contexts. The use of sampling and economic thresholds is aimed primarily at optimization of pesticide use. Crop rotation systems offer numerous advantages in soil structure, fertility and erosion management, as well as aiding in control of various pest species. Crop rotation for pest management consists of a planting pattern alternating susceptible and nonsusceptible crops. Planting and harvesting dates of some crops can be altered to reduce or to avoid pest damage. One of the most successful, nonchemical approaches to pest management is that of biological control.

3. SOLAR PEST CONTROL

INSECT AND PEST CONTROL METHODS

Nowadays there are many ways to destroy insects and reduce damage from pests. Besides, there are pests in exported products that affect the export value and setting price of agricultural products. Insect and pest

control is necessary for agriculturists to solve the problem. Farmers use many ways with insects and pests such as,

BIOLOGICAL CONTROL OR BIOCONTROL

This method is using pests as natural killers to destroy and control the outbreaks. For example, farmers used *Chelisoches Mario* (Fabricius) and *Trichogramma* was to control and destroy *Brontispalongissima* *Gastrowhich*ruined the top of coconut trees. Farmers also maintained a good environment for pest killers to live and propagate. This method is widely used to control *Plutellaxylostella*, *Trichoplusia Ni*, *Spodoptera Spp*, *Heliothisarmigera*, and Leaf rolling caterpillar. The natural pest killers are Rove beetle, Parasite, Pathogen, fungi, Entomogenous nematode, etc.

PLANT RESISTANCE

This method is using Pest-Resistant Crop Variety planted appropriately in farms. The plants are improved to prevent pests from breeding and genetic engineering. After improvement, the plants are called Transgenic Crop Plants. Nowadays the TCP are corn, potato, bean, tomato, cotton, tobacco, rice, wheat, etc. We call products from TCP as Genetically Modified Organisms; GMOs. In Thailand, the improved plant resistances are rice, cane, and sesame.

CULTURAL METHODS

This method can control only one group of pests at a time. Such as cultivating the least pest plant, using transplantation instead of seeding, choosing mulching materials, intercropping, and crop rotation to cut the pest's life circle.

MECHANICAL AND PHYSICAL METHODS

This method controls the important pests in every group by using light, radiation, sound, heating techniques and machines to control and prevent pests; this method requires hi-technology which is expensive

EXISTING SYSTEM

Light traps are mainly used for attracting moths and other night flying insects which are attracted towards the light. The insects are actively caught and encouraged to enter a trap. Oil or kerosene filled vessel is placed under the UV light So the flying insects attract by UV light and die by falling into the kerosene filled vessel. In the method drawbacks arefalling insects only die.It may have a chance to escape some flying insects. Daily cleaning process is necessary in this method.solar trap is shown in fig 1.



Fig .1.Light Trap

PROPOSED SYSTEM

The main structure of Solar Energy-Based Pest Trap is made from PVC pipes for durable use in agricultural fields. Solar energy based light trap is shown in below fig 2.



Fig 2 Solar Energy based Light Trap

WORKING PRINCIPLE

Solar cells are an efficient way to harness the energy of sun, they convert the energy of the sun into electricity, when the sunlight irradiates the surface of solar panels, and parts of the photon are absorbed by silicon and convert into electrical energy. Then the battery store the power generated from the sunlight, and discharge the power through the controller to the UV light, DC fan, Wiremesh and sensors. A special optical source is developed to utilize low-temperature plasma produce by lighting, and UV radiation will give birth to the effect of photo tropism and induce the pest to fly towards the light. In a bottom of a UV light DC fan fitted. The fan sucks the insect and pushes the insect to the wire mesh. A high voltage power supply is given to the metal mesh. So when an insect flies between the Meshes it creates a low resistance path between the meshe so the high voltage creates an ARC through the body of the insect which is instantly electrocuted. A high voltage power supply is given to the metal mesh. So when an insect flies between the meshes it creates a low resistance path between the meshes so the high voltage creates an ARC through the body of the insect which is instantly electrocuted.

CONCLUSION

These Renewable energy-based insect pest trap researches choose general materials to be adopted for the pest trapping such as electronic mosquito trap and DC fan. Then simple design was created for easily teach to framers. Agriculture pest control can trap many pest such as flying nymphs, adults insects like leaf folder, stem borer, fruit borer moths, hoppers, bugs, moths, fruit weevil and beetles. This trap did not appropriate for tall and leafy trees because the sunlight could not shine on the trap, the solar cells could not produce electric energy to battery. The trap should be improved for lighter scattering as 360 degrees from the trap. The ways into LED should be provide more for insects and effectively trap.

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82 FORMULATION AND EVALUATION OF HERBAL COOKIES ENRICHED WITH *CENTELLA ASIATICA L.*

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ABSTRACT:

Centella asiatica Linn (Apiaceae) one of the most important medicinal plant used to cure various types of diseases. This present study focuses the formulation of herbal cookies enriched with *Centella asiatica* using Response Surface Methodology and analysis of proximate composition of formulated cookies. The phytochemical screening of aqueous and ethanolic extract on *Centella asiatica* revealed the presence of various compounds like carbohydrates, protein, alkaloids, terpenoids, tannins, steroids, glycosides, saponins, flavanoids. *Centella asiatica* based cookies were formulated and sensory evaluation was analyzed by Response Surface Methodology. The sensory evaluation showed that the cookies supplemented with 4g of *Centella asiatica* powder were well acceptable in terms of Appearance, taste, texture, flavor and overall acceptability compared to other treatment. The mixture of 4gram of *Centella asiatica* and 100 gram of wheat flour was successful for the formulation of cookies enriched with *Centella asiatica*. Among the sensory parameters tested for the formulation, appearance and taste were found to be significant. The optimal amount of ingredients was obtained by three-dimensional response surface plots. Proximate composition of cookies such as carbohydrates, protein, fat, crude fibre, ash and moisture content was analysed for the formulated cookies. The Shelf – life of cookies was analysed by microbial study to check the growth of microorganism where the moisture content was found to be low (3.20%) which reduce the chance of contamination.

Keywords: *Centella asiatica*, herbal cookies, sensory evaluation, Response Surface Methodology, Proximate composition and shelf life.

Abbreviation: RSM, Response Surface Methodology; ANOVA, Analysis Of Variance; CCRD, Central Composite Rotatable Design; MR, Moisture Ratio.

1 INTRODUCTION:

A cookie is a small sweet, usually containing refined sugar and butter. Cookies were first made after sugar became available as a baking ingredient about 1400 years ago [1]. Cookies are also known as biscuits are consumed all over the world by both the adult and the children. There are enormous reasons behind its popularity such as high nutritional value, ready to eat, easily available in affordable price, reduction in the usage of sugar. Many attempts are made to improve the biscuit functionality, nutritional value by modifying their composition which is achieved by changing the ratio of the flour and *Centella asiatica* leaf powder. During baking of biscuit, temperature, time and rheological properties of dough plays an essential role in its final characteristics of the product [3].

Centella asiatica(L.) is a prostrate, faintly aromatic, stoloniferous, perennial and creeper herb. The leaves of *Centella asiatica* are orbicular-reniform, sheathing leaf base, crenate margins, glabrous on both sides. Modern medicine recognizes the use of herbal food products as an alternative medicine which is derived from the natural sources [1]. Sensory profile and preference mapping of cookies enriched with medicinal herbs were

used to stimulate metabolism and regulate the body weight [16]. Now a- days, consumers becoming nutritionally aware about the merits of herbal food products contains bioactive compounds like flavonoids, terephenoids, saponins, alkaloids, carbohydrates, protein and antioxidants to prevent several diseases. The chemical constituents present in *Centella asiatica* are centellin, asiaticin, centellicin, polyacetylenes, triterpenes and asiaticocides. Among this, the triterpenes of *Centella* are composed of many compounds including asiatic acid, madecassic acid, asiaticoside and madecassoside. Due to its importance, they have been used as the biomarker components for quality assessment of *Centella* [21].

Through the literature and by keeping the views in mind, it assures that the cookies enriched with *Centella asiatica* are useful for the human healthcare. Therefore, *Centella asiatica* is the best raw material for the development of the herbal cookies. Our approach in the present study will help the consumers to maintain their health which contains many medicinal properties.

2 MATERIALS AND METHODS

COLLECTION OF THE PLANT SAMPLES

Centella asiatica leaves were collected from the local regions of Sanjeeviroyanpet, Salem district, Tamil Nadu and the collected sample were cleaned and stored for further research.

PREPARATION OF PLANT EXTRACTS

The plant leaves were washed in running tap water and rinsed with distilled water and then they were shade dried at room temperature for six days, grounded into powder by mechanical grinder. The cold extraction method was performed by dissolving 1g of powdered leaf sample in 10ml solvents of different polarity like Ethanol and water. It was kept in orbital shaker for 24 hours. After incubation it was filtered through What Mann No.1 filter paper. Then shade dried for two days and stored for further research.

PHYTOCHEMICAL SCREENING OF LEAF EXTRACTS

The prepared cold extract was subjected to Phytochemical analysis. Phytochemical are the chemicals produced by plant through by primary or secondary metabolism. According to Thite *et.al* ²², phytochemical compounds are Carbohydrates, Protein, steroids, flavanoids, Terephenoids, Alkaloids, Tannins, Saponins and Glycosides was analysed.

i. Carbohydrate (Anthrone test)

5ml Anthrone reagent was added to 3ml of sample. The formation of yellow color indicates the presence of carbohydrates

ii. Proteins (Ninhydrin test)

To the 3ml of test sample few drops of Ninhydrin was added and boiled for few minutes. The presence of the compound was indicated by the formation of blue color.

iii. Alkaloids (Hager's test)

The Hager's reagent was prepared by dissolving 1g of picric acid in 100ml of water. To the 1ml of test solution few drops of Hager's reagent was added. The formation of yellow precipitate indicates the presence of alkaloids.

iv. Flavanoids (Alkaline test)

To 2ml of test solution 2ml of 10% NaOH was added. Intense yellow was formed which disappears on addition of dilute HCl. This shows the presence of flavanoids.

v. Tannins (Ferric chloride test)

A few drops of 0.1% of ferric chloride was added to the 1ml of test solution. The presence was indicated by brownish green or a blue color.

vi. Saponins (Foam test)

Add 2ml of water to the test solution, shake well. Stable foam for 10-15 minutes indicates the positive result for saponin.

vii. Glycosides (Acetic acid test)

Glacial acetic acid and ferric chloride was added as drop to the test solution to that conc.H₂SO₄ was added. The reddish brown color for indication of a positive result.

viii. Terephenoids (Salwowski test)

2ml of chloroform was added to the 3ml of test solution, and then 3ml of con.H₂SO₄ was added. A reddish brown color in inter-phase indicates the presence of terephenoids.

ix. Steroid (Salwowski test)

To the 3ml of test sample 1ml of chloroform and equal volume of H₂SO₄ was added to the side of the tube. The upper layer turns into red and lower layer turns into yellow with green fluorescence indicates the presence of steroid.

FORMULATION OF COOKIES

INGREDIENTS:

The powdered *Centella asiatica* were taken for formulation of cookies. The other ingredients such as Butter, wheat flour, Jaggery powder, baking powder were obtained from Salem market, Tamil Nadu, India.

FORMULATION OF CENTELLA ASIATICA BASED COOKIES:

Formulation of *Centella asiatica* Cookies was carried out in Department of Food technology, K.S.Rangasamy College of Technology, Tiruchengode. For the formulation of *Centella asiatica* cookies, the above mentioned ingredients were measured in appropriate quantity and mixed thoroughly until smooth and homogeneous dough mixture was obtained. It was made into circular pieces. The dough pieces were transferred to trays and baked at 195°C for 10 minutes in baking oven. The baked cookies were allowed to air cool for 20 minutes to room temperature and were packed in air tight plastic container.

EXPERIMENTAL DESIGN FOR THE OPTIMIZATION OF THE COOKIES ENRICHED WITH CENTELLA ASIATICA:

For designing the experimental process, Response Surface Methodology (RSM), a central composite design was applied using a commercial statistical package (Design expert software) for the generation of response surface plot and optimization of process variables. According to the Bhadur singh *et. al*⁶, design and analysis of experiments were carried out by the method outlined by Montgomery. Two factors of *Centella asiatica* leaf powder (A) and Flour (B) was used on responses of sensory score parameters such as Appearance (R1), Taste (R2), texture (R3), flavor (R4) and Overall acceptability (R5). Five levels of each variable were chosen and fourteen baking trials were performed for the evaluation of the optimized formulation.

SENSORY EVALUATION:

The sensory evaluation was carried out by the panel of 25 members including 10 males and 15 females in the age 20-45 years involving of both the students and faculty of Department of Biotechnology, K.S. Rangasamy College of Technology, Tiruchengode. The various sensory parameters such as Appearance, Texture, Taste, Overall acceptability and flavour was assigned by nine-point Hedonic scale as Like extremely = 9, Like very much = 8, Like moderately = 7, Like slightly = 6, Neither like nor dislike = 5, Dislike slightly = 4, Dislike moderately = 3, Dislike very much = 2, Dislike extremely = 1.

ANALYSIS OF PROXIMATE COMPOSITION

Proximate analysis of cookies for moisture, carbohydrates, crude protein, crude fat and ash content were determined according to the AOAC (2000) standard methods.

i. Determination of moisture:

Moisture content of the cookies were analyzed by moisture analyzer. The moisture content of the cookies can be determined by AACC-44-15 a method (AACC, 2005) based on the loss in weight after drying the sample for 1hour at 120°C, expressed in percentage moisture content. Initially the weight of sample is taken and then dried in oven. After drying the weight of the sample is taken and the difference in weight is calculated using formula. According to Muralidhar *et. al*¹⁵., usually the moisture content is denoted in percentage as given below.

Moisture % = $\frac{\text{Wt. of the sample} - \text{Wt. of the sample after drying}}{\text{Wt. of the sample before drying}} \times 100$

ii. Determination of ash:

5g of the sample was weighed into a pre-weighed silica crucible. It was incinerated over a burner till charring was complete. Then, the crucibles were transferred to a muffle furnace maintained at 550-600°C until light grey ash resulted or to constant weight, the cooled in a desiccator and the weight was noted.

Ash% = $\frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$

iii. Determination of fat:

The total amount of fat was estimated by ether extraction method. Petroleum ether was used to extract the fats that are present in the sample. According to Badhur *et. al*⁶., the Soxhlet extraction method was followed to extract the fats.

iv. Determination of protein:

According to Lowry *et. al*¹³., different concentrations of working standard (0.2, 0.4, 0.6, 0.8, 1µg/ml) solutions was taken in the test tube. The sample was diluted to 100ml of distilled water and 0.2 and 0.4ml of sample was taken into the test tube. Distilled water was used as a blank solution. 5ml of Alkaline copper reagent was added to all test tubes, mixed well and allowed to stand at room temperature for 10 minutes. 0.5ml of Folin's reagent was added to all the test tubes and incubated at room temperature for 30 minutes. After the incubation the blue color was developed and the absorbance was taken at 600 nm.

v. Determination of carbohydrate:

According to Anthrone *et. al*¹³., different concentrations of working standard (0.2, 0.4, 0.6, 0.8, 1µg/ml) solutions was taken in the test tube. This was followed by 0.5 and 1ml of sample was taken and 200ml of Anthrone's reagent was added to the all the test tubes. It was incubated in the water bath for 10 minutes then cool the test tubes to room temperature. The absorbance was taken at 620 nm.

Amount of carbohydrate present in 100mg sample = $\frac{\text{mg of glucose} \times 100}{\text{Volume of sample}}$

vi. Determination of crude fiber:

Centella asiatica powder of 2 gram with ether to remove the fat. Boil 2 g of powder with 200 ml of sulphuric acid for 30 mins. Filter through muslin cloth and wash with the boiling water until washing are no longer acidic. Boil with 200 ml of NaOH solution for 30 mins. Filter through muslin cloth again and wash with 25 ml of boiling H₂SO₄ three 50 ml portions of water and 25 ml alcohol. Remove the residue and transfer to ashing disc (Pre weighed dish weight W1). Dry the residue for 2 hrs at 130° C. Cool the dish in desiccators and weight (W2). Ignite for 30 mins at 100° C. Cool the dish in desiccators and reweigh (W3).

% Crude fiber = (Weight of the sample & dish – Weight of empty dish) – (Weight of ash – Weight of empty dish) / (Weight of sample)*100

vii. Total energy:

The total energy was calculated by using the formula $4.0 \times \text{protein (g)} + 4.0 \times \text{carbohydrate (g)} + 9.0 \times \text{fat (g)}$. The total energy (Kcal/g) for the formulated cookies was found to be 427 Kcal/100g.

Shelf Life Analysis:

The shelf life of the cookies was evaluated by standard plate count method using nutrient agar media. The number of colonies in the plates was recorded by using the colony counter. The sensory evaluation was carried out to get the consumer response for the shelf-life analysis. The evaluation was performed at weekly intervals to assess the changes in sensory parameters for the duration of three weeks. The formula used to analyse is $\text{CFU/ml} = (\text{Number of colonies}) * (\text{Dilution factor})$

3. RESULT AND DISCUSSION

Phytochemical analysis of *Centella asiatica* leaf extracts:

The phytochemical compounds present in the aqueous and ethanolic extracts of *Centella asiatica* were shown in the Table.1 as given below. Alkaloids were present in the ethanolic extract. Flavonoids were present in the aqueous and ethanolic extract which may indicate the presence of antioxidant, anticancer, antimicrobial activity. Terpenoids were present in the both solvent extracts which have the aromatic qualities and plays a role in herbal remedies. Saponin and Tannin were also present in all the solvent extract which improves the immune function by stimulating the production. Similar observation were reported by so and metabolites were present in *Centella asiatica* extract were compared to the report in (Sugunabai *et al*²¹, 2018).

Table 1: Phytochemical analysis of *Centella asiatica* extract

Phytochemical Tests	Ethanolic extract of <i>Centella asiatica</i>	Aqueous extract of <i>Centella asiatica</i>
Carbohydrates	+	+
Alkaloids	+	-
Flavonoids	+	+
Tannins	+	+
Saponins	+	-
Glycosides	-	+
Terpenoids	+	+
Protein	+	+

(+) Presence; (-) Absence

Formulation and sensory evaluation of *Centella asiatica* cookies using Response Surface Methodology (RSM):

The Response surface methodology was done to evaluate the effects of *Centella asiatica* powder and flour on the overall acceptance and optimized conditions for the responses. This design consisted of 14 randomized runs with five replicates at the central point to reduce the mistakes (Figure 1). The initial trial experiments, the upper and lower limits for the variables are established and the range of values are illustrated in the Table 2. The low degree of factors are coded as -1 and the high degree of factors are coded as +1. Central composite design of independent variable plant powder (A) and Flour (B) along with the sensory score responses on Appearance (R1), Taste (R2), Texture (R3), Flavour (R4), Overall acceptability (R5) obtained through conducting experiment were illustrated in the Figure 1 as given below. The optimization variables, response were selected based on the direct effect on the acceptability quality of cookies (Waleed *et. al*²⁶, 2018). The values of “Prob>F” less than 0.05 indicate that the model term is significant and values greater than 0.1 indicate that the model terms are not significant (Ashwanth *et. al*²⁴ 2015).

In the present study R1 and R2 gave significant result for the sensory score responses such as Appearance and Taste. Among the five responses of Appearance and Taste has the high F-value and low P value. It indicates that these are significant parameters of formulated cookies. The calculated F-value and P value are given in the Table 3. RSM provides the clear understanding of interactions between the different parameters and its optimum significant level. Most polynomial model design by RSM was effective in recital the correlation between the studied factors and the responses. It was investigated by the 3-Dimensional contour plots. Three dimensional response surface plots illustrating the effects of *Centella asiatica* powder and flour on responses such as appearance, taste, texture, flavor and overall acceptability which was given in the Figures 2a, 2b, 2c, 2d, 2e, 2f respectively. High scores are obtained for the majority of the parameters which indicated that they were not disagreeable panelist (Table 4). The RAMP function graph for the extract, flour, appearance, taste, texture, flavor and overall acceptability was shown in the figure 3a, 3b, 3c, 3d, 3e, 3f,3g respectively. The mean result of sensory evaluation of formulated cookies i.e, radar graph was shown in the figure 4a and 4b. The before and after optimization of the formulated cookies was shown in the figure 5a and 5b.

Table 2: Level of Design variables for Response Surface Methodology

Ingredients	Low level	High level
A: Plant sample	2	6
B: Flour	90	110

Std	Run	Block	Factor 1 A: extract g	Factor 2 B: flour g	Response 1 appearance	Response 2 taste	Response 3 texture	Response 4 flavour	Response 5 overall accepta
	1	Block 1	4.00	100.00	7	7	7	7	8
7	2	Block 1	4.00	100.00	8	7	8	8	7
6	3	Block 1	4.00	100.00	8	6	9	8	9
4	4	Block 1	5.00	110.00	8	8	8	7	9
2	5	Block 1	5.00	90.00	7	6	8	9	8
1	6	Block 1	3.00	90.00	7	8	7	7	9
3	7	Block 1	3.00	110.00	8	7	9	8	8
10	8	Block 2	4.00	85.86	9	8	8	7	7
14	9	Block 2	4.00	100.00	8	7	9	9	9
12	10	Block 2	4.00	100.00	8	8	8	8	8
13	11	Block 2	4.00	100.00	9	7	6	7	7
9	12	Block 2	5.41	100.00	7	8	7	8	8
11	13	Block 2	4.00	114.14	9	9	8	7	9
8	14	Block 2	2.59	100.00	8	8	7	8	8

Figure 1. Central Composite Rotatable Design for the optimization of cookies

Table 3: ANOVA for Response Surface quadratic model for taste (response 2) of formulated cookies

Source	Sum of square	Df	Mean square	F – value	P – Value Prob > F
Model	5.28	5	1.06	4.70	0.0336
Extract	0.13	1	0.13	0.56	0.4803
Flour	0.73	1	0.13	3.24	0.1150
Residual	1.58	7	0.23	-	-
Lack of fit	0.24	3	0.081	0.24	0.8636
Pure error	1.33	4	0.33	-	-

F-Value = 4.70 implies that the model is significant; P- value > 0.05 implies that the model is found to be significant.

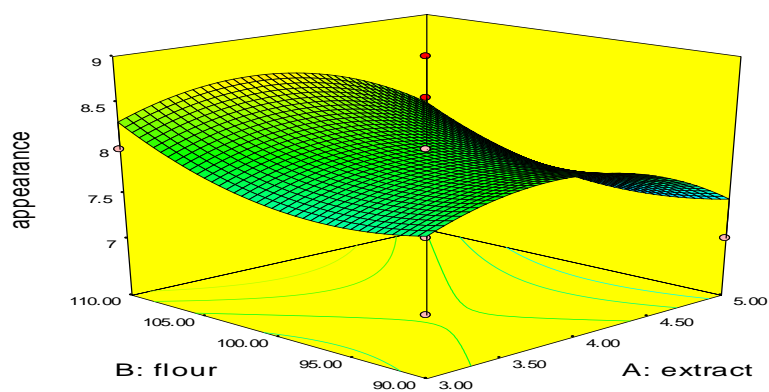


Figure 2a: Response surface plot showing the effect of plant powder and flour on Appearance.

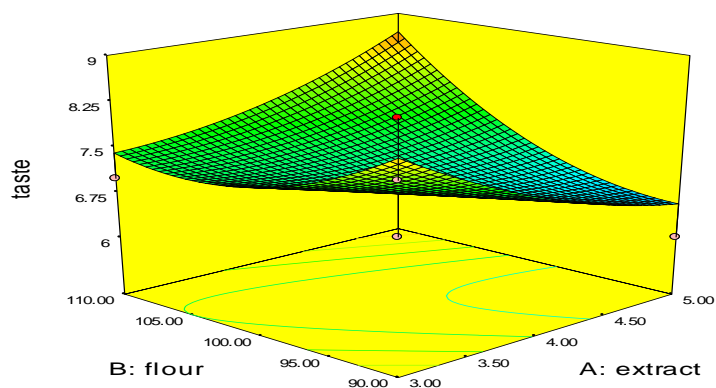


Figure 2b: Response surface plot showing the effects of plant powder and flour on Taste

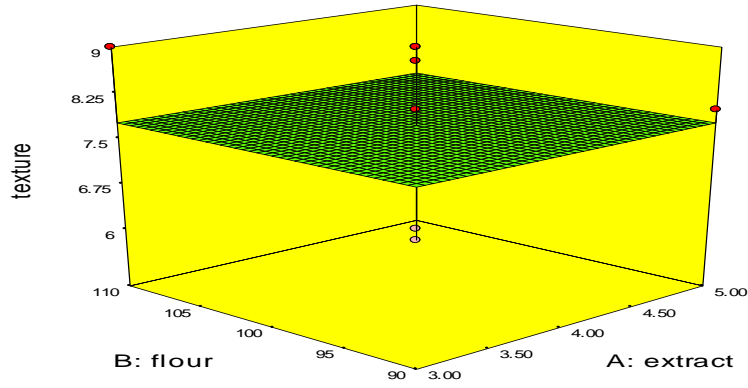


Figure 2c: Response surface plot showing the effects of plant powder and flour on Texture

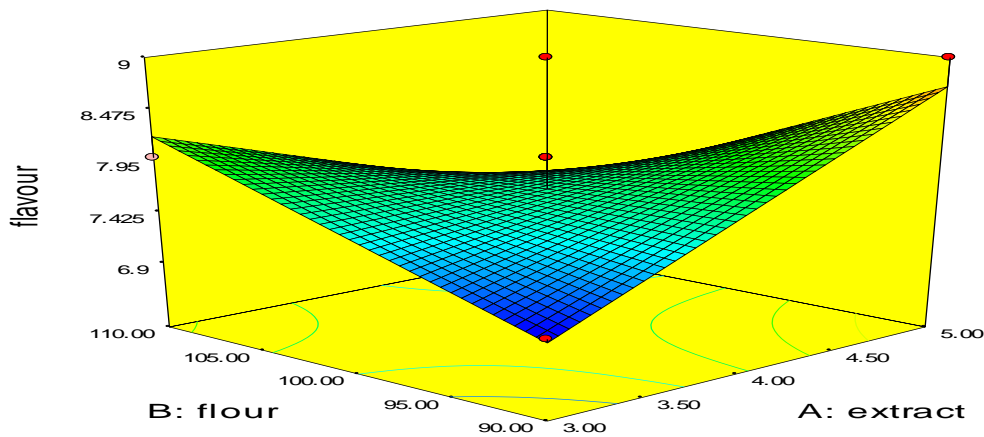


Figure 2d: Response surface plot showing the effects of plant powder and flour on flavour

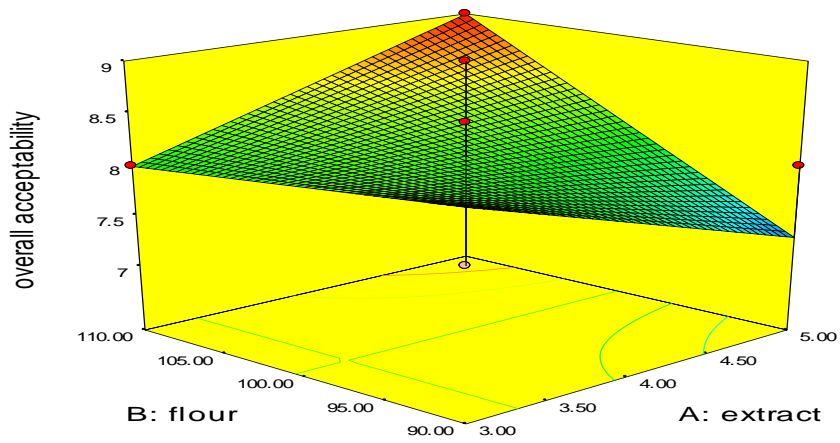


Figure 2f: Response surface plot showing the effect of plant powder and flour on overall acceptability

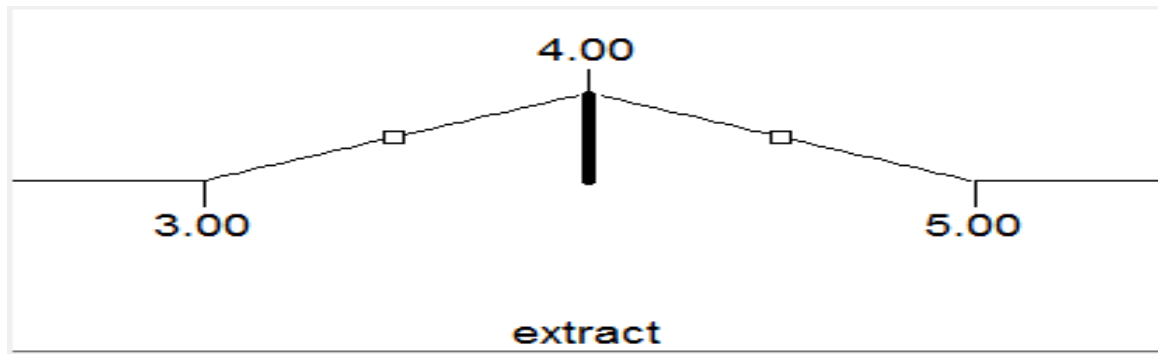


Figure 3a: RAMP function graph for extract

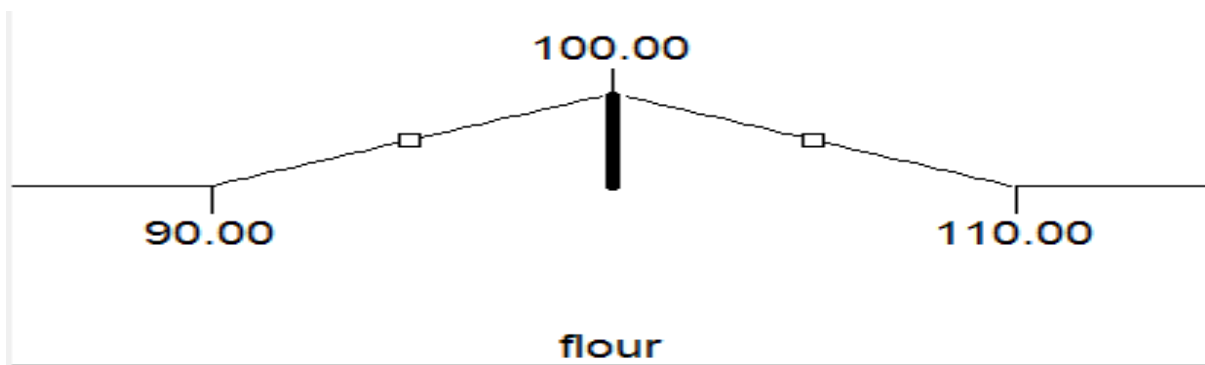


Figure 3b: RAMP function graph for flour

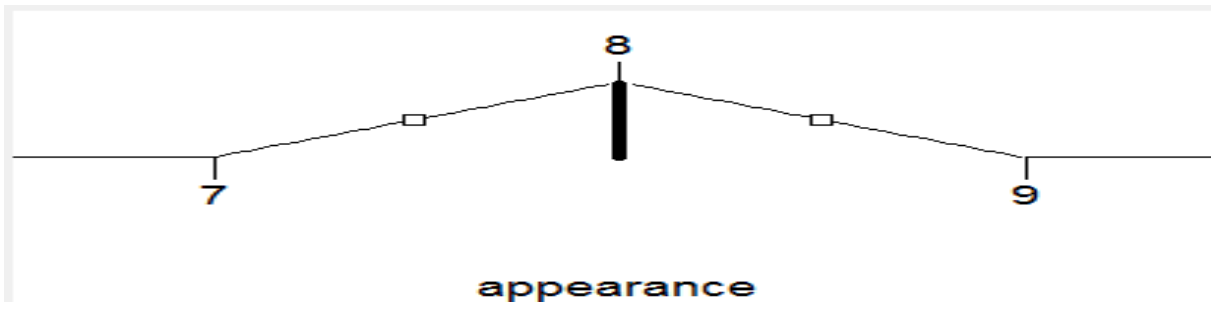


Figure 3c: RAMP function graph for appearance

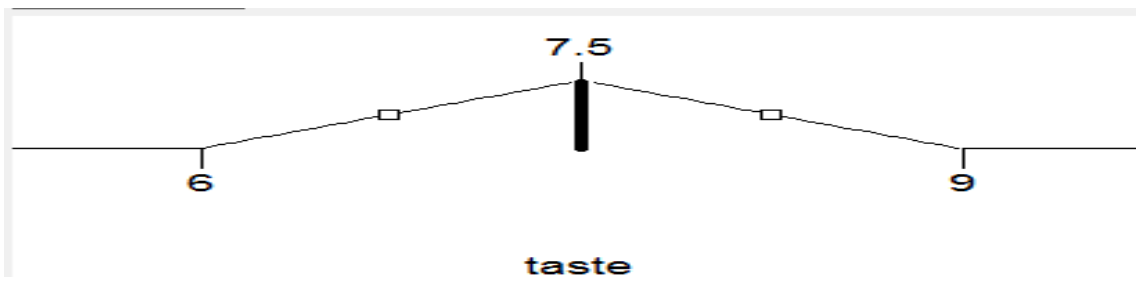


Figure 3d: RAMP function graph for taste

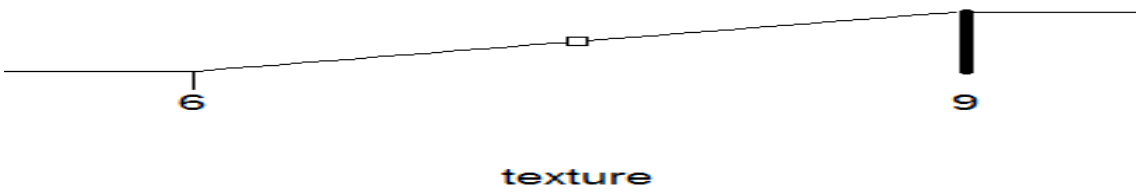


Figure 3e: RAMP function graph for texture

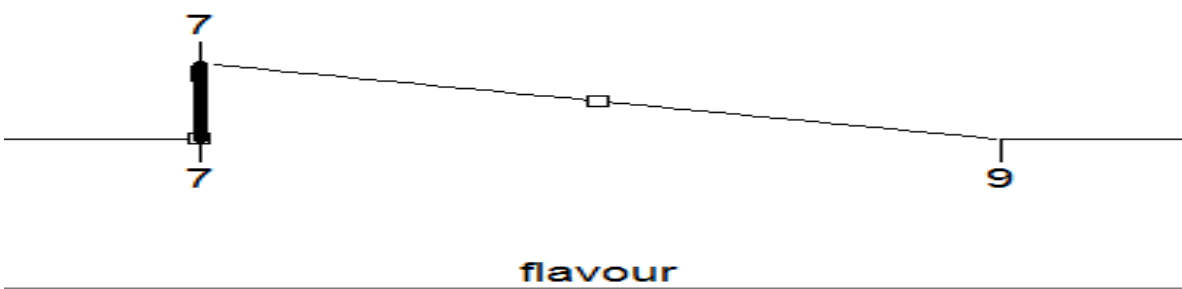


Figure 3f: RAMP function graph for flavour

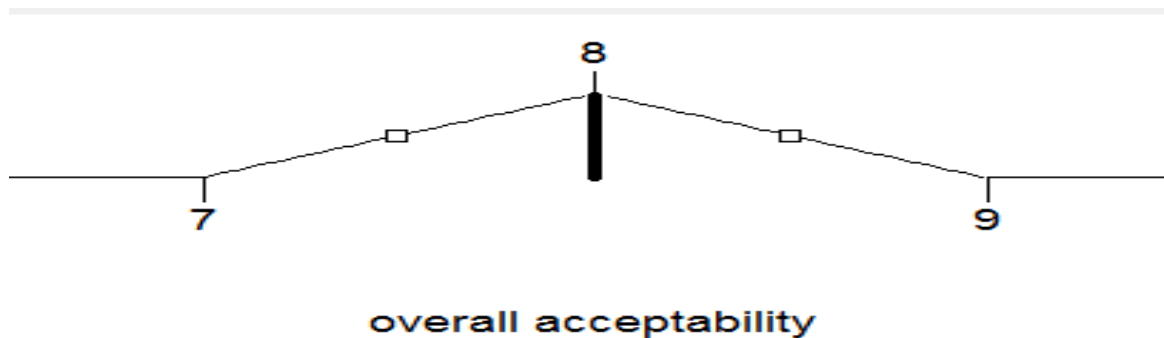


Figure 3g: RAMP function graph for Overall acceptability

Table 4: Hedonic rating scale of cookies

Parameters	Average score	
	Before optimization	After optimization
Appearance	7.5	9
Taste	8	9
Texture	8	8
Flavour	8.2	8
Overall acceptability	8	9

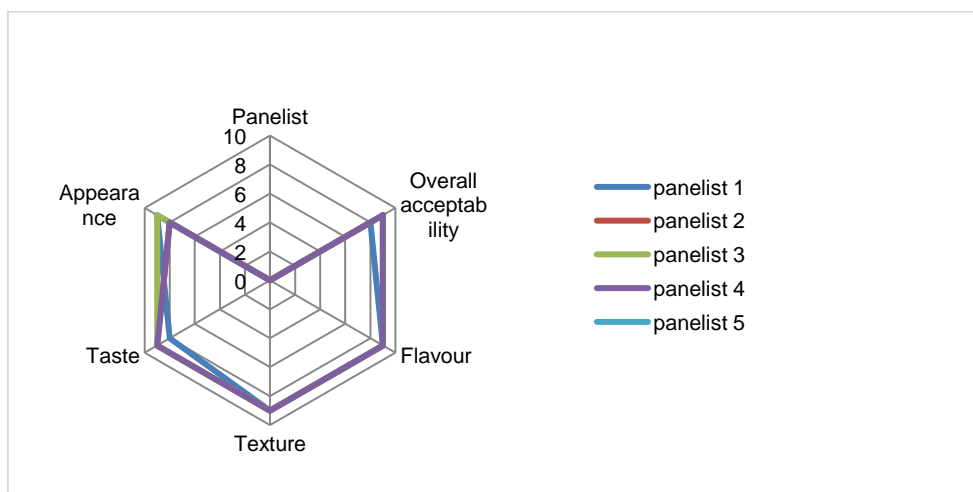


Figure 4a: Radar graph for the formulated cookies by sensory evaluation before optimization

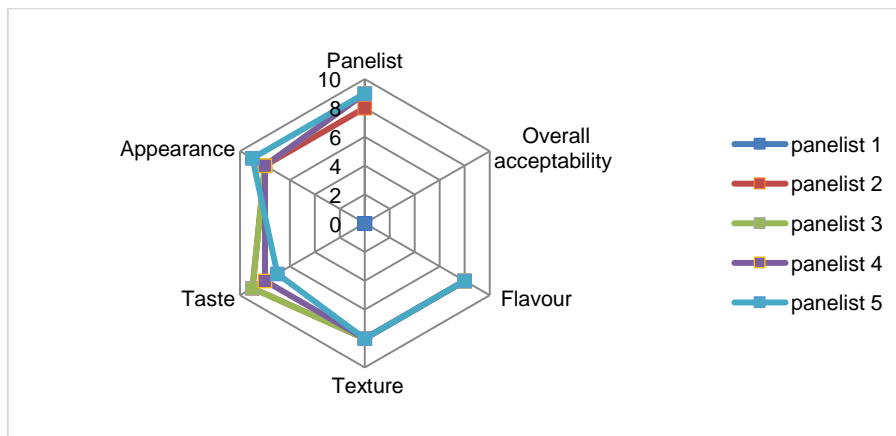


Figure 4b: Radar graph for formulated cookies by sensory evaluation after optimization



Figure 5a: Pre - trial of cookies before optimization

Figure 5b: Post - trial of cookies after optimization

Proximate composition of the formulated cookies:

The proximate composition of *Centella asiatica* cookies was analysed. The percentage of nutritional composition on cookies was listed in the Table 5. The result showed that the high level of carbohydrates, protein, ash and fiber when compared to the commercialized product. According to (Muralidhar *et. al*¹⁵ 2017), increasing in moisture leads to contamination, but the *Centella asiatica* cookies have only 3.54% of moisture content (Table 5).

Table 5: Proximate composition of cookies

Nutritional composition	Weight %
Carbohydrates	57.91%
Protein	16.80%
Moisture	3.54%

Ash	1.65%
Crude fiber	Detection Limit 0.9%
Fat	13.64%
Total energy (K cal)	427 K cal/100 g

Shelf – life of the formulated cookies:

Microbial analysis is important to find out the shelf life of the developed cookies and there by ensure the safety of the product. Microbial analysis was carried out in the cookies for one month to identify the development of bacterial colony. No contamination in the plate was observed due to low moisture content and also low microbial growth was observed. The number of colonies in the cookies was found to be 0.003 CFU/ml (Figure 6b).

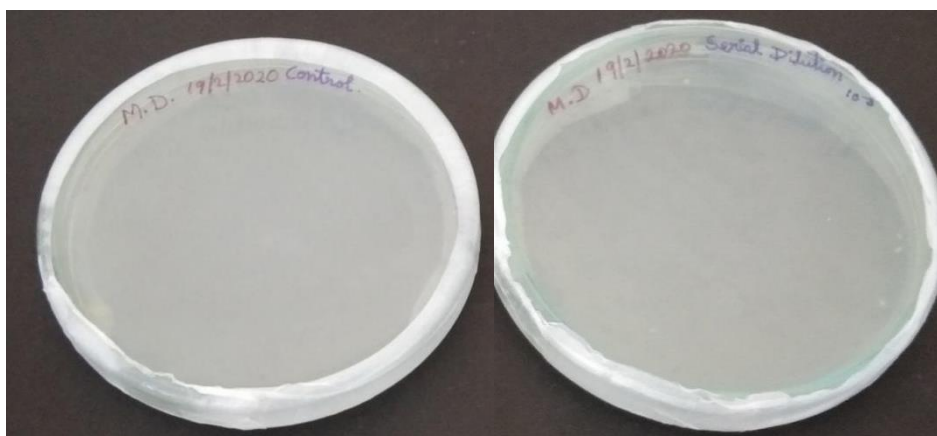


Figure 6a: Control plate (Nutrient agar)

Figure 6b: Serially diluted cookies stripe

Over the nutrient agar plate

IV. CONCLUSION

Centella asiatica is one of the pharmaceutically important medicinal plants, commonly available in different part of the world and this plant is used in Indian system of medicine to cure various diseases in human and animals. Malnutrition being an alarming condition in India needs a healthy and nutritious diet. These products can serve as good vehicles for nutraceuticals like protein, dietary fiber, or calcium. From the study, the phytochemical screening of the aqueous and ethanolic extracts of *Centella asiatica* showed the presence of major biochemical compounds. The sensory evaluation indicated that the *Centella asiatica* based formulation is widely accepted by the consumers of all age groups mainly due to multifarious health benefits. The nutritional composition and shelf life of formulated cookies are high. Among ready to - eat foods, Cookies are one of the most popular, convenient food consumed both in Urban and rural areas. The present study on the formulation and evaluation of herbal cookies enriched with *Centella asiatica* is an alternative approach for supplementing the most beneficial herbal extract in an easy way to consume and to treat various crises.

V. FUTURE SCOPE

The present study has the many benefits such as a long shelf life due to low moisture content of the formulated cookies which limits the microbial growth, jaggery powder was added instead of sugar, energy and nutrient density means a high weight/volume ratio. It was the main food that the people had during their long journey back home.

4 CONFLICT OF INTEREST

The author declares that there is no conflict of interest of any kind.

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83 DEVELOPMENT OF *HIBISCUS ROSA SINENSIS* BASED TEA MASALA POWDER

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ABSTRACT

Medicinal plant plays an important role in curing various types of diseases and acts as a good Nutritive source. More than 80% of Asian and African peoples uses herbal medicine as a Precaution and treatment. *Hibiscus rosa sinensis* an ornamental plant with huge medicinal properties against diabetes, inflammation and hepatic disease. The prevalence of diabetes increases day by day worldwide. This study focus on the development of health effective Hibiscus Tea Masala Powder providing possible therapeutic effects. Comparison of Proximate analysis of fresh hibiscus flowers and dried flowers. . Phytochemical analysis confirmed the presence of Alkaloids, Amino acids and Proteins, Phytosterols, Carbohydrates, Terepenoids and Saponins. Proximate analysis such as Carbohydrates, Proteins, Fat, Energy, Crude fiber, Ash, Moisture, Iron, Sodium, Potassium was found in Hibiscus Tea Masala Powder. DPPH Assay was performed for antioxidant analysis. Statistical and Cost Analysis of Hibiscus Tea Masala Powder Showed the feasibility of the product and Formulation included Trial and error method, Sensory evaluation was done based on 9 point hedonic scale for the product formulation such as Hot Tea with and without milk.

Keywords: *Hibiscus rosa sinensis*, Tea Masala Powder, Therapeutic effects, anti-diabetic activity, Phytochemical analysis, Proximate Analysis, Statistical Analysis.

1. INTRODUCTION

1.1 New Product Developement

According to Bahuguna et al (2018) The nutritional composition and antioxidant activity of dehydrated red Hibiscus rosa-sinensis flowers were studied to develop value added products by incorporating the dehydrated flower powder to increase the consumption of edible flowers in the daily diet. Three different variations of the chocolates, cake and shrikhand was prepared by incorporating dehydrated hibiscus powder and was subjected to acceptability studies. Al-Snafi (2018) showed that Hibiscus rosa-sinensis contained tannins, anthraquinones, quinines, phenols, flavanoides, alkaloids, terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugars, mucilage, essential oils and steroids. The previous pharmacological studies revealed that Hibiscus rosa-sinensis possessed reproductive, antidiabetic, fibrinolytic, hypolipidemic, antioxidant, antiinflammatory, antipyretic, analgesic, immuno-modulatory, anticonvulsant, antidepressant, memory enhancement, cytotoxic, antimicrobial, antiparasitic, dermatological, anti-haemolytic, urinary, hepatoprotective, neuroprotective, antitussive and many other effects.

India is the largest producer and consumer of some important common spices. Commercial cultivation in India is undertaken on 27 spices besides the herbal spices. Spices and herbs are mostly used as seasonings to impart flavors, pungency, aroma and color in the food. In addition, spices enhances shelf life of the food by preventing and delaying the spoilage and by preserving the sensory attributes of food products. Spices contain several important phytochemicals like aromatic compounds, essential oils, phenolics and pigments which imparts characteristic flavour and aroma and gives a herbal appeal to the food and beverages and enhances their consumer acceptability.

2 Materials and Methods

2.1 Selection of ingredients

Formulating a flavorful masala tea powder involves selecting a balanced blend of spices and other ingredients.

- **Adhimathuram:** Intrinsically sweet taste
- **Bay leaf:** adds bitter and pungent taste
- **Fennel:** Adds a mild licorice flavor.
- **Mace:** Slightly sweet taste with spicy fragrance
- **Rose:** Slightly sweet and floral
- **Cinnamon:** Adds sweetness and warmth.
- **Cardamom:** Both green and black cardamom pods can be used for a unique flavor.
- **Cloves:** Provide a warm, pungent taste.
- **Black Pepper:** Adds a subtle heat.
- **Ginger:** Fresh or dried ginger brings a spicy kick.
- **Nutmeg:** A small amount can add depth to the flavor.
- **Star Anise:** Imparts a hint of licorice flavor.
- **Tulsi (Holy Basil):** Adds a herbal note and is believed to have health benefits.

2.2 Phytochemical Analysis and Proximate analysis

Phytochemical Analysis such as Test for tanins, phenols, Saponins, Flavonoids, Terepenoids, Glycosides, alkaloids, Carbohydrates and steroids. Proximate analysis such as Moisture Content, Ash, Crude Fibre, Fat, Carbohydrates, Protein, Sodium and Potassium.

2.3 Sensory Evaluation of Hibiscus tea masala powder

Developed products are Organoleptically evaluated by the semi trained panelist by using the 9 point hedonic scale. Average of scores for all sensory characteristics, viz., color, appearance, flavor, texture, taste was expressed in terms of overall acceptability. Graph is plotted based on the acceptability of the Tea made with Hibiscus Tea Masala Powder

2.4 Statistical and Cost analysis

One way anova was carried out for identification of significance of the product. Cost analysis was carried out to know the market feasibility of Hibiscus Tea Masala Powder.

3. Result and Discussion

Fresh *Hibiscus rosa sinensis* flower were collected from local plants of Salem, India. Samples were cleaned, shade dried for 96 hrs, to remove all the moisture content from the flowers.

3.1 Composition OF Hibiscus tea masala powder

S.no	Ingredient	Qty in %
1	Cardamom	55%
2	Dried Ginger	28%

3	Black pepper	5.4%
4	Fennel	4%
5	Star Anise	1%
6	Basil	0.4%
7	Nutmeg	0.4%
8	Cinamon	0.4%
9	Hibiscus	1%
10	Mace	0.5%
11	Clove	0.5%
12	Rose	1%
13	Bay leaf	0.4%
14	Adhimadhuram	2%

Table 3.1 Composition of Hibiscus based tea powder

3.2 PHYTOCHEMICAL ANALYSIS

Table 3.2 Phytochemical analysis of Hibiscus tea masala powder

S.NO	Phytochemical test	Nutritional Supplement
1	Alkaloids	+
2	Glycosides	-
3	Flavonoids	-
4	Amino acids and proteins	+
5	Phytosterols	+
6	Carbohydrates	+
7	Tannin & Phenol	-
8	Saponins	+
9	Terepenoids	+

Table 3.3 Comparison of Proximate Analysis

S.no	Parameters	Fresh Flowers	Dried Flowers	Nutritional Supplement
1	Moisture	84.57 %	0.10 %	77.47 %
2	Ash	5.4439 %	6.456 %	7.442 %

3	Fat	0.72 %	1.50 %	1.35 %
4	Crude Fiber	1.165 %	7.27 %	2.01 %
5	Protein	1.57 %	12.18 %	3.12 %
6	Carbohydrates	6.11 %	72.5 %	10.07 %
7	Energy	41.24 Kcal	352.22 Kcal	288.38 Kcal
8	Calcium	972.80 mg/kg	3627.84 mg/kg	1567.22 mg/kg
9	Iron	Nil	22.0625 mg/kg	10.34 mg/kg
10	Potassium	201.7 mg/100g	1998.65 mg/100g	789.34 mg/100g
11	Sodium	45.9 mg/100g	430.15 mg/100g	134.68 mg/100g

While comparing the moisture content of fresh flowers, dried flowers and nutritional supplement, fresh flower was high with 84.57 %. Ash content is high in nutritional supplement as 7.442 %. Dried flowers have high fat content when compared with fresh flowers and nutritional supplement as 1.50 %. Crude fiber is very much high in dried flowers as 7.27 %. 12.18% of protein is found in dried flower which is higher than nutritional supplement. 10.07% of carbohydrate is present in nutritional supplement. 288.38 Kcal of energy is produced by nutritional supplement. The moisture content of nutritional supplement is comparatively low when compared to fresh flowers as 77.47 % and 84.57 % respectively. The mineral content of nutritional supplement is comparatively high when compared to fresh flowers as 7.442 % and 5.443 % respectively. The fat content of nutritional supplement is comparatively high when compared to fresh flowers as 1.35 % and 0.72 % respectively. The fiber content of nutritional supplement is comparatively high when compared to fresh flowers as 2.01 % and 1.165 % respectively. The protein content of nutritional supplement is comparatively high when compared to fresh flowers as 3.12 % and 1.57 % respectively. The Carbohydrate content of nutritional supplement is comparatively high when compared to fresh flowers as 10.07 % and 6.531 % respectively. The energy of nutritional supplement is comparatively high when compared to fresh flowers as 288.38 % and 41.24 % respectively. The calcium content of nutritional supplement is comparatively high when compared to fresh flowers as 1567.22 mg/kg and 972.80 mg/kg respectively. The Iron content is only present in nutritional supplement 10.34 mg/kg respectively. The Potassium content of nutritional supplement is comparatively high when compared to fresh flowers as 789.34 mg/kg and 201.7 mg/kg respectively. The Sodium content of nutritional supplement is comparatively high when compared to fresh flowers as 134.68 mg/kg and 45.9 mg/kg respectively.

3.3 Antioxidant activity:

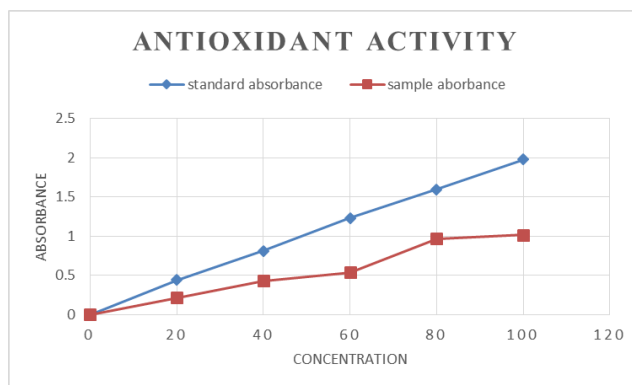


Figure 3.1Antioxidant activity of *H. rosa sinensis* compared to ascorbic acid. Ascorbic acid() Nutrition Supplement(■).

It is found that Hibiscus based tea masala also has potential antioxidant capacity when compared with standard ascorbic acid. with the concentration in x- axis and Absorbance in y- axis the absorbance of different concentration of 20 mg/μl, 40 g/μl, 60 mg/μl, 80 mg/μl and 100 mg/μl.

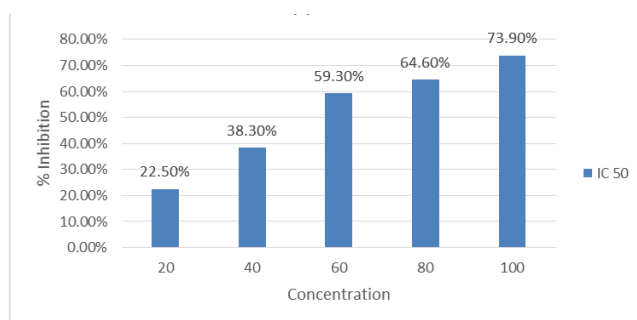


Figure 3.2 Inhibitory effect of Hibiscus based tea masala powder on Antioxidation in comparison with standard ascorbic acid.

The inhibition concentration for antioxidant activity, Concentration of ascorbic acid as standard and concentration of Tea Masala as sample, IC50 value was plotted in graph. 20 mg/μl showed 22.50% of inhibitory value. 40 mg/μl showed 38.30% of inhibitory value. 60 mg/μl showed 59.30% of inhibitory value. 80 mg/μl showed 64.60 % of inhibitory value. 100 mg/μl showed 73.90% of inhibitory value.

3.4 Statistical analysis

Table 3.4 One way Analysis

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.885714	4	0.471429	0.642857	0.636152	2.689628
Within Groups	22	30	0.733333			
Total	23.88571	34				

Hibiscus based tea masala is significant because of F value is less than F critical value.

3.5 Cost analysis of Hibiscus BASED tEA MASALA POWDER

Table 3.5 Cost Analysis of Hibiscus based Tea masala powder

S.no	Raw material	Quantity (g)	Cost /kg (Rs)	Cost / Quantity(Rs)
1	Cardamom	550	1500	825.00
2	Dried Ginger	280	200	56.00
3	Black pepper	54	600	32.40
4	Fennel	40	400	16.00
5	Star Anise	10	900	9.00
6	Basil	4	280	1.12
7	Nutmeg	4	860	3.44
8	Cinamon	4	600	2.40
9	Hibiscus	10	230	2.30
10	Mace	5	2500	12.50
11	Clove	5	950	4.75
12	Rose	10	300	3.00
13	Bay leaf	4	250	1.00
14	Adhimadhuram	20	280	5.60
15	Sub cost			974.51
16	Packaging Material	cost @1kg	15	15.00
17	Label Cost		30	30.00
18	Labour/day		25	25.00
19	Sub total			1044.51
20	Interest on Investment at 12%			116.94
21	Building Maintainance @5%			48.73
22	Equipment Maintenance@5%			48.73
23	Electricity@20%			116.94
24	Profit @10%			116.94
25	Loss @15%			116.94
26	Transport			10.00
27	Total cost /1000g			1619.73
28			For 100g	161.97

The cost calculation for the production of 1kg of Hibiscus based tea masala powder with optimum level of ingredients revealed the total cost of production was minimum Rs.1620/- per kg .

3.6 Sensory Evaluation of Hibiscus BASED TEA MASALA POWDER

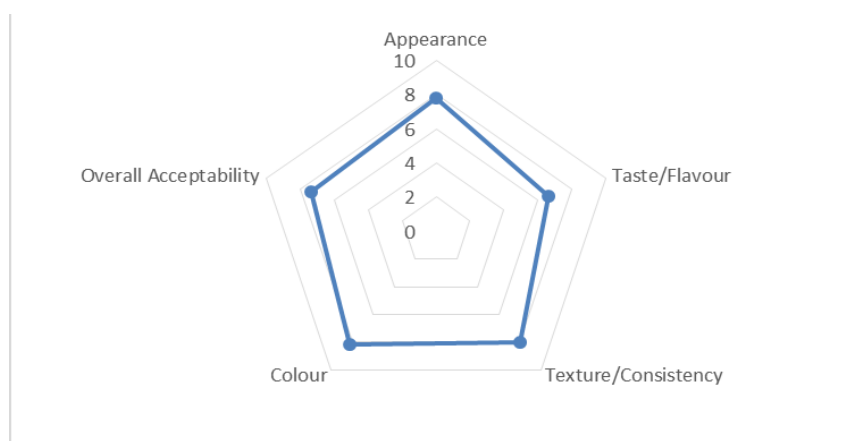


Figure 3.5 Radar representation of Sensory Evaluation of Hibiscus based tea masala powder

Tea possessed good flavour and smell. Average of 5 panelist score for attributes, Results showed 8 for appearance, 7 for taste/flavour, 7.7 for texture and Consistency, 7.7 for Colour, 7.9 for overall acceptability

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84 DEVELOPMENT OF MEDICAL PLASTERS AND BANDAGES USING ARTHROSPIRA PLATENSIS

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Abstract

Medical textile is one of the highly developing fields in technical textile. There is wide range of textile materials used in medical field in which bandages made of textile material plays a vital role in wound dressing. Our purpose of the study is to increase the efficiency of wound healing activity without using any toxic chemicals, which causes various side effects later on. Wound dressing material is made of various natural substances like spirulina (microalgae), Aloe Vera and Ocimum Basilicum (basil seed). Each component has its own function in wound healing due to various functions like anti-oxidant, anti-inflammatory, anti-fungal, anti-viral and digestive enzymes. Antioxidants are compounds, which inhibit oxidation. Oxidation is

the process of chemical reaction that can produce free radicals, thereby leading to chain reactions that may damage cells of living organisms. Anti-inflammatory is the property of a substance or treatment that reduces inflammation or swelling. Resist in growth of fungus and virus, which enters the body parts, is known as anti-fungal and anti-viral respectively. The digestive enzyme of the *Ocimum basilicum* (basil seed) is applied over the fabric above the *Arthrospira plantensis* (spirulina) extract. When it gets contact with water molecules in the blood it converts into gelatinous and enters into the wound, which heals the wound quicker than the other medicines available.

1 INTRODUCTION

WOUND

A wound is a type of injury which happens relatively quickly and damages the skin tissue such as torn, cut, or punctured (an open wound), or where blunt force trauma causes a contusion (a closed wound). In pathology, it specifically refers to a sharp injury which damages the Epidermis of the skin.

HEALING

The healing of a wound is a complex, dynamic and continuous process aiming at the repairing of damaged tissue. The efficient treatment system of a wound is very important to improve the healing process, in terms of both quality and time, as well to reduce the costs associated with the treatment.

Currently, there is a great variety of wound-care products, available in the market, including creams, solutions, dressings or skin tissue engineering substitutes. Among these products, bioactive wound dressings represent an effective method for wound treatment, presenting a good relationship between clinical efficacies and manufacturing cost.

However, for some types of wounds, such as infected wounds, use of bioactive wound dressings cannot be sufficient to promote the healing process, as many of these materials do not present therapeutic activity (e.g. antibacterial and anti-septic characteristics). In order to solve this limitation, some dressings, based on natural bioactive compounds, were developed incorporating different protein and compounds to reduce the growth of microorganisms in wounds. The continuous administration of protein contents in infected wounds though associated with the development and spread of antibiotic resistant strains of bacteria present satisfactory clinical results. To address this challenge, the potential of bioactive wound dressing material is being developed, consisting of *Spirulina plantensis*, *Aloe vera* and *Ocimum basilicum* seed for biomedical applications.

SPIRULINA

Seaweeds are present in a large scale as unused protein rich content. *Spirulina* contains large percent of beta carotenoids and associated proteins. This kind of material can be used to produce the hygienic material. So the aim of the project is to produce the medical textile product with the help of *spirulina*.

Spirulina plantensis is a filamentous blue green algae, it grows naturally in fresh, brackish, sewage water and even in saline environment. It grows through photosynthesis, hence, can be termed as vegetative food. It has been already affectively promoted as a natural food. It holds valuable compounds like polyunsaturated fatty acids (PUFA), phycocyanin and phenolic, which act as antioxidants. It is also used as nutraceutical agent due to the presence of macro and micronutrients like carbohydrates, proteins, essential fatty acids, vitamins (B-complex, vitamin E and carotenoids), magnesium, selenium, copper, manganese, zinc and iron. Several strains of blue green algae are well known for diverse biological activities such as antibacterial, antifungal, cytotoxic, algacide, immunosuppressive⁹ and antiviral activities

ALOE VERA

Aloe Vera is a green colour plant with thick, fleshy, tapered, spiny, marginated and dagger shaped leaves growing from a short stalk near ground level. *Aloe Vera* is the most widely used species, both commercially and for its therapeutic properties. This plant contains two materials with a juicy consistency: the first, a yellow exudate containing a high concentration of anthraquinone-type compounds, which have been used for decades

as cathartics and purgatives, and the second, a clear mucilaginous gel that has been used since ancient times for the treatment of burns and other wounds.

OCIMUM BASILICUM

Basil seeds have been used in traditional medicine for a long time to treat colic ulcer, dyspepsia, diarrhoea and inflammations, among others ailments. In many parts of Asia, basil seeds are frequently included in beverages (Sharbat) and ice desserts (Faloodeh) for aesthetic purposes as well as a source of dietary fibre. Sweet basil seeds are also known as sabja seeds, falooda seeds, tukamaria seeds. When the seed of *Ocimum basilicum* is soaked in water, the outer pericarp swells into a gelatinous mass due to the presence of a polysaccharide layer.

WOUND DRESSING

The range of dressing materials manufactured on the basis of Textiles is very wide. Overall, dressing materials can be divided into those which have direct contact with a wound and outer, protective dressings, which are put on those direct once. Dressings that adhere to the wound have a big influence upon the way and time of wound healing, and also upon the psyche and general feeling of patients, resulting from the degree of laboriousness of keeping these dressings and changing them. From this reason, dressings are in the centre of particular interest of medical services as well as producers of dressing materials. With a help of doctors, engineers and technologists employed in health service, research institutes and in industry, trying to take these aspects into account, better and more modern dressing materials are developed. They shorten the time of wound healing and are characterized by improved comfort of use by patients. The desired properties required for modern dressing materials, especially these having direct contact with the wound.

- Healing properties, regulated mainly with substances applied to or added to the dressings
- Causing no mechanical injury of granulating wound
- Decreased adherence surface
- Eliminating a possibility of loose fibres caught in the wound.
- Stable and spatial structure
- Easy penetration of wound secretion to the absorbing dressing
- Non-interrupted process of wound healing-as only the outer gauze compress is changed

PAINLESS CHANGING OF THE DRESSING

Textile substrates have wide applications in wound dressing materials. These dressing materials coated with aloe vera, which is more effective against bacteria is an ideal material for wound care applications without losing their inherent textile features. The substrate used as wound dressing materials should act as reservoir of antimicrobial agents and should release them regularly at the unnatural site for a sustained period of time. Wounds have been characterized in many different ways, but they all commonly reflect the differences in the required treatment, the expected time and prospects of healing. The classification of wounds identifies the type of injury (blunt contusion, sharp laceration, thermal, chemical, etc.), the extent of tissue loss, the presence of infection, foreign bodies and underlying structural injuries.

OBJECTIVE

In this present work spirulina, protein content is used for producing wound care and dressing materials because of its bio-compact ability and bio-degradability and other excellent biological, physical and chemical property. Now we expect our spirulina coated material can perform very well when compared to the conventional material.

The objectives of the work is

- To determine the wound healing efficiency of spirulina
- To determine the antifungal activity of aloe vera
- To determine the moisture absorbing efficiency of Ocimum basilicum seed
- To develop and characterize the spirulina coated wound dressing material

2 MATERIALS AND METHODS

MATERIALS

The raw materials used in this work are non-woven fabric, spirulina plantensis, aloe vera and ocimum basilicum seed.

Non-woven Fabric

The material selected for this study is spun bonded non-woven fabric consist of Viscose/cotton in the blend ratio of 80:20. The spun bonded non-woven fabric is selected because it has excellent water absorbency, breathability and hygiene property. The fabric is sourced from Rade MYRA non-woven industry pvt ltd.

Spirulina

Spirulina platensis is a potential source of high value compounds with functional properties e.g., phycocyanins, carotenoids, phenolic acids and omega-3 and omega-6 polyunsaturated fatty acids. Spirulina is a great source of beta-carotene (provitamin A) and vitamin B-12. Vit B-12 is very useful in treatment of pernicious anemia. Carbohydrates - Glucose, rhamnose, mannose, xylose and galactose etc are found in microalgae biomass. spirulina plantensis is directly purchased from Vetra spirulina private limited, Coimbatore.

Aloe vera

Aloe vera is consists of 98-99% water and the remaining 1-2% contains the active compounds, such as aloesin, aloin, aloemodin, aloemannan, acemannan, aloeride, naftoquinones, methylchromones, flavonoids, saponin, sterols, amino acids, and vitamins. The levels of these compounds vary according to species, strain, and growth conditions. The pharmacological actions of Aloe vera include anti-inflammatory, antibacterial, antifungal, antioxidant, immune-boosting and hypoglycemic properties. Aloe vera leaves are collected from our home garden.

Ocimum Basilicum seed

Sweet basil seeds are also known as sabja seeds, falooda seeds, tukamaria seeds. O cimum basilicum is the technical name, which represents the basil seed. Ocimum basilicum seed is purchased from Tirupur.

Chemicals

The chemicals such as ethanol are purchased from Microtroniks Quali-Tech chemicals, Agra. The other chemicals Such as diclofenac, chloroform and other auxiliaries are purchased from Tirupur

METHODS

Preparation of spirulina wound dressing material.

Chemicals Required

Ethanol

Distilled water

Glassware& equipment required

Beakers

Polymeric tray

Centrifuge tubes

Pipettes

Funnels

Filter papers (What man no 1)

Equipment required

Weighing balance

Centrifuge machine

Ortex machine

Vaccum filter

PROCEDURE

Spirulina powders were extracted with ethanol (20 mg/100mL). 20mg of spirulina powder is dissolved in 100ml of solvent. The spirulina powder is mixed thoroughly by stirring for 30 min and remains untouched for about 24 hours. Extracts were then filtered through What man no. 1 filter paper in a Buchner funnel under vacuum. The filtered Spirulina extract is stored until use.

Aloe vera the spines of the leaf were chopped and the upper layer of the skin called rind was opened longitudinally to collect the gel. The collected gel is mixed with electrical blender to get a low viscosity of aloe vera gel. Then the gel was homogenized to make a crude paste and used for further process. Basil seed mucilage was obtained by Vacuum filtration process. The whole nutlets were soaked in aloe vera gel, in a seed: gel ratio of 1:50. The mucilage of basil seeds was extracted by continuous centrifuge on a electrical centrifuge at 10000 rpm for 40 min at 40°C. Vacuum filtration was carried out to remove all likely seed residuals from the separated mucilage.

COATING OF SPIRULINA/ ALOE VERA/ OCIMUM BASILICUM SEED ON NON-WOVEN FABRIC

The spun bonded non-woven is washed in distilled water and dried in oven to get better absorbing efficiency. The dried non-woven fabric is weighed in weighing balance, based on the weight of the fabric amount of extract required is calculated.

The non-woven fabric is placed in a polymeric tray and the ethanol extract of Spirulina is poured inside the polymeric tray. The tray is left undisturbed for about 15 minutes, effective absorption of spirulina extract will take place. Finally the fabric is dried in the room temperature for about 18 hours. The ethanol content evaporates in air and spirulina coated non-woven material is covered with aluminium foil sheet, then stored for further use.

After 24 hours, the fabric is placed on a smooth surface. Then the extracted mucilage of basil seed is poured on the top of the coated non-woven fabric. Mechanical holder is used to clamp the fabric firm and tightly, squeegee is used to spread the mucilage evenly over the surface of the fabric. Ocimum basilicum (basil seed) is applied over the spirulina coated fabric. The fabric is dried at room temperature for 12 hours, then the same procedure is carried out for the other side of the fabric. Finally the fabric is dried for 14 hours and stored in a aluminium foil sheet.

CONCLUSION

Based on this study plasters and bandages using arthrospira platensis gave excellent result oriented properties. It increase the efficiency of wound healing activity without using any toxic chemicals, which causes

various side effects later on. This bandage material is made of various natural substances like spirulina (microalgae), Aloe Vera and Ocimum Basilicum (basil seed). This product resist in growth of fungus and virus, which enters the body parts. When it gets contact with water molecules in the blood it converts into gelatinous and enters into the wound, which heals the wound quicker than the other medicines available.

85 DEVELOPMENT OF HYGIENIC NAPKINS USING NATURAL FIBERS

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Abstract

The expectations from sanitary napkins, perception of sanitary napkin performance characteristics and the problems in current sanitary napkins were questioned. In addition, some information to design a novel/functional sanitary napkin was collected. However, they pose a menace to the environment because of the associated non-biodegradability. Conventional sanitary napkins are composed of around 90% plastic and harmful super absorbent polymers (SAP), which goes to landfill and remains there for centuries leading to an increased carbon footprint. A study conducted on major brands of sanitary napkins in India revealed that the presence of various phthalate groups harms neurological, cardiovascular, and reproductive systems in women and volatile organic compounds show harmful neurological effects including paralysis and memory loss. To overcome this environmental may hem and severe pathological effects, various approaches have been undertaken by researchers and government authorities. Plant-based alternatives aid the dire need to manufacture sanitary napkins which can decompose and leaves no threat to biodiversity. The use of organic materials like cotton, jute, bamboo, banana fibers, betal nut, areca, pineapple and neem leaves in making sanitary napkins holds magnanimous potential. This review sheds light on the grave issue of disposal and non-biodegradability of currently used marketed sanitary napkins, various biodegradable approaches and their importance over conventional sanitary napkins that can be adopted to overcome this environmental problem. There were some statistically significant differences between the expectations, sanitary napkin selection factors and problems of the women depending on the age and weight ranges.

Keywords: Napkins; Superabsorbent polymer; health effects; organic material; eco-friendly.

1. Introduction

The world is facing a very big problem of carbon footprint of feminine hygiene product. As there is a huge amount of non-biodegradable material dumped in landfill, which releases harmful gasses into to the atmosphere. India is being a developing country, with a population of 1.34 billion, out of which 323.6 million females between the age group of 15-49. A study in 2017 showed that on an average 240 sanitary napkins are used by menstruating women each year. 10,000–12,000 disposable menstrual products are used by a woman in her lifetime. Moreover, obesity is a global health concern, affecting millions of people of all ages and backgrounds. Plus-size individuals, particularly women, face unique challenges in their daily lives, and one such challenge is finding personal care products that cater to their specific needs. The most of the commercially available sanitary napkins are made up of synthetic material and super absorbent polymers (SAP). These materials are non-biodegradable in nature and add to pollution load due to improper disposal and waste management. These synthetic non-biodegradable materials are not only a threat to the environment but also a serious threat to the user itself. Use of such sanitary napkins is also one of the identified risk factors for the reason behind cervical cancer. The raw materials used in commercial sanitary napkins focuses mainly on

absorbing blood fluids, surface dryness for comfort, odour free fragrance finish and compactness of napkin for wearers comfort whereas least importance is given for environment and human health. Serious health risks for the wearer have been reported due to the harmful chemicals and fragrance used in commercial sanitary napkins. Another issue is the cost of the sanitary napkin which is far from the economical level of average and below average community in the country. Affordable sanitary pads and diapers can be produced using locally available materials from anti-bacterial biodegradable cellulosic materials. Sanitary pads made from anti-bacterial biodegradable cellulosic fiber materials would also be more environmentally friendly than the synthetic non-biodegradable commercial pads. Leftovers of many natural products during their processing end up creating an increased amount of waste material. Incorporating the industrial waste in the absorbent layer to generate eco-friendly napkins retains the sustainable tripod and also reduces the cost which will make napkins affordable by women of every class in society.

In this context, proposing a review aimed at developing a high liquid-holding napkin from plant based alternatives such as pine apple, nano cellulose fiber, tailored to address the comfort and convenience requirements of average and fat women. This review focuses on creating a multilayer, environmentally friendly sanitary napkin using biodegradable materials. The re-designed shape of the sanitary napkin aims to provide a better fit for fat women, ensuring improved comfort and reduced chances of leakage or discomfort during use. By incorporating a plant fiber as a core material, the objective is to enhance the napkin's fluid holding capacity. This allows for improved absorption and better protection against leaks, providing women with a higher level of confidence and convenience.

History of materials used for sanitary napkin

Sanitary napkin was the first disposable article of commercial significance and introduced in 1921. The first menstrual tampon was introduced by Tampax Corporation in 1933. The original Tampax brand tampon was made of cotton fiber wrapped in a nonwoven rayon coversheet. Today, the absorbent medium used in most modern tampons is cellulose fluff. Another development in absorbent technology occurred in the 1960s with the advent of superabsorbent. Superabsorbent diapers were introduced in Japan in 1979, but have only become widely used in the west since 1984[1]

Currently, the world is facing a very big problem of carbon footprint of feminine hygiene product. As there is a huge amount of non-biodegradable material dumped in landfill, which releases harmful gasses into to the atmosphere. India is being a developing country, with a population of 1.34 billion, out of which 323.6 million females between the age group of 15-49. If we consider that 10% of Indian women uses disposable sanitary pad then each individual will generate at least half a kilo of waste a month. In that way, 10% of the female population in India will generate 16180 tons of waste every month. In order to deal with it, we need to focus on developing a more sustainable product by choosing the raw material having low carbon footprint. Material which are used in feminine hygiene product are derived from natural resource mostly petroleum based which cannot be reused or compost and at the same time over-exploitation of these resources have to be stopped otherwise nothing will be left for our future generation. We have to find an alternative raw material that is sustainable in nature, without compromising on the functional requirement of the product [2].

Hygienic issues pertaining to the utilization of sanitary napkin

Menstrual hygiene is an issue that every girl and women had to deal with in her life, but nowadays there is a lack of awareness about the physical and psychological changes associated with puberty and menstruation process for managing and regulating menstruation. The commercially available menstrual hygiene pads are mainly laced with dioxins, petrochemicals, and artificial fragrances and when these chemicals react with the sensitized skin tissue, it can cause skin irritation. The ingredients present in the synthetic pads are problematic for female reproductive system as it is very sensitive and absorptive.

Choice of alternative materials to synthetic sanitary napkin

In order to overcome and reduce these severities, we can use natural materials like banana fiber, bamboo fibers, papyrus, cotton, water hyacinth, aloe vera, hemp with antimicrobial activity for preparing sustainable sanitary pads. The presence of bamboo in sanitary napkins so that it is an excellent absorbent material compared to cotton and also can reduce the complications of women during menstruation [3]. Menstrual hygiene products used by women have evolved in the past several decades with comfort, ease of use and cost driving women's choices. In a country like India, where women form nearly 50% of the population, the sheer volume of periodic menstrual non-biodegradable waste generated has significant environmental implications. With majority of the country hailing from low-middle class backgrounds, observing healthy menstrual hygiene practices with environmentally friendly products necessitates the consideration of affordable and highly sustainable alternatives. Further, during the COVID-19 pandemic, period poverty is higher than ever, causing women to turn to the reusable product market for affordable and long-lasting alternatives. Hence, we studied the Feasibility and Acceptability (FA) of a novel banana fiber based menstrual pad (BFP) amongst women living in rural and urban environments [4].

Menstrual hygiene is an often-ignored problem in international development: lack of access to sanitation keeps women out of schools and the labor force. Sanitary napkin solutions to this issue normally focus on supply chain and manufacturing. This study aims to look at solutions from a materials perspective, assessing available materials for the properties needed for a good napkin, and reviewing the literature for comparison between these and other materials. Tests for absorption, comfort, durability, and drying time are measured on materials ranging from foam to traditional cottons both individually and in combination. These tests include microscopy observations, retention and wicking rate, tensile resistance, stiffness, and roughness. Though no single design emerges as the most effective for this application, clear differences emerge across materials that narrow down the options for optimal design. This information, in conjunction with user testing, can be used to inform local designs for sanitary napkins across borders [5]. The functional unit chosen for the analysis, as the reference to express the environmental impacts on par with ISO 14040 (ISO 14040, 2006) recommendations, was the production of the total number of products used to cover the need of a menstruating person for one year. This functional unit highlights the fact that menstruators will use many more disposable products (tampons and pads) than reusable ones. Previous studies set this number for disposable products (nonorganic and organic) at 240 per year. For reusable products, we calculated the number from brands websites that suggested the number of products used per typical cycle and product lifespan. For reusable pads, we estimated ten products per cycle with a lifespan of five years or approximately the use of 2 products/year. For the menstrual underwear, we determined a use of three products per cycle with a lifespan of five years or 0.6 products/year. For the menstrual cups, we found that users typically buy two, each of which can be used for ten years resulting in 0.2 products/year [6].

Design structure of sanitary napkin

Presently available sanitary pads are mainly comprised of three parts: a fluid permeable top sheet, an absorbent core of cellulosic patch, and an impermeable back sheet. The soothing top sheet is made of a polyethylene/polypropylene fabric which is not woven. A core is a polyacrylate polymer foam while a back sheet is a polyethylene film with an adhesive. Fragrance is added between the core and the back sheet in scented pads. This overall composition includes volatile organic compounds (VOCs) such as styrene, chloromethane, chloromethane, chloroform, acetone, which are classified as carcinogens, phthalates, dioxins, dioxin-like compounds, furans, and methyl dibromo, glutaronitrile (MDBGN). These VOCs have been subjects of studies in terms of safety, as their toxicity easily affects the reproductive function by hindering a precisely operating feedback system, an accurate timing and balance, and appropriate communication between cells and organs. In addition, a seemingly minor dysfunction in the reproductive system caused by their toxicity can greatly affect reproductive disorders and further pregnancy outcomes, implying the need for studies on the VOCs [7]. Purchasing a menstrual cup is 5% to 7% of the cost of disposable pads and tampons over an individual's life

cycle, making increasing access to menstrual cups economically effective to menstruators around the world. Similarly, as most reusable cloth pads can be washed and reused for 5 to 10 years and most period underwear for 2 to 6 years, the cost per menstrual cycle is also significantly lower than using disposable products. In addition to being more cost-effective over time, reusable menstrual pads, underwear, and cups may also be part of the solution for product distribution challenges, as providing disposable single-use monthly menstrual supplies (as well as the associated monthly waste management concerns) is a significant issue in many areas around the world [8]. Toilet facilities designed to accommodate menstrual hygiene practices, provide access to absorbents, and encourage safe handling and disposal of used absorbents are important measures supporting women's health and dignity. In the design of communal toilets, disposal of menstrual waste has often been overlooked, leading to improper waste disposal. To improve this situation in the future, knowledge of the variety of current menstrual materials is required. For example, if thermal treatment technologies are considered, these will need to be optimized for different materials. Disposing of menstrual blood can have particular cultural considerations, and the breadth of these needs to be fully understood before designing a technology. Menstruation is still regarded as an impure and unsanitary process in developing countries, including India, and is associated with certain taboos, stigmas and cultural interventions. In India, girls are missing school and even dropping out because of their inability to manage and afford commercial sanitary products to practice better menstrual hygiene. Absenteeism causes loss of studies for girls every month due to lack of toilet and water facilities at school and the fear of staining their clothes [9-11].

Selection of material and its skeleton for sanitary napkin

Sanitary napkins comprise of multi-layered structure made up of non-biodegradable materials like polyethylene, polymeric films, wood pulps degrading environment each day, which is the leading concern of the economy. The top sheet of sanitary napkin consists of thermoplastic fiber and hydrophilic absorbent fiber, the absorbent core is made up of wood pulp and polyethylene and polymeric film used as barrier sheet are non-breakable by bacteria and poisons environment which is shown in the Fig.1. Women hygiene products are the necessary commodities but from the point of view of environment they are the bad commodities but feminine population dependency on sanitary napkin has increased notwithstanding of its negative effect on environment [12]. Affordable sanitary pads and diapers can be produced using locally available materials from anti-bacterial biodegradable cellulosic materials.

Sanitary pads made from anti-bacterial biodegradable cellulosic fiber materials would also be more environmentally friendly than the synthetic non-biodegradable commercial pads. Sanitary napkins were disposed to open environment leading to contamination and pollution. These cannot be recycled or reused [13].

Sanitary napkins contain multilayered structure and each layer should have some specific function. Banana fiber, organic cotton, muslin cloth and canvas cloth were used as a source of material. Banana fiber is naturally occurring material and completely degradable and poses no side effect to humans and environment organic cotton as top layer is one the generally prompted crude material in napkin due to its non-aggravation, tissue-friendly and prevalent fluid maintenance properties. Cotton material keeps away moisture and keeps skin dry and makes skin comfort [14]. More research is happening in developing an eco-friendly sanitary napkin, with multilayer construction by using biodegradable resources. Hybrid top sheet was developed by needle punching wool fibre over cotton non-woven fabric to keep the top sheet dry. Three different combinations of core layer were tried by sandwiching SAP (Super Absorbent Polymer) sheet between cotton, bamboo and a blend of cotton/bamboo (50/50). Biodegradable polyethylene plastic was used as barrier layer.

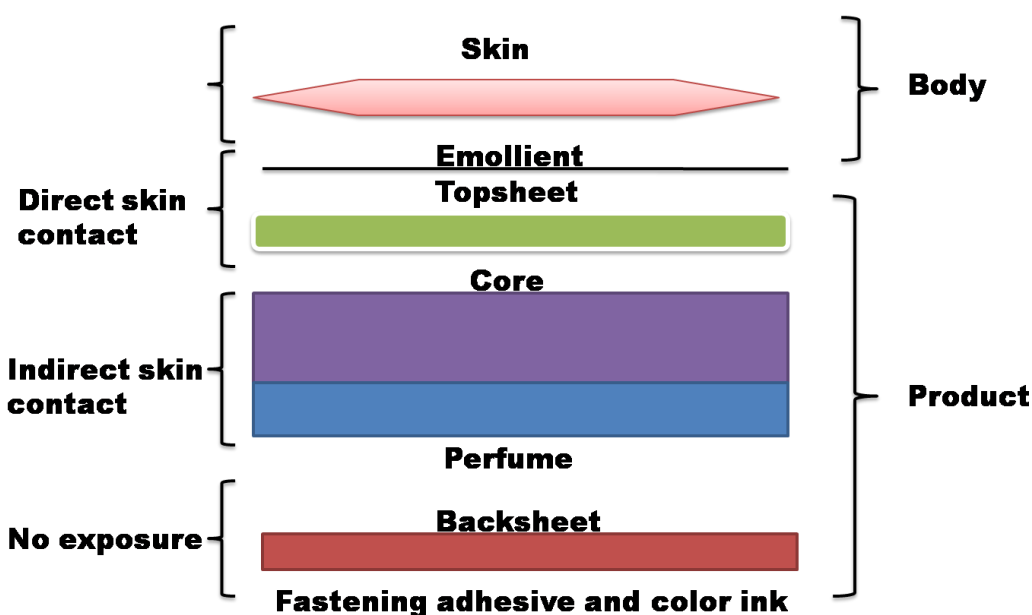


Fig 1. Sanitary napkin components with consumer exposure

The performance of sanitary napkin was assessed by absorption capacity, strike through, wet back test. Two natural herbal extract (*Curcuma longa* and *Azadirachta indica*) were used as antimicrobial agents. It is revealed from the results that sanitary pad made of bamboo core with *Azadirachta indica* finished top sheet shows best menstrual hygiene performance [15]. Emphasis is given to use of naturally available absorbent fibers such as organic cotton, banana fibre, jute, bamboo etc., which are widely available and biodegradable in nature having low carbon footprint which not only makes it eco-friendly but also reduces the cost of sanitary pad. And to enhance the retention of fluid cellulose based hydro gel can be used instead of synthetic super absorbent polymer. Sustainability of hygiene product can be attained by replacing petroleum based raw material with an eco-friendly one [2]. Synthesizing superabsorbent material from polysaccharides, which are derived from environment-friendly raw materials like ligno-cellulosic agro-waste.

Figure 2 shows the availability of various natural fibers and other natural ingredients used for producing the napkins. Three ligno-cellulosic agro-waste fibers, namely banana, sisal and bagasse, have been taken for this particular review, to synthesize natural superabsorbent polymer which are eco-friendly and biodegradable. Cellulose has been extracted from sisal, bagasse and banana, of which cellulose yield has been high for banana fibers. Carboxyl methyl cellulose (CMC) synthesized from the extracted cellulose is cross-linked with aluminium sulphate octa decahydrate to subsequently synthesize superabsorbent polymer from these agro-waste fibers. The synthesized CMC from all the three agro-waste fibers shows great reduction in immersion time; CMC from sisal shows the least immersion time of 2.67s. Banana fibers have recorded the highest degree of substitution.

The superabsorbent polymer synthesized from banana fibers has shown an increase in absorbency and swelling rate but reduction in immersion time [16]. Managing menstrual hygiene in the least developed countries represents a significant obstacle for women and girls. Commonly dirty stuffs are used to control the menstrual cycle which causes many diseases, while disposable hygiene absorbent material during menstruation is an essential requirement. Most local commercial sanitary napkins offer high absorptiveness and flexibility; however, most of them, due to the use of synthetic superabsorbent polymer (SAP) within the core layer, are not biodegradable and harmful to human skin. This research aims to create a sanitized and biodegradable pad in order to replace SAP with environmentally sound biopolymer that give rural poor women competent performance and characteristics [17].

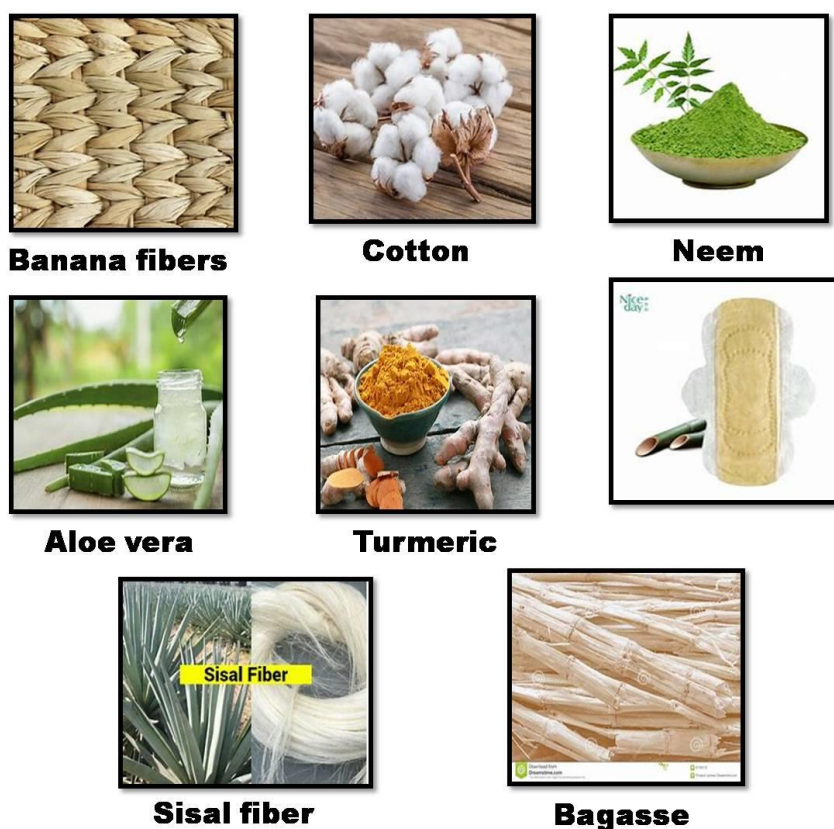


Fig.2 various natural fibers and ingredients employed for producing napkin

Bio-SAPs were synthesized by crosslinking citric acid with carboxymethyl cellulose, derived either from cellulose fibers as reference source, or from recovered cardboard. Different particle sizes were used and their influence on the final properties of the bio-SAPs is described [18]. Almond gum has received less attention in India, resulting in total wastage of this exudate. The state can produce sizeable quantities of this gum which could accomplish to broaden the spectrum of its use in food products. This natural polysaccharide is almost colorless, odourless and non-toxic which may qualify it as an additive in wide variety of food systems. Almond gum is a natural polymer composed, on dry weight basis, of proteins (2.45%), fats (0.85%) and carbohydrates (92.36%). Carbohydrates comprise of arabinose (46.83%), galactose (35.49%) and uronic acid (5.97%) with traces of rhamnose, mannose and glucose [19]. Grafting AA to starch is a common method to improve the water absorbency of starch-based water retention agents. For example, AA was used to polymerize with sulfamic acid-modified starch by solution polymerization. The water absorbency of the resulting product was 1026 g/g in deionized water and 145 g/g in 0.9 wt% NaCl solution as a result of the adsorption and transfer of water molecules by the sulfonic acid groups [20]. Pine apple is a cellulosic natural fiber extracted out from pineapple leaf (PALF) that is different from the regularly grown fruit. Fiber from pineapple can be done both manually and mechanically. This fiber is creamy, white and lustrous as silk with good bio composite qualities. It is 10 times as coarser as cotton but as fine as jute. It consists of high cellulose content, a large amount of hemicellulose, and some lignin, too. The moisture content of this fiber is 10% - 11.5%. The advantage of being cost-effective and delicate in texture adds value to its application in traditional formal wears and accessories. It imparts additional strength and an extra degree of dimensional stability. Pineapple fiber can be pulped chemically or with the application of enzymes. The pulp is then used in making industrial paper having many potential applications [21, 22]. Pineapple leaf fibres have superior mechanical properties due to their high composition of cellulose (74.33 %) compared to hardwood or softwood (Nadirah et al., 2012), thus making them suitable in producing good pulp for use as a core material in diapers. They have a white appearance, a silk-like feel, are smooth and soft and display higher tenacity than cotton fibers [23]. Cellulose and some

cellulose derivatives can play vital roles in the enhancement of the performance of absorbent products. Cellulose itself, in the form of cellulosic fibers or nano-fibers, can provide structure, bulk, water-holding capacity, and channeling of fluids over a wide dimensional range. Likewise, cellulose derivatives such as carboxymethylcellulose(CMC) have been widely studied as components in superabsorbent polymer (SAP) formulations. The present review focuses on strategies and mechanisms in which inclusion of cellulose – in its various forms – can enhance either the capacity or the rate of aqueous fluid absorption in various potential applications [24]. Most agricultural wastes are rich in cellulose. Through chemical and/or mechanical processes, nanocellulose can be extracted to produce superabsorbent hydrogels. As soil amendments, superabsorbent hydrogels act as water and nutrient reservoirs when applied in agricultural fields. This article reviews the recent advances in agricultural waste-derived nanocellulose-based superabsorbent hydrogels and discusses the possible impacts of their applications in agriculture [25]. This product was made of an outer leak-proof layer, a middle absorbent layer made of water absorbent material, and an internal contact layer made of water penetrating material [26].

To maintain a woman's health and personal hygiene, it is essential to use hygienic menstrual protection and the methods of menstrual production is shown in Fig,2. One of the organizations called NFHS-5 surveyed women aged 15 to 24 about their menstrual protection practices. In India, 41% of these women use sanitary napkins, 50% use cloth, and 9% use locally made napkins. Overall, 78% of women in this age group use hygienic methods to manage their menstruation.

Hygiene methods of menstrual protection

■ Sanitary Napkin ■ Cloth ■ Locally produced napkin

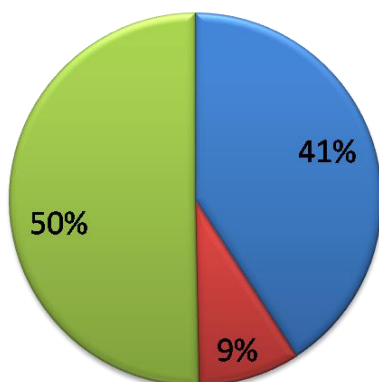


Fig.3 Representation of hygiene methods of menstrual protection using Pie chart

The lowest percentage of women using hygienic menstrual protection is found in Bihar (59%), followed by Madhya Pradesh (61%) and Meghalaya (65%). In contrast to urban women, who use hygienic menstrual protection at a rate of 90%, only 73% of rural women do the same. Sanitary napkins fulfill two primary functions: collecting and holding menstrual fluid, and keeping it separate from the body. They are designed to prevent leaks, avoid unsightly appearance or color, eliminate odors, remain silent, stay securely in place, be comfortable to wear (with a slim profile), and maintain a high level of hygiene. These are the key and desired characteristics.

The fibres of the materials were attached with a constituent capable of releasing far infrared anions to achieve a sanitary anti- bacterial effect and a nursing care condition [27]. The injection speed was set and the solution was filled into the syringe. The sanitary napkin was first weighted and stuck to a flat surface. A filter paper was then weighted and put on top of it. The pressure loading was put onto this bundle and testing can then be

started. After predetermined period, the syringe pump was stopped. The liquid uptake as well as the liquid spreading area in each layer was recorded [28]. This study investigated the physiological and psychological effects of sanitary napkins (SN) on women in hemorrhage treatment during the menstrual phase. Mesh and non-woven napkins were employed, and the effects were studied during the follicular and menstrual phases; mesh SN presented a higher textural surface-roughness. In both phases, the increases in systolic and diastolic blood pressure were significantly dependent on the application intervals. The low frequency component of systolic blood pressure variability significantly increased, while the salivary secretion rate decreased with the use of mesh SN during the follicular phase compared with non-woven SN [29].

Sanitary napkins are subjected to compressive forces as a result of moving, sitting, sleeping and other daily actions. The compression and subsequent thickness recoveries of sanitary napkins are repeated during the day. This can lead to fragmentations in nonwoven content and cause shape changes during usage. As a result, the wearer can feel discomfort and experience leakage. Also, compression can change the porosity, hydraulic and absorption properties of nonwoven layers. This can also adversely affect the absorptive performance of sanitary napkins [30]. Skin health related to the use of absorbent hygiene products has accordingly also greatly improved. Still, the wearing of absorbent hygiene products will affect the skin, and for some users the changes in microclimate, mechanical interactions and the exposure to urine and faeces may result in irritant contact dermatitis [31]. Although feminine pads and baby/adult diapers are used for different purposes, the main constituents of the absorbent hygiene products share similar functions and materials. The absorption capacity of disposable absorbent products had significantly improved with the implementation of superabsorbent polymer (SAP) in the core absorbent layer. The safety of SAP material has been evaluated rather thoroughly including its potential risks involving ingestion and dermal contact [32]. The sanitary napkins SOPs, testing procedures, standards are mentioned [33-40].

The development of biodegradable sanitary napkins has gained significant attention in recent years due to growing environmental concerns and the need for sustainable menstrual hygiene solutions. Table 1 provides the information of various patents related to biodegradable sanitary napkins, highlighting innovations, technologies, and materials used in their design and production.

Table 1. Literature survey on various patents on biodegradable sanitary napkins

Title	Study	Publication	References
Leakage-proof suction paper for sanitary towel	This invention pertains to the field of leak-proof paper, specifically designed for sanitary napkins. It addresses the issues of high cost and the potential health risks associated with the use of traditional sanitary napkins.		[41]
Water-dispersible fluid absorbent	This study seeks to develop water-dispersible sanitary napkins by incorporating various biodegradable polymers in different layers to improve both water dispersibility and biodegradability. Additionally, ultrasonic welding is employed to bind these layers together, eliminating the need for adhesives.	CN113395952A	[42]
Biodegradable sanitary pads	The sanitary napkin features a cover layer, an absorbent layer, and a waterproof layer (from top to bottom). Each of these layers is	KR102459823B1	

	intentionally crafted from biodegradable materials such as PBAT and PLA, while still maintaining all necessary physical and mechanical properties.		[43]
Non-adhesive Sanitary pad	This study aims to eliminate the use of adhesive in the top sheet of sanitary napkins by bonding the waterproof layer (made of LLDPE) with the top sheet and wing sheet through ultrasonic sealing or heat-sealing methods.	KR102409721B1	[44]
Environment-friendly absorption pad	The layers of the sanitary napkin are composed of different biodegradable materials. The top layer is made from Korean paper and bamboo, the absorbent layer consists of polylactic acid (PLA) and green tea, and the back sheet is made of PLA, making the sanitary napkin both biodegradable and user-friendly.	<u>KR20220053742A</u>	[45]
Hydrolysable eco-friendly sanitary napkin	The sanitary napkin in this study comprises several layers: a permeable endothelium, a pulp absorbent layer, a water-soluble film, an impermeable endothelium, and an adhesive layer made from hydrocarbon resin. The goal of this study is to create biodegradable sanitary napkins that also help control bacterial infections and unpleasant odors.	KR102383114B1	[46]
Sanitary pad including top sheet without adhesive and biodegradable sanitary pad	This study aims to eliminate the use of adhesive in the top sheet of sanitary napkins by bonding the secondary absorbent sheet, non-woven fabric, and top sheet using ultrasonic or high-frequency welding.	KR20210068210A	[47]
The hydrolyzable eco-friendly sanitary napkin	This study aims to produce biodegradable sanitary napkins that also help control bacterial infections and unpleasant odors. The layers include a permeable inner layer, an absorbent pad, and an impermeable waterproof outer layer, along with an adhesive layer.	KR102085567B1	[48]
Recycled biodegradable/bio-based sanitary pads	This study aims to produce biodegradable sanitary napkins using bagasse or recycled cigarette butts, combined with small quantities of fuller’s earth, tragacanth gum powder, and psyllium husk in the absorbent core. Additionally, turmeric may be	<u>WO2019167054A1</u>	

	incorporated to enhance antifungal and antibacterial properties.		[49]
Biodegradable sanitary pad and absorption pad for the human body	This study aims to manufacture biodegradable sanitary napkins by incorporating seaweed into the absorbent layer, eliminating the need for superabsorbent polymers.	WO2019093700A1	[50]

Existing biodegradable sanitary napkins at market

Existing biodegradable sanitary napkins in the market are designed to offer an eco-friendly alternative to conventional pads, addressing both menstrual hygiene and environmental concerns. In the following Figure.4, lists the brands of biodegradable napkin available in the market with its own merits and demerits

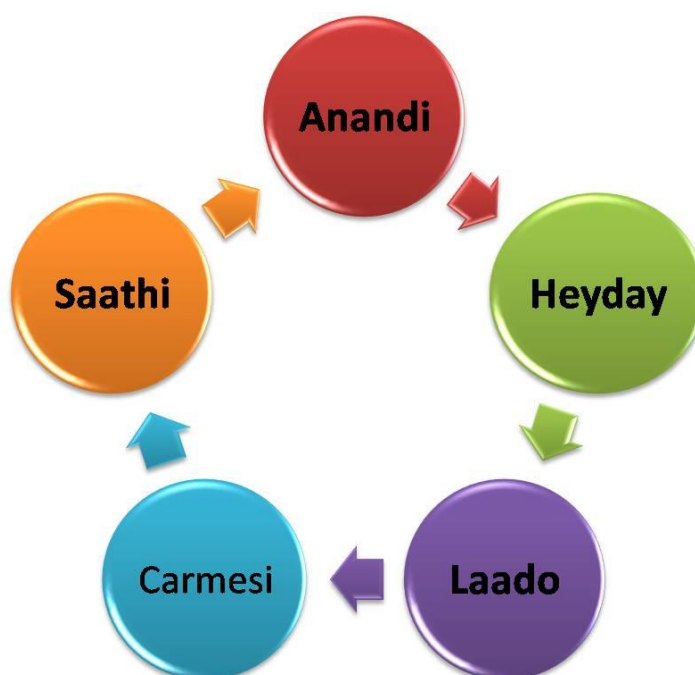


Figure.4. Existing biodegradable sanitary napkins at market

Anandi

According to ISO-17088 standards, Anandi is the first and only brand of sanitary pads in India that is 100% compostable and biodegradable. Under composting conditions, these pads decompose into manure within 3–6 months. Anandi pads feature a 100% organic cotton top layer with industry-first wet reduction technology. They are superior to other biodegradable sanitary napkins on the market due to their bio-superabsorbent material, providing excellent absorbency and ensuring a completely rash-free experience. The top layer is exceptionally soft and free from harmful chemicals. Additionally, they have a breathable, plant-based back layer and utilize leak locker technology, which is also free from scents and plastics^[51].

Heyday

Heyday sanitary pads are fully biodegradable, decomposing within two years of disposal due to their composition of 100% organic corn and bamboo plant fiber spun lace weave. The corn provides a naturally soft texture, ensuring a completely rash-free experience. Bamboo offers excellent absorbency and inherent antibacterial and bacteriostatic properties, which prevent leaks, infections, and redness during menstruation. The pads feature fibers made from bamboo and natural corn, a gel-free bamboo pulp absorber, and anti-leakage

side barriers with wings. The bottom film is made from corn starch, and the adhesive is composed of plant resin and paper release strips ^[52].

Saathi

Saathi, an environmentally friendly hygiene products manufacturer, was founded by alumni from Nirma University and MIT (US) with a clear mission. In 2015, Kristin Kagetsu, Tarun Bothra, and Grace Kane co-founded Saathi to create 100% compostable sanitary napkins using locally sourced banana fiber from Gujarat, India. Saathi Pads are made from this banana fiber and plant-based materials for the outer leak-proof layers. Free from plastic and harmful chemicals, Saathi pads decompose 1,200 times faster than conventional plastic pads, making them highly eco-friendly. Additionally, the Saathi team organizes workshops and discussion groups to educate rural women on the importance of menstrual hygiene ^[53].

Carmesi

Carmesi is a premium brand of feminine hygiene products in India, known for being the only pad certified by a gynecologist to be 100% rash-free. The top layer of the Carmesi pad is crafted from corn fiber, while the middle and barrier layers are made from a superabsorbent material and breathable plastic, respectively. The wrapper is plastic, and the disposal bag is made from oxo-biodegradable material. Carmesi pads are designed to be extremely lightweight and comfortable, with wide wings for added protection against leaks, allowing users to engage in activities without concern about stains ^[54].

Laado

The Laado sanitary pad by Reckon Care is both biodegradable and organic, featuring eight distinct layers:

First layer: Organic cotton that is super soft and itch-free.

Second layer: An anion chip that effectively blocks bacteria and germs while controlling odor.

Third layer: A soft cotton layer with a quick-absorbing surface, enabling the liquid to soak in ten times faster.

Fourth layer: Made of air-laid wrapped paper to prevent unwanted leaks.

Fifth layer: Contains extra-absorbent polymer paper with special cushioning and additional side leak prevention.

Sixth layer: Another layer of air-laid wrapped paper to lock in dryness.

Seventh layer: A comfortable, breathable bottom layer that promotes the passage of clean air and inhibits the growth of harmful microorganisms.

Eighth layer: A releasing paper layer that includes a back adhesive for comfort, designed with women's ergonomics in mind.

A biodegradable disposable pouch made from corn starch is included with the product.

Advantages of biodegradable herbal sanitary pads:

The optimal treatment for stomach aches, cancer, and uterine infections is the use of organic herbal sanitary pads or napkins. These pads are also beneficial for treating cysts, allergies, and hives, and are highly effective for addressing infertility, irregular bleeding, PCOS, and white discharge. Herbal sanitary pads provide chemical-free, 100% herbal sanitary napkins made entirely of pure cotton, without any plastic components, ensuring a safe and natural option for you and your loved ones. Figure 5 illustrates the advantage of using biodegradable herbal sanitary pads.

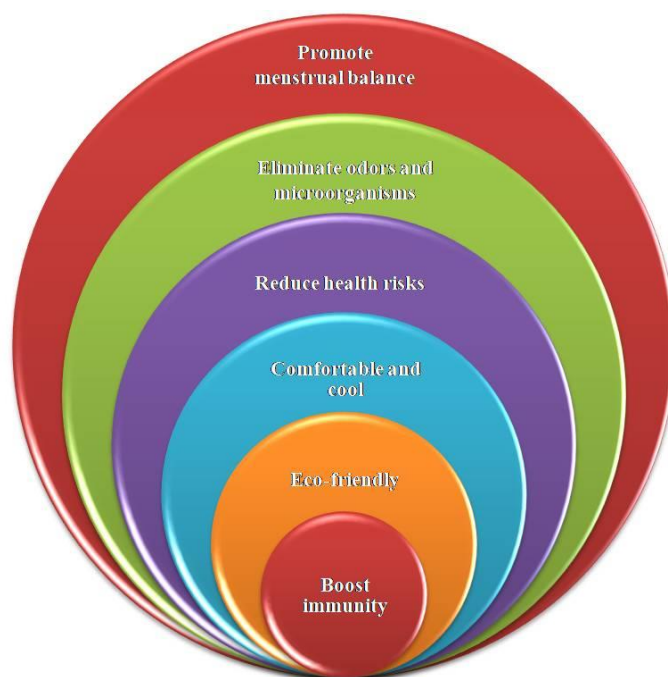


Figure 5. Benefits of biodegradable herbal sanitary pads

Using organic herbal sanitary pads or napkins helps maintain a balanced and harmonious menstrual cycle. They lower the risk of pelvic inflammatory disease and cervical cancer. These pads can help reduce the risk of uterine loss. They are naturally hygienic and help strengthen the immune system. Designed to be cool and comfortable. Effectively remove potential odors and kill harmful microorganisms. In general, the napkins are completely biodegradable with no negative environmental impact. These pads do not irritate sensitive areas because they are free from latex, plastics, chlorine, and carcinogenic chemicals. Being readily biodegradable, they contribute to a society that is less reliant on plastic and more environmentally sustainable.

Current perspective and future directions

The increasing environmental concerns and the need for sustainable solutions have led to a growing interest in biodegradable sanitary napkins. Traditional sanitary napkins often contain non-biodegradable materials, contributing to environmental pollution. Biodegradable alternatives offer a promising solution to reduce the environmental impact associated with menstrual hygiene products. This paper provides an overview of the current perspective on biodegradable sanitary napkins and explores future directions in their development and utilization.

Biodegradable sanitary napkins are designed to degrade naturally after disposal, minimizing their environmental footprint. These products are typically made from natural and renewable materials such as bamboo, organic cotton, biodegradable polymers, and plant-based fibers. Manufacturers are increasingly incorporating innovative materials into their designs to enhance absorbency, comfort, and biodegradability ^[56].

Several studies have highlighted the benefits of biodegradable sanitary napkins compared to conventional counterparts. Biodegradable materials reduce the accumulation of non-biodegradable waste in landfills and oceans, mitigating environmental pollution. Additionally, these products are often free from harmful chemicals and additives, making them safer for both users and the environment ^[57].

The product innovation is a significant positive predictor of consumer preference for female hygiene products. The economically active female prefers innovative products assuring no leakage and controlling order for a long time. This suggests that manufacturing companies need to work to innovate such products to attract economically active female consumers. The need for better absorbent materials in personal care products is growing globally, which encourages basic research and the creation of effective absorbent materials and

systems with additional advantages such enhanced absorption capability, biodegradability, and biocompatible nature. Consequently, a new wave of personal care items based on naturally occurring SAPs, such as different kinds of polysaccharides and hydrogels based on proteins were introduced. Comparing these materials to the traditional superabsorbent, there are a few advantages and they don't harm the environment or human health in any way. Because feminine products, like newborn diapers, are personal care items. Skin care, adult incontinence products, and hygiene all have unique needs utilising substances free of skin allergy symptoms, like inflammation and rashes are desirable. Hydrogels made of cellulose are both biocompatible and biodegradable. It is impossible to comprehend and handle the disposal of spent absorbents in a however; instead, user-centred design thinking must take into account socio-cultural conventions surrounding menstruation, product availability, quality, and use, as well as current sanitation infrastructure. In communal and institutional contexts, menstrual waste disposal needs to be considered in the design of sanitation systems. Incorporation of solid waste management and sanitation aspects of a wash program, provides appropriate, discreet, and dependable solutions that mitigate adverse health impacts on female sanitation workers and girls, while also addressing broader environmental concerns.

Conclusion

In conclusion, the future is looking brighter as natural resources play an increasingly vital role in addressing global issues. This study has shown that using biodegradable materials for producing feminine hygiene products is both cost-effective and environmentally beneficial. Incorporating natural materials in napkins not only reduces costs, making them accessible to those with lower incomes, but also offers a sustainable solution.

Biodegradable sanitary napkins offer a sustainable solution to address the environmental challenges associated with menstrual hygiene products. The current perspective on biodegradable sanitary napkins reflects growing consumer demand for eco-friendly alternatives and the industry's commitment to innovation and sustainability. Future directions in research, technology, marketing, and regulation will further drive the development and adoption of biodegradable menstrual hygiene products, contributing to a healthier planet for future generations.

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86 INVESTIGATION OF MOISTURE MANAGEMENT PROPERTIES OF RECYCLED WOVEN FABRIC

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Abstract

As the textile industry increasingly pivots towards sustainable practices, exploring recycled materials becomes integral to achieving environmental goals. This research investigates the moisture management properties of recycled woven fabric, a critical aspect often overlooked in the pursuit of ecologically responsible textile solutions. The study adopts a systematic methodology involving a comprehensive literature review, meticulous material selection, and standardized testing methods. Key moisture-related characteristics are evaluated, including absorption capacity, wicking ability, drying rate, water repellence, and moisture retention. By scrutinizing various recycled materials and weaving techniques, the research seeks to unravel the nuanced interplay between these factors and the fabric's efficacy in managing moisture. This investigation addresses a significant gap in current knowledge, offering a detailed understanding of how recycled woven fabrics perform in moisture management. The outcomes of this study have implications for diverse stakeholders, including textile manufacturers, designers, and consumers, providing valuable insights into the suitability of recycled woven fabrics for different applications. Anticipated results encompass a nuanced comprehension of the moisture behaviour of recycled woven fabrics, potentially identifying materials and weaving techniques that optimize moisture management properties. This research not only contributes to the scientific understanding of sustainable textiles but also informs practical decision-making in the textile industry, fostering a balance between environmental responsibility and functional performance.

Keywords: Dope Polyester, Recycled Polyester, Physical and Chemical Properties, Moisture Management Properties

1. Introduction:

In an era characterized by a growing awareness of environmental sustainability, the textile industry faces the imperative to adapt and embrace eco-friendly practices. One pivotal aspect of this transition involves the exploration and optimization of recycled materials, seeking not only to reduce the ecological footprint but also to enhance the performance of textiles. This study delves into a critical facet of textile functionality – the moisture management properties of recycled woven fabrics. As moisture management plays a crucial role in determining the comfort and usability of textiles, a detailed investigation into this aspect of recycled materials becomes paramount. The textile industry has witnessed a paradigm shift towards sustainable practices, with an increasing emphasis on recycling and repurposing materials to mitigate the environmental impact of traditional production processes. Recycled woven fabrics, often crafted from post-consumer or post-industrial waste, present a promising avenue for sustainable textile development. However, a comprehensive understanding of their performance characteristics, particularly concerning moisture management, remains an essential but underexplored area. Moisture management in textiles is multifaceted, encompassing properties such as absorption, wicking, drying, water repellence, and moisture retention. These properties influence not only the comfort of the wearer but also the functionality and durability of the fabric. As the demand for sustainable textiles rises, it is imperative to scrutinize recycled woven fabrics through rigorous scientific investigation to ascertain their moisture-related behaviours. This research endeavours to fill a crucial knowledge gap by

systematically evaluating the moisture management properties of recycled woven fabrics. By examining different types of recycled materials and weaving techniques, we aim to elucidate the impact of these factors on the fabric's ability to handle moisture. The findings from this investigation hold the potential to inform textile manufacturers, designers, and consumers about the suitability of recycled woven fabrics in diverse applications. As the textile industry grapples with the need for sustainable alternatives, this study contributes valuable insights that align ecological responsibility with functional efficacy. The following sections will outline the methodology employed in this investigation, delve into the specific properties under scrutiny, present the anticipated outcomes, and discuss the broader implications of the research for the evolving landscape of sustainable textiles.

The various characterization of sportswear comfort, their evaluation methodology, effects of fiber parameters like fineness and diameter, aspect ratio, and geometry, yarn constructional parameters like Twist per Inch (TPI), direction of twist, fabric structural parameters, finishes, performance enhancement and innovative material for sportswear [1]. Increase in demand for the performance fabric for fitness wear fabric textile industries are indulged into research of providing a quality fabric right from fiber, polymers, yarn, special finished that can enhance the performance with its comfort properties of sportswear needs products [2]. Measuring methods that determines fiber characteristics like moisture vapor permeability and wear comfort of eco-friendly fiber in woven fabric can be done by upright cup method initially dependent hygroscopicity of the eco-friendly fiber in yarns and balance dependent on fabric pore size. Sweating guarded hot plate method is mainly governed by fabric pore size and partially hygroscopicity of the eco-friendly fabric [3]. Sweat generate when a human body workout for fitness purpose. During that process not only sweat generates heat as well generates. Sweat need to transferred into atmosphere similarly heat need to be evaporated into atmosphere. All this can happen only when fabric has quick dry characteristics and good absorbency in nature that can perform the critical role in moisture management study [4]. Increasing demand in the market of active wear requirement textile industries not only focusing on diversifying the product line but also investing its time to study the special need of the end customer to meet the basic requirement in terms of fits and outlook, Secondly availability that can sever the needs of an hour since ongoing demand process procedure and finishing that meets the functionality, desirability, durability etc [5]. The research focus comfort properties different knitted patterns with cotton / antistatic polyester blended yarns. The conclusion of research is X1 rib design more water absorption and better air permeability properties when comparing to other knitted patterns. The fibre proportions also play important role of comfort properties. The cotton blend proportion is directly proportional to comfort properties [6]. Based on the construction fabric or weave structure liquid absorption and transmission determines the fabric comfort. Moisture management tester (MMT) was used for multi-dimensional liquid transport of the fabric produced. Result says polyester fabric had higher OMMC value than those cellulosic –based fabrics. Liquid transport has decreased with increasing tightness in general [7, 8]. Sports clothing is manufactured in large volume for a shorter life cycle leading to huge waste when it disposed to earth. Synthetic fiber are used in sports apparel for better comfort properties and performance. The latest techniques and manufacturing processes are adopted to produce sustainable sports apparels. Digital concepts have been adopted to minimize material wastes, ensuring reduction in the resource exploitation [9]. In textiles, in particular wearable technology structured, battery-illuminated electronic fabrics are moving toward to both electrical and esthetic aspects of printed LED (PLED) textiles. It is on one dimension that have had questioned an economic resolution of extensional methods as for battery-charged interior materials, and also has gained a more general questions on how to develop its recycle both yarn and fibre as traditional raw goods in together with any recyclable electronic parts or graphene, carbon nanotube contained components with that textile materials. Furthermore, recyclable assembled electronic parts back to the renewable materials are continuous moving in the low-energy, high-reusable rate evaluation in the lifecycle assessment (LCA) of them. Specifically, during the de-sulfurization and decolouring in the post-production processing in the quick removal of active carbon fibre or nanoparticle coating on surface of fibre-porous geo-matrix could advance the renewing production efficiency. In assumption of low-energy and high-conductible transformation from off-market polyester with dyes or metallic yarns for polyester in e-textiles, recyclable conductive graphene/microfiber/composites are articulated, as far as industrial lifecycle management

of braided, fiber, and ultra-high-density polyethylene has impeccable performance in the high mechanical property, medium rheological expansion over molding process, and high-yield strength as in the following sustainability in the wearable garment [10]. The significant enhancement in wettability, absorptive capacity, drying rate and wicking length proved moisture management property of polyester fabric. This fabric coating strongly withstood more than 10 cycles of laundry and against 5000 abrasion cycles. Physical and mechanical properties of modified fabrics remained unchanged, while tensile strength and elongation showed a slight improvement due to fibre preserving aminolysis reaction between APTES and ester groups in polyester fabrics. It is expected that this bio-inspired BNC modified polyester fabric may break the barrier of using polyester in various hydrophilic textile applications [11]. Air permeability is one of the thermal comfort properties of clothing and fabrics. This study evaluated the quick dry properties of summer men's shorts of different brands (Nike, Adidas, Decathlon and Columbia) by studying the air permeability behavior. Both Nike and Adidas samples were made out of woven recycled polyester shorts. The materials for Adidas and Nike were polyester while Decathlon was made of DDP and polyester. Overall, Decathlon were found to perform better in terms of air permeability than those of Nike and Adidas [12]. The sportswear industry has been early adopter of technical textile and fibre innovation. This chapter will focus on selection of fabric for the functional clothing layering system for use in the outdoor environment where garment design and manufacturing methods are interdependent. It will draw attention to growing concerns associated with environmental footprint of the global textile and clothing chain [13]. The exponential increase in population increases the demand on food, energy, water, resources and chemicals, and affects a corresponding increase in environmental pollution and a depletion of finite resources. Biodegradable polymers and the fiber that can be produced from them are very attractive in offering a possible solution to waste-disposal problems. Nevertheless, in a world with limited resources and many environmental impacts, it is obvious that sustainable life and industrial styles are also becoming important [14]. The sportswear segment, particularly athleisure, has witnessed an upsurge and become crucial component of mainstream market owing to health and fitness consciousness among millennials and Generation Z. High performance fiber such as coolmax, micro denier, hollow fiber, polyester of varying cross-sections and smart materials, namely phase change materials and shape memory polymers are extensively utilized to meet the basic and desirable properties of dry feel next to wearer skin, rapid moisture transportation and wearer comfort in sportswear. However, like any other clothing segment, there is an ardent need to incorporate sustainable principles in design and development of sports clothing to avert deleterious environmental impact on account of massive production of sports collection. A range of sustainable fiber, namely bamboo, hemp, soybean, etc. and recycled materials are explored for their potential and suitability for sportswear design and development. Clothing intended for professional training as well as leisure activities are designed utilizing sustainable raw materials along with incorporation of innovative concepts of layering, asymmetrical styling, elaborate patch work, strategic positioning of eco-friendly labels and trimmings. A myriad of sportswear designers such as Decathlon, Satva, Stretchery, Deivee, Pact, Etiko and Tentree are trailblazers in launching sustainable sportswear ensemble. The chapter highlights the sustainable approaches adopted by various sportswear brand [14]. The essential properties of active sports fabrics are moisture management, quick-drying, body heat management and thermal regulations. Fibre type, blending nature, yarn and fabric structure and the finishing treatment are the key parameters that influenced the performance of the clothing meant for sportswear. This study aims to investigate the effect of fibre blending and structural tightness factors on bi-layer sport fabric's dimensional, moisture management and thermal properties [15, 16]

2. Material and Methodology:

Recycled PET Bottles: Most 100% recycled polyester fabric is made from post-consumer PET (polyethylene terephthalate) plastic bottles. These bottles are collected, sorted, cleaned, and processed into polyester fiber.

Environmental Benefits:

Reduction of Waste: Using recycled polyester reduces the amount of plastic waste that ends up in landfills or oceans.

Energy and Resource Conservation: Producing recycled polyester generally requires less energy and water compared to virgin polyester production, reducing carbon emissions and environmental impact.

Quality and Performance:

Similar to Virgin Polyester: Recycled polyester fiber exhibit similar qualities to virgin polyester, including durability, moisture-wicking properties, and resistance to shrinking and wrinkling.

Versatility: It can be used in various textile applications, including apparel (such as activewear, outerwear, and casual clothing), home textiles (like bedding and upholstery), and accessories.

Certifications and Standards:

Global Recycled Standard (GRS): Many manufacturers and brands adhere to standards like GRS to ensure the authenticity and traceability of recycled content in their polyester fabrics.

Oeko-Tex Standard 100: Certifies that recycled polyester fabrics are free from harmful substances, making them safe for human use.

Market Demand and Trends:

Growing Demand: Consumers and brands are increasingly prioritizing sustainability, driving the demand for eco-friendly materials like recycled polyester.

Fashion Industry Adoption: Leading fashion brands and retailers are incorporating recycled polyester into their collections as part of their sustainability commitments.

Challenges:

Quality Consistency: Maintaining consistent quality and performance characteristics across different batches of recycled polyester can be a challenge.

Cost: Recycled polyester fabrics may be slightly more expensive than conventional polyester due to the additional processing steps involved in recycling.

Future Outlook:

Innovation: Continued research and development are focusing on improving the recycling process and expanding the use of recycled materials in textiles.

Regulatory Support: Governments and organizations are implementing policies and incentives to encourage the use of recycled materials and promote sustainability in the textile industry

Dope dyed polyester

To refer to a method of colouring polyester fiber during the manufacturing process by adding colourants (pigments or dyes) to the polymer melt before extrusion into fiber. This technique contrasts with traditional methods where fiber are dyed after they are extruded.

Key points about dope dyed polyester:

Colouring Process:

Incorporation of Colourants: Colourants (dyes or pigments) are mixed with the polyester polymer melt before extrusion.

Uniform Colour: The colour is distributed evenly throughout the fibre, ensuring uniformity and colourfastness.

Advantages:

Colour Fastness: Dope dyed polyester fiber are generally more colourfast compared to fiber dyed through traditional methods.

Environmental Benefits: It reduces water usage and chemical consumption associated with traditional dyeing processes.

Energy Efficiency: The process typically requires less energy since it skips the dyeing and finishing stages.

Applications:

Textile Industry: Dope dyed polyester is widely used in various textile applications, including apparel (such as active wear, outerwear, and uniforms), home textiles (like curtains and upholstery), and industrial fabrics (such as automotive textiles and outdoor fabrics).

Variants:

Different Colour Options: Dope dyed polyester fibre are available in a wide range of colours and shades, offering flexibility in design and product development.

Blend Compatibility: They can be blended with other fibre like cotton, viscose, or nylon to create innovative fabric blends with enhanced properties.

Sustainability Considerations:

Reduced Environmental Impact: By integrating colorants during the manufacturing process, dope dyed polyester reduces water consumption, wastewater generation, and chemical usage associated with traditional dyeing processes.

Compliance: Manufacturers often adhere to environmental standards and certifications (such as Oeko-Tex Standard 100) to ensure the safety and sustainability of dope dyed polyester products.

Challenges:

Colour Matching: Achieving precise colour matching across different production batches can be a challenge due to variations in raw materials and processing conditions.

Cost: Dope dyed polyester fiber may have slightly higher initial costs due to the additional processing steps involved in dye incorporation during extrusion.

Industry Adoption:

Growing Demand: Dope dyed polyester is increasingly preferred by textile manufacturers and brands seeking sustainable and cost-effective solutions without compromising on quality or performance.

Results and Discussion:

The variables are taken as doped dyed polyester fabric and recycled polyester dyed fabric. The variable physical and comfort properties are analysed as per Table 4.1. The physical and comfort properties are tested by the respective international standards of textile materials like ASTM, ISO and AATCC.

Comparative Analysis of Dope Dyed Polyester vs. Recycled Dyed Polyester

This report comprehensively compares dope-dyed polyester and recycled-dyed polyester fabrics. Each property is analysed based on the given standards and specifications, focusing on their performance and suitability for various applications.

Fabric Specification

Width of Fabric

Dope Dyed Polyester: 60 inches Recycled Dyed Polyester: 59.5 inches RECYCLED POLYESTER FABRIC

DOPE DYED POLYESTER FABRIC TEST PROTOCOLS, STANDARDS AND RESULTS

	Properties	Dope Dyed Polyester	Recycled Polyester with Dyed	Standards
1	Specification			
	Width of fabric	60 inches	59.50 inches	ISO 22198 - 2006
2	GSM	112	119	BSEN 12127- 1998
3	Yarn count			
	Warp	83 Denier	75 Denier	ASTM D 1059
	Weft	83 denier	83 Denier	
4	Stitch Density			
	EPI	145	162	ASTM D 3775- 2003
	PPI	140	120	
5	Dimensional Changes			ISO 6330 4N – 2021
	Shrinkage %			
	Warp	-0.30%	-0.30 %	
	Weft	-0.30%	-0.60%	
6	Skewness Changes			ISO 16322 – 2 – 2021
	Spirality Changes%	+ 0.30%	+ .30%	
7	Colour Fastness to Laundering			ISO 105 C 06 A2S: 2010
	Polyester	4-5 Grade	4 Grade	
8	Colour Fastness to Water			ISO 105 E 01 2013
	Polyester	4-5 Grade	4 Grade	
9	Colour Fastness to Sea Water			ISO 105 E 02 2013
	Polyester	4-5 Grade	4 -5 Grade	
10	Colour Fastness to Perspiration (Acidic and Alkaline Nature)			ISO 105 E 04 2013
	Polyester	4-5 Grade	4 Grade	
11	Colour Fastness to Rubbing			ISO 105 X12 2016
	Dry	4-5 Grade	4-5 Grade	
	Wet	4 Grade	4 Grade	
12	Colour Fastness to Artificial Light	4 Grade	4 Grade	ISO 105 B 02 3 2014
13	pH	7.19	7.23	ISO 3071 2020
14	Martindale Pilling			ISO – 12945-2 – 2000
	After 125 Rubs	4-5 Grade	4-5 Grade	

	After 500 Rubs	4-5 Grade	4-5 Grade	
	After 1000 Rubs	4-5 Grade	4-5 Grade	
	After 2000 Rubs	4-5 Grade	4-5 Grade	
15	Fibre Analysis	100 % Polyester	100 % Polyester	AATCC TM 20 A-2020
16	Tensile Strength			ISO 1393 4 -2 – 2014
	Warp Direction	63.3Kg/ cm ²	62.30 Kg/ cm ²	
	Weft Direction	64.1 Kg/ cm ²	58.00 Kg/ cm ²	
17	Tearing Strength			ISO 1393 7 -2 – 2000
	Warp Direction	1728 gms/ cm ²	1920 gms/ cm ²	
	Weft Direction	1760 gms / cm ²	1728 gms / cm ²	
18	Moisture Content %	0.40%	0.40%	ASTM D 2054
19	Vertical Wicking Test			AATCC TM 197
	Warp @ 20 mm	5 seconds	6 seconds	
	Weft @ 20 mm	6 seconds	7 seconds	
	Warp @ 150 mm	7 min, 34 seconds	8 min, 46 seconds	
	Weft @ 150 mm	9 min, 13 second	11 min, 47 seconds	
20	Absorbency of Textiles	1 Second	1 Second	AATCC TM 79-2010
21	Drying Rate (Rate of Evaporation)			ISO 17617 - 2014
	After 30 Min	50.40%	45.90%	
	After 60 Min	87.10%	82.10%	

CONCLUSION

The comparative analysis of dope-dyed polyester and recycled dyed polyester fabrics reveals distinct advantages for each material, catering to different application needs and performance requirements. Dope-dyed polyester demonstrates superior performance in color fastness, tensile strength, wicking properties, and drying rate. These attributes make it particularly well-suited for applications such as performance and active wear, outdoor gear, and sportswear, where high durability, effective moisture management, and rapid drying are crucial. Its slightly better color retention and higher tensile strength ensure long-lasting fabric quality, which is essential for products exposed to frequent laundering and harsh environmental conditions.

On the other hand, recycled dyed polyester offers notable benefits in terms of fabric density, weave tightness, and tearing strength. With a higher GSM and EPI, recycled dyed polyester presents a denser and tighter fabric, which can translate to increased durability and a more substantial feel. This makes it an excellent choice for heavy-duty applications where robust fabric construction is prioritized. Additionally, its higher tearing strength in the warp direction provides enhanced resistance to rips and tears, making it suitable for applications that demand extra durability. Both fabrics exhibit excellent resistance to pilling, maintaining their surface appearance over time, which is advantageous for applications where fabric aesthetics are important. They also share similar properties in moisture content, pH levels, and immediate absorbency, indicating their suitability for comfortable and skin-friendly products.

In summary, the choice between dope-dyed polyester and recycled dyed polyester should be guided by the

specific requirements of the intended application. Dope-dyed polyester is ideal for high-performance, activewear, and outdoor products that require superior durability and moisture management. In contrast, recycled dyed polyester is better suited for environmentally friendly products and heavy-duty applications where fabric density and weave tightness are critical. Both materials offer valuable benefits, ensuring their relevance and applicability across various textile industries.

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87 NUTRITIONAL PROWESS UNVEILED: ESSENTIAL ELEMENTS WITHIN INDIAN MICROGREENS

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ABSTRACT:

This review explores the nutritional richness and health benefits of Indian microgreens, focusing on their potential impact on human well-being. Originating in Southern California in the 1990s, microgreens have gained popularity for their fresh flavors and enhanced nutritional value compared to mature counterparts and sprouts. We delve into their elevated levels of minerals, vitamins, and beneficial plant compounds, emphasizing their role in promoting health. Despite their delicate nature and short shelf life, to enhance their nutritional quality, attempts have been made. The increasing availability of diverse microgreen varieties, including Amaranth, Spinach, and Cumin, offers a promising avenue for culinary diversity. As we uncover the nutritional mysteries of Indian microgreens, this review highlights their potential as a dietary choice for preventing chronic diseases. The article calls for future studies to deepen our understanding of their nutritional dimensions and health advantages, paving the way for continued exploration and utilization in Indian diets.

KEYWORDS:

Indian microgreens, nutrition, health benefits, culinary diversity, micronutrients.

Introduction:

Vegetable greens that are still young and picked after cotyledonary leaves have formed are called microgreens. Since the 1990s, microgreens have been grown in Southern California, and for the last ten years, their fresh flavor and healthful properties have made them more and more popular [1]. Because of their higher nutritional content and stronger flavor and taste, microgreens might be thought of as superior replacements for sprouts [2]. Furthermore, compared to their mature counterparts, microgreens may have higher concentrations of minerals, vitamins, and phytochemicals [3,4]. Microgreens may thereby enhance the nutritional value of meals and help consumers achieve better health results. As a result of their exceptional fragility and limited shelf life, microgreens have also posed numerous issues for farmers and the supply chain [2]. Numerous pre- and post-interventions have been studied to increase the nutritional quality and shelf life of microgreens [5]. Overall, as microgreens are a relatively new niche commodity, regarding their nutritional content and potential health benefits, there is still a lot to discover.

While there were initially few microgreens accessible, a variety of varieties are now commercially available [6]. The following are some common species that are used to grow microgreens: Cucurbitaceae cucumber and melon; Carrot, Celery, Cilantro, Cumin, Dill, and Fennel from Apiaceae; Chicory, lettuce, Radicchio, and Sunflower from Asteraceae; Amaranth, Beet, Spinach, and Quinoa from Amaranthaceae; Garlic and Onion from Amaryllidaceae; Common species for microgreen cultivation include Barley, Corn, Oat, Rice, and Wheat

from the Gramineae family; Bean, Chickpea, Fenugreek, Lent, and Pea from the Leguminosae family; Basil from the Lamiaceae family; and Chives from the Liliaceae family. [7].

A multimodal experience can be enhanced by combining different species of microgreens to produce a variety of colors and flavors [4]. Moreover, microgreens have a great deal of promise for enhancing the nutritional content of human meals and may also be a viable dietary choice for preventing chronic diseases because they are high in bioactive components and nutritious density. In [11]

The height of microgreens is typically 2.5–7.6 cm (1–3 in.), and they are marketed with the stem and cotyledons (seed leaves) attached, depending on the species, microgreens are typically harvested 7–14 days after germination [12,13]

1. Indian Microgreen Medley:

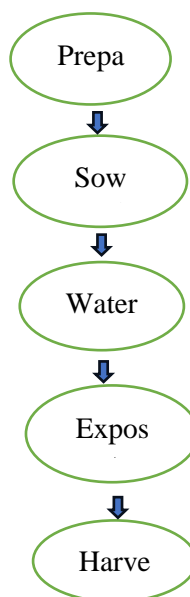
Table 1: list of Indian microgreens

Common Name	Scientific Name	Reference
Mustard Microgreens	Brassica juncea	[14]
Fenugreek Microgreens	Trigonella foenum-graecum	[15]
Radish Microgreens	Raphanus sativus	[16]
Cilantro Microgreens	Coriandrum sativum	[17]
Amaranth Microgreens	Amaranthus spp.	[18]
Sunflower Microgreens	Helianthus annuus	[19]

2. Microgreen Cultivation Techniques

The method begins with seed-soaked seeds, which have been soaked in water to aid in the germination process. These seeds are then planted and allowed to develop into sprouts, which are immature plants that have just sprung from their seeds. Microgreens are picked when the sprouts have reached a particular size. Microgreens are immature plant seedlings that are harvested when they are just a few inches tall. They are well-known for their delicate texture and intense flavor and are frequently used as a tasty and healthy garnish in salads, sandwiches, and other foods. Growing microgreens can take anywhere from a few days to a few weeks, depending on the type of seed used and the climatic circumstances under which they are cultivated. However, with appropriate care and attention, it is feasible to grow an abundant harvest of fresh, tasty microgreens that are guaranteed to satisfy the taste while also providing a variety of health benefits [22].

2.1 Flowchart of microgreens Production [20,21]:



3. Environmental Factors

3.1. Light Spectrum and Intensity

Research has shown that the choice of light spectrum (wavelengths) and intensity significantly influences microgreen growth and nutritional composition. Red and blue light, often provided by LED systems, have been found to enhance pigmentation and nutrient content in microgreens [43].

3.2. Photoperiod and Duration

The duration of light exposure, or photoperiod, also plays a role in microgreen development. Tailoring light exposure to mimic natural day-night cycles can influence the accumulation of secondary metabolites and antioxidant compounds [44].

3.3. Temperature-Dependent Growth Rates

Studies have highlighted the influence of temperature on microgreen growth rates, with each species having an optimal temperature range. Maintaining suitable temperatures positively correlates with biomass production and nutrient accumulation [45].

3.4. Cold Stress and Nutrient Retention

Exposing microgreens to controlled cold stress has been explored as a strategy to enhance nutrient retention. Cold stress can stimulate the production of certain secondary metabolites, contributing to increased nutritional quality [46].

3.5. Role of Atmospheric CO₂ Levels

Carbon dioxide (CO₂) levels in the growing environment influence photosynthesis and, consequently, microgreen development. Elevated CO₂ concentrations have been shown to enhance biomass production and alter the nutritional composition of microgreens [47]. Understanding and optimizing these environmental factors are crucial for maximizing the nutritional quality and overall yield of microgreens.

3.6. Ascorbic acid

Since it functions as an antioxidant, ascorbic acid is a necessary food for humans. The plant may undergo FAA oxidation to DAA in response to physiological or physical stressors (such as radiation, cold, harvesting injuries, etc.) [23]. Despite having a differing metabolic turnover time, it has been previously demonstrated that DAA and FAA consumption are similar [24].

Table 2: Mean Total Ascorbic Acid, Free Ascorbic Acid, and Dehydroascorbic Acid Concentrations in 4 Microgreens:[4]

Microgreen Name	TAA (Mg/100 G FW)	FAA (Mg/100 G FW)	DAA (Mg/100 G FW)
Cilantro	40.6 ± 2.40	24.5 ± 1.80	16.1 ± 2.20
Garnet Amaranth	131.6 ± 2.90	105.1 ± 3.10	26.5 ± 1.40
Green Daikon Radish	70.7 ± 2.70	58.8 ± 1.70	11.9 ± 1.10
Red Mustard	62.2 ± 2.60	40.8 ± 1.40	21.4 ± 1.30

Total Ascorbic Acid (TAA), Free Ascorbic Acid (FAA), and Dehydroascorbic Acid (DAA)

Their varied amino acid contents per 100 grams of fresh weight are shown by the examination of the microgreens red mustard, green daikon radish, cilantro, and garnet amaranth. With 131.6 ± 2.9 mg of total amino acids and 105.1 ± 3.1 mg of free amino acids, respectively, Garnet Amaranth is the most notable, having much greater levels than Red Mustard, which has somewhat raised levels of 62.2 ± 2.6 mg of TAA and 40.8

± 1.4 mg of FAA. Green daikon radish and cilantro, on the other hand, have lower TAA values (40.6 ± 2.4 mg and 70.7 ± 2.7 mg, respectively), while their levels of FAA and Dietary Essential Amino Acids (DAA) vary. The aforementioned distinctions highlight the diverse nutritional profiles of these microgreens, offering consumers and food enthusiasts a range of options that can be tailored to specific dietary requirements and culinary preferences. Additionally, these differences may contribute to their potential health benefits due to their unique amino acid compositions [4].

4. Vitamins:

Carotenoids: beta-carotene.

An essential fat-soluble antioxidant, β -carotene can shield cellular membranes by scavenging free radicals [25].

As a precursor to vitamin A, microgreens provide a vivid range of beta-carotene in various amounts in each variety. At 11.7 ± 1.1 milligrams of beta-carotene per 100 grams of fresh weight (FW), cilantro is the most abundant plant. Alongside significant quantities of lutein/zeaxanthin (8.4 ± 0.1 mg/100g FW), violaxanthin (4.4 ± 0.1 mg/100g FW), garnet amaranth comes in second with 8.6 ± 0.3 mg/100g FW. In addition to lutein/zeaxanthin at 4.5 ± 0.1 mg/100g FW, violaxanthin at 1.7 ± 0.0 mg/100g FW, green daikon radish adds a milder but noteworthy beta-carotene concentration of 6.1 ± 0.1 mg/100g FW. Red Mustard provides 6.5 ± 0.4 mg/100g FW of beta-carotene, 4.9 ± 0.3 mg/100g FW of lutein/zeaxanthin, and 1.7 ± 0.1 mg/100g FW of violaxanthin [4].

Table 3: Mean β -Carotene, Violaxanthin, and Lutein/ Zeaxanthin Concentrations in 4 Microgreens: [4]

Microgreen name	β -carotene (mg/100 g FW)	lutein/zeaxanthin (mg/100 g FW)	Violaxanthin (mg/100 g FW)
Cilantro	11.7 ± 1.10	10.1 ± 0.30	7.7 ± 0.60
Garnet Amaranth	8.6 ± 0.30	8.4 ± 0.10	4.4 ± 0.10
Green Daikon Radish	6.1 ± 0.10	4.5 ± 0.10	1.7 ± 0.00
Red Mustard	6.5 ± 0.40	4.9 ± 0.30	1.7 ± 0.10

FW: Fresh Weight

5. Tocopherols: Acknowledged as fat-soluble antioxidants, tocopherols and tocotrienols together constitute "vitamin E." There are four isomers in each group: α , β , γ , and δ . α -tocopherol is the most active form of tocopherols, while γ -tocopherol is the type found in plants in the highest concentration.[26] The present study provides a summary of the α -and γ tocopherol levels for each of the four microgreen types examined (Table 4).

Alpha-tocopherol and gamma-tocopherol, two essential forms of vitamin E with unique antioxidant properties, are dynamically combined in microgreens. A favorite in cooking, cilantro enhances taste and nutrition with 53.0 ± 13.5 mg of alpha-tocopherol and Gamma-tocopherol 12.5 ± 2.0 mg/100g FW. With 87.4 ± 15.9 mg of alpha-tocopherol and 39.4 ± 7.8 mg of gamma-tocopherol, Green Daikon Radish is tocopherol powerhouse. Red mustard and garnet amaranth, on the other hand, provide smaller but still substantial amounts of tocopherol. These microgreens offer a concentrated concentration of antioxidants, supporting cellular health in a little, tasty package, in addition to enhancing flavor profiles.

Table 4: Mean α - and γ -Tocopherol Concentration in 4 Microgreens [4]:

Microgreen name	α -tocopherol (mg/100 g FW)	γ -tocopherol (mg/100 g FW)
Cilantro	53.0 \pm 13.5	12.5 \pm 2.00
Garnet Amaranth	17.1 \pm 2.10	11.2 \pm 1.30
Green Daikon Radish	87.4 \pm 15.90	39.4 \pm 7.80
Red Mustard	22.1 \pm 1.90	8.2 \pm 0.70

FW- Fresh Weight

6. Minerals Content: (mg/100 g FW): [27]

Microgreens' mineral makeup - Na, Ca, Mg, K, and K+ are calcium, magnesium, and potassium respectively. In particular—highlights their nutritional importance. A mineral profile of 47 \pm 2 mg of calcium, 28 \pm 1 mg of magnesium, 52 \pm 2 mg of phosphorus, 289 \pm 5 mg of potassium, and 27 \pm 1 mg of sodium per 100 grams is shown by red mustard microgreens. With 66 \pm 2 mg of calcium, 60 \pm 2 mg of magnesium, 84 \pm 4 mg of phosphorus, 176 \pm 10 mg of potassium, and 57 \pm 4 mg of sodium per 100 grams, Green Daikon Radish microgreens have greater amounts. Including these microgreens in diets improves general health and well-being by providing nutrients that are necessary for a variety of physiological processes in addition to flavor and texture.

Table 5: Mineral level

Microgreen name	Ca	Mg	P	K	Na
Red Mustard	47 \pm 2.0	28 \pm 1.0	52 \pm 2.0	289 \pm 5.0	27 \pm 1.0
Green Daikon Radish	66 \pm 2.0	60 \pm 2.0	84 \pm 4.0	176 \pm 10.0	57 \pm 4.0

Ca-calcium, Mg-magnesium, K-potassium, Na- sodium.

7. Other Bioactive Compound

Naturally occurring bioactive substances called phytosterols, or plant sterols, are found in the lipid bilayer of all plant cell membranes. They are especially prevalent in vegetable oils and fats, cereal products, fruits, and vegetables. Phytosterols have a main skeleton made up of 28 or 29 carbon atoms [28].

They have received a lot of attention for their ability to lower blood cholesterol levels and the danger of heart disease in humans, as well as other bioactivities such as anticancer, anti-inflammatory, and immune-regulatory actions [29].

Currently, over 200 different forms of phytosterols have been recognized in various plant species; campesterol, β -sitosterol, and stigmasterol being the most prevalent. Free sterols are often found as relationships between (*acetylated*) glycosides and fatty acid esters [28].

Past research indicates that both Phytosterols are plentiful in Brassica juncea and Brassica napus L. (rapeseed) products., with different kinds and concentrations of phytosterols detectable [30].

A few advantageous polyamines, including spermine and spermidine with potential for neuroprotection and cardioprotection and agmatine with reversing effects upon disorders of the central nervous system, were also found in microgreens since sprouting typically causes an accumulation of polyamines. Of the four sprouts and microgreens that were chosen, namely alfalfa, daikon radish, fenugreek, and lentil, three of the legume

microgreens—fenugreek, lentil, and alfalfa, respectively—had the highest concentrations of spermine (922 mg kg⁻¹), spermidine (579 mg kg⁻¹), and agmatine (5392 mg kg⁻¹), while their corresponding sprouts had the lowest levels of cadaverine (undesired polyamines). However, compared to its microgreens, daikon radish sprouts displayed a superior profile of polyamines [31].

8. Nutritional Benefits:

Numerous studies have looked into the quantity of bioactive substances found in microgreens, such as vitamins, minerals, and phytochemicals. Particular interest among researchers has been shown in the study of antioxidants such as vitamin C (VC), phytochemicals (like carotenoids and phenolics), and specific minerals like selenium (Se), zinc (Zn), and copper (Cu). Free radicals are neutralized by antioxidants, which also aid in preventing oxidative stress-related damage. The antioxidant concentrations and capacities of microgreens and their mature counterparts have been contrasted [32, 6]. Antioxidant concentrations were higher in a few microgreens; however, the findings could not be applied generally [3,33]. Ascorbic acid another name being a powerful antioxidant, vitamin C is necessary for many biological processes, including collagen production, wound healing, and immune system control [34]. Since vegetables are abundant in VC, numerous investigations have assessed the VC content of different microgreens [4,35]. For example, [3] measured the volatile carbon (VC) contents of nine microgreens and discovered that the VC of the microgreens of jute (*Corchoris olitoris* L.) and cucumber (*Cucumis sativus* L.) was higher at 25 mg/100 g FW and 34.90 mg/100 g FW, respectively, than it was at their mature stages (17.45 mg/100 g FW and 10.00 mg/100 g FW, respectively). The water spinach's mature and microgreen phases had comparable VC contents. Other species with mature plants exhibiting higher VC than the microgreen stage include Amaranthus (*Amaranthus tricolor* L.), bottle gourd (*Lagenaria siceraria* Standl), palak (*Beta vulgaris* L. var. *bengalensis* Roxb), pumpkin (*Cucurbita moschata* Duchesne), and radish (*Raphanus raphanistrum*) [33]. reported a markedly increased VC content in the baby green stage (6.1 mg/g) versus the microgreen stage (7.5 mg/g) of traditional Sicilian broccoli ($P < 0.05$). A related finding was reported in [36], wherein microgreen stages of fenugreek (*Trigonella foenum-graecum* L.), spinach (*Spinacia oleracea* L. var.), and roselle (*Hibiscus sabdariffa* L.) were shown to have 120%, 127%, and 119% higher VC content than their mature stage ($P < 0.05$). Ten commercially produced microgreens had VC concentrations ranging from 29.9 to 123.2 mg/100 g FW [36], which is similar to citrus fruits [37], a popular food source of VC [4].

The effectiveness of microgreens in controlling blood glucose, helping people lose weight, and regulating adipose tissue, as demonstrated by both in-vitro and in-vivo studies, has been the subject of relatively limited studies, but it has laid the groundwork for further investigation into the possible advantages of microgreens in the prevention and treatment of chronic diseases like obesity, type 2 diabetes, and cardiovascular diseases. [38,39]

Following digestion, these bioactive chemicals' high bio-accessibility can offer anti-inflammatory, anti-cancer, antibacterial, and anti-diabetic effects [40]. According to an in vitro investigation, the antiproliferative effects of microgreens on the formation of colon cancer cells were demonstrated by the significantly decreased cell viability of tumoral colon cells treated with kale, radish, mustard, and broccoli microgreens ($P < 0.05$) compared to the blank group [41].

Due to their high bio-accessibility, these bioactive compounds have anti-inflammatory, anti-tumor, antibacterial, and anti-diabetic properties after digestion [40]. Based on an in vitro study, tumoral colon cells treated with kale, radish, mustard, and broccoli microgreens showed significantly lower cell viability ($P < 0.05$) than the control group, indicating that the microgreens have antiproliferative effects on the formation of colon cancer cells [41]. As they examined the effects of microgreens, on the enzymatic release of glucose, Wadhawan et al. [38] discovered that 2–3.3 mg/mL of fenugreek microgreen extract (FME) reduced the activity of porcine α -amylase, the enzyme that breaks down the α -1,4-glycosyl linkages in starch to produce glucose, in contrast to fennel seeds, curry leaves, and asafoetida (control groups). Furthermore, compared to

control groups, FME at 2 mg/mL dramatically reduced nonenzymatic glycation by 70%, suggesting that it had a positive effect on blood glucose regulation [38].

9. Future Perspectives and Research Directions

9.1. Technologies in Microgreen Cultivation

The future of microgreen production holds exciting prospects with the integration of cutting-edge technologies. Advancements in controlled environment agriculture, including vertical farming, hydroponics, and aquaponics, are likely to play a pivotal role in optimizing resource use and enhancing overall sustainability [48].

9.2. Vertical Farming Systems

Vertical farming, with its potential for space-efficient, year-round production, presents an intriguing avenue for scaling up microgreen cultivation. Research examining the outcomes of various vertical farming methods on microgreen growth and nutritional quality is anticipated to provide valuable insights [49].

9.3. Internet of Things (IoT) in Microgreen Cultivation

The integration of IoT technologies for real-time monitoring and control of environmental parameters holds promise for precision agriculture in microgreen production. This includes monitoring light, temperature, humidity, and nutrient levels, allowing growers to optimize conditions for maximum yield and quality [50].

9.4. Potential Innovations in Nutrient Management

Advancements in nutrient delivery systems and formulations are expected to contribute to more efficient and sustainable microgreen cultivation. Tailoring nutrient solutions to specific crop varieties and growth stages, along with exploring alternative nutrient sources, can further enhance the nutritional content of microgreens [51].

9.5. Nutrient-Fortified Substrates

Research on developing substrates enriched with essential elements or bioactive compounds can contribute to enhancing the nutritional profile of microgreens. Nutrient-fortified substrates may offer a sustainable and bioavailable source of essential elements during microgreen growth [52].

9.6. Nutrient Recycling and Circular Economy

The exploration of nutrient recycling systems and the principles of a circular economy in microgreen cultivation align with sustainable practices. Efficient nutrient recovery from organic waste and its integration into cultivation systems could reduce environmental impact and resource consumption [53].

10. Conclusion

Lastly, Indian microgreens such as Sunflower, Fenugreek, Mustard, Radish, Cilantro, Amaranth, and Marigold surpass their mature counterparts in terms of vitamins, minerals, and phytochemicals, making them nutritional powerhouses. Some cultivars, such as Red Mustard, Green Daikon Radish, Garnet Amaranth, and Cilantro, have nutrient profiles that are rich in minerals, ascorbic acid, and carotenoids. Plant sterols and polyamines are examples of distinct bioactive chemicals that may have anti-inflammatory, anti-cancer, antibacterial, and anti-diabetic effects or other health advantages. It is important to continue researching the many species and health effects of microgreens since, in addition to their nutritional value, they may be able to reduce the symptoms of chronic illnesses. For this reason, adding Indian microgreens to everyday meals is not only a great way to improve the quality of food but also a great way to improve overall health. Further investigation could reveal other aspects of their potential as a treatment.

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88 DEVELOPMENT OF COMPOSITES FROM BAGASSE FIBRE AND POLYPROPYLENE USING EPOXY RESIN

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ABSTRACT

Nowadays development of composites from renewable resources has become great interest as to reduce the usage of plastics . This study aimed at developing cardboard composite made from bagasse and polypropylene material using epoxy resin that will be suitable for ceiling boards, walls and floors of a home, office or commercial building in order to reduce the amount of plastics from our environment and conserve our natural resources such as forests from depletion. This composite was compared to the already existing ceiling materials in the market. A composite cardboard of melted waste polypropylene as the matrix was reinforced with bagasse fibres after being treated by alkali solution (NaOH) were prepared and the mechanical properties such as Compressive strength, Impact strength, Flexural strength, were investigated. Water absorption was also studied.

1. INTRODUCTION

In construction industry has over the years been heavily dependent on wood as construction of materials such as ceiling boards, particle board, block board and floor tiles among others and less has been done to develop more alternative materials to replace wood in order to save our forests from depletion[1]. More recently natural fibres have been employed in combination with plastics. Availability of natural fibres in India such as Bagasse, Bamboo, Banana are abundant and this gives attention on the development of natural fibre composites primarily to explore value-added application avenues[2].

Polyethene bags and plastics, including PVC items, make up approximately 225 tonnes out of the 2000 tonnes of solid waste generated daily in Salem. This represents about 11% of total waste generated daily. This results in lot of plastics as wastes in our environment that are never recycled but rather end up in landfills or in dumpsites. This plastic bags poses the biggest challenge to solid waste management in Salem and so this calls for proper disposal[3].

Natural fibres reinforced with polymer composites have gained more interest because of their biodegradable, less expensive, light weight, easy processing, high specific modulus and also environmentally appeal. Plant fibres from agricultural crops are renewable materials which have potential for creating green products and replacing synthetic materials which have potential for creating composites panel[4].

According to all the natural fibres listed, bagasse is biomass remaining after sugarcane stalks are crushed to extract their juice and today bagasse is used as a major raw material for fuel, as well as for pulp and paper production, in addition to being a reinforcement material in value-added composite panel production. Transforming bagasse into high-quality panel products provides a prospective solution because it has a potential as the core material replacing high density and expensive wood-based fibre board[5].

This study aimed at developing a composite made of polypropylene matrix weight%(polypropylene 3% & 6%)and sugarcane bagasse fibers in mat form of weight% (bagasse 35% & 30%) materials that can be used as cardboards for construction purposes suitable for floors, walls, ceilings of homes.The samples of the composites were designed and fabricated by hot press. The tests that were carried out include; Compression test, Bending/flexural test, Impact test and Water absorption test[6].

2.MATERIALS AND METHODS

Raw material specification Sugarcane-bagasse

Sugarcane bagasse was collected from juice stall had been extracted. The extraction of bagasse fibres from sugar cane does not require a complicated technological process. Bagasse is eco-friendly, biodegradable fibre which is produce by less cost and having widely use in feature for many applications. Further research in this field will help to find better application of this fibre. So, we are here to make cardboard from bagasse fibres.

Production of raw material

Sugarcane is a natural plant fibre, which is collected from sugarcane plant. It is an oldest crop known to man, a major crop of tropical and sub-tropical regions worldwide. Sugarcane contains about 70% water. In the milling process, the harvested sugarcane brought to the mill is chopped and passed through crushers to extract juice.

The wastes generated from sugar industry are press-mud, bagasse, bagasse fly ash, sugar cane trash, sugar beet mud, sugar beet pulp, molasses etc.

The waste coming from extraction of sugarcane juice is called ‘BAGASSE’. The bagasse fibre is treated with some other substance to make a useful product.

Extraction of bagasse fibre

The bagasse fibre collected from sugarcane juice stall and it is extracted. They were neutralized by soaking in 70% ethanol for an hour with a volume ratio of ethanol (litre) to the weight of fibres (kg) as 2:1. The aim of neutralization was to prevent bagasse from fermentation. Neutralized sugarcane bagasse was then dried in an open air for 6 hours. After drying, the bagasse was soaked in alkaline solution (NaOH). Treated bagasse was rinsed with distilled water few times and they were ensured clean. They were dried in an open air for 6 hours followed by oven dried at 50°C for 1 hour to remove all moisture content from the fibres. The sieve size was used to obtain small size fibres to design a composite with consistent properties. The extracted bagasse fibers were formed as matt form to get more strength. Bagasse fibers are formed as a matt using cotton yarn.

Raw material specification

Thermoplastic resins -polypropylene plastic PP

Thermoplastic resins (Plastics-polypropylene PP) PP belongs to polyolefin family of polymers and is one of the top three widely used polymers today. Polypropylene has applications both as a plastic and a fibre. Polypropylene is a tough, rigid and crystalline thermoplastic produced from propene (or propylene) monomer. It is a linear hydrocarbon resin. The chemical formula of polypropylene is $(C_3H_6)_n$. PP is among the cheapest plastics available. It is used were waste plastics collected from Pradeep chemical industry. The collected plastics were first cleaned using warm water and soap to remove dirt, paper labels, oils, fats etc. They were sorted according to the type of plastic in order to remain with the PP plastics. The PP plastics were further sorted according to colour to act as dye and size. To achieve homogeneous mixture between bagasse and PP, the Polypropylene plastics were cut into small square pieces of approximately 20mm x 20mm and left to dry in the open air and finally weighed.

Power of polypropylene

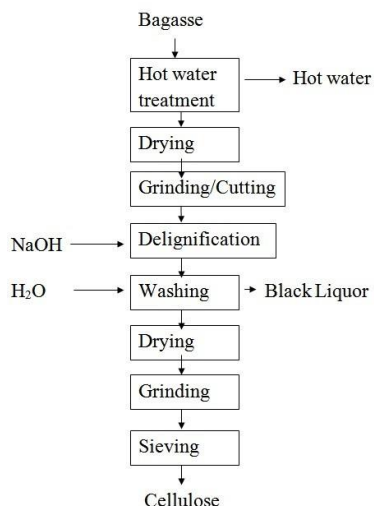
Polypropylene produces less solid waste by weight than PET, PS or PVC. Thus, many recycling applications exist for Polypropylene: battery cases, paint cans, home storage, flower pots, pallets, crates, composite lumber, and more.

Polypropylene plastic waste that is collected from landfill and the materials which are rejected by factories are to be recycled.

The collected waste plastic is categorised and the suitable waste is taken in to process washing, shredding, resizing, identifying and compounding.

Methods

Preparation of bagasse fibre



Sugar cane fibre bundles were extracted from the separated rind of cane stalks using alkaline treatments. The amount of lignin removed depended on alkaline concentration and time and pressure of treatment; agitation and vigorous boiling also affected the lignin removal. A severity factor R was calculated to compare the delignification conditions. Alkali concentration significantly affected the mechanical properties of the fibre bundles. Tenacity, toughness, and linear density were higher for the fibres extracted at the lower concentration, as were bending rigidity and hysteresis.

Preparation of waste polypropylene plastic

Waste collection is the part of process of waste management, the categories include source reduction and reuse, animal feeding, recycling, composting, landfills and land application. For separating polypropylene plastics from other types of plastic polymers. it is achieved through a sink-float separation technique where polypropylene is separated based on its ability to float when polymer will sink. Sorting is mostly done according to codes, the symbols do not have anything to do with number of times the plastic can be recycled and is commonly believed. The coding system is used around the world by recyclers to separate and sort plastics so that they can be processed according to the main polymer present. Sorting is done manually or with machines using technologies that recognize different sorts of plastics.

Plastic washing plants start with crushing machines. We use wet crushing machines and washing process start inside crushing chamber. Crushing machine bring down the plastics entering into wash line into uniform size. High speed separator after the crusher removes excessive water along with dirt from plastic. Shredding is also an efficient waste disposal method, and this greatly reduces the cost of recycling for several industries They convert plastic waste into reusable raw material for manufacturing plastic

containers, PET bottles and PVC products. They also help recoup waste disposed from commercial units Identification of plastic is done by,

- DE formulation and Product Analysis.
- FTIR Analysis of Polymers and Plastics.
- Polymer Chemical Testing.

Separation technologies are divided into gravity separation, electrostatic separation, magnetic density separation, flotation, and sensor-based sorting. The sorted flakes were then grinded into powder form. Compounding is a process of melt blending plastics with other additives. This process changes the physical, thermal, electrical or aesthetic characteristics of the plastic. The final product is called a compound or composite. Compounding starts with a base resin or polymer.

Preparation of composites

To produce samples for flexural, impact, compression, water absorption, and tensile testing, hydraulic compression moulding was employed. A back pressure and a compression pressure were applied. Compression moulding temperatures range from 90 to 100 degrees Celsius. Throughout the half-hour procedure, a pressure of 1500 psi is maintained. Also, sheets of the different samples were obtained using a hot-plate press and a forced water circulation cooling system. To shape the specimens, stainless steel moulds were used. The moulding was conducted. Finally, the sheets were demoulded and adjusted to the required dimensions for Dynamic Mechanical Analysis tests using a computer numerical control router.

3 RESULT AND DISCUSSION

Material testing

Mechanical property of the final composites was evaluated using compression test, bending/flexural test, impact test, water absorption test. Further-more, the two composite samples were compared and analysed.

The composite samples had various wt. % ratio of Bagasse to PP (polypropylene 3% & 6%) and sugarcane bagasse fibers in mat form of weight% (bagasse 35% & 30%), this was done based on previous works done.

Compression test

Composite compression testing methods provide a means of introducing a compressive load into the material while preventing it from buckling. Compression tests are performed for composite materials that are in the form of a relatively thin and flat rectangular test specimen such as laminate panels. Compression testing was conducted for polymers, composites, and elastomers and can also be conducted on plain or “open/filled hole” specimens. Remarkably, compression testing determines behaviour of materials under a crushing load, and the compression and deformation at various loads is recorded to calculate compressive stress and strain. In general, there are three methods of introducing a compressive load into a test specimen

- End loading: all of the load is introduced into the flat end of the test specimen.
- Shear loading: the load is introduced into the wide faces of the test specimen.
- Combined loading: a combination of shear and end loading is used

Bending / flexural test

For flexure testing, the metal grips on the universal hydraulic testing machine were replaced by a three-point test jig. The flexure test method measures the behaviour of material subjected to simple beam loading. Maximum stress and maximum strain is calculated for increments of load. Results were plotted in stress- strain diagram. The force required to bend the specimen was then recorded.

Water absorption

This test was done to determine the amount of water absorbed by the composite material when immersed in water for a stipulated period of time. The sample test specimen samples of 20mm x 20mm were prepared and dried in the oven, and then allowed to cool. The specimens were then weighed on the electronic weighing machine to the nearest 0.001g before soaking in water. After 24 hours , the specimens were removed from water and weighed again. The results were recorded and water absorption in different specimens was noted in 24 hours.

Impact test

Impact testing is the ability of an object to resist high-rate loading. It is determined by the energy absorbed in fracturing a test speed at high-rate velocity. The machine used was the Pendulum Impact testing machine.

4. CONCLUSION

Bagasse (sugarcane residue) is currently underutilized in India and is therefore available to be used, bonded with a resin to make a composite material. Also, the use of waste plastics to make the composite material is a very effective way of recycling plastics and hence removing them from our environment. Since bagasse fibre and waste plastics (PP) are easily available, this will cut down the cost of materials for manufacturing the composite hence becomes less expensive compared to other cardboards in the market.

Polypropylene and bagasse fibres can be effectively used to develop a cardboard composite that can be used in construction industry and in that way it will be the effective way of disposing waste plastics and making use of the naturally available fibre. Because we will not be comparing our product to other cardboards on the market. Our sole goal is to replace the wood-based product that contributes to environmental depletion. Thus the development of composite using bagasse and polypropylene plastic were done with further test methods includes, compression test, bending/flexural test, impact test, water absorption test. As can be seen from the above tests, different composite ratios result in varied strengths. As a consequence of the test findings, these products were employed in various applications based on their strength.

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89 INNOVATION OF NOVEL HELMET LINER WITH BAMBOO KNITTED FABRIC

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Abstract

Recently there has been upsurge interest in apparel technology all over the world for much demanding functionality of the products like wrinkle resistance, water repellence, fade resistance and resistance to the microbial invasion. Among these, development of antimicrobial textile finish is highly indispensable and relevant since garments are in direct contact with the human body. Bamboo is an eco-friendly and multifunctional plant. Bamboo clothing has recently entered the textile market with a claim for its antimicrobial properties.

Microencapsulation technique the process of wrapping very small gas particles, gases, or active solid content with a coating material/membrane to protect the active particles (core) from environmental influences like unwanted effects such as light, moisture, and oxygen to increase shelf life of the product by imparting natural medium as a capsule insulator. An effective solution to enhance helmets cooling is the utilization of microencapsulated inner layer with the tanners cassia and lemon grass generated from the wearer's head, thereby facilitating cooling within the helmet. . The fabric comfort parameters such as air permeability, moisture vapour permeability and thermal insulation property is be tested. Comparison study is also done for comfort properties, liquid barrier property and antimicrobial property, which is then converted into a inner layer suit for the Helmet.

Key words: microcapsules, antimicrobial, multifunctional plant, aroma

1. Introduction

Plants having antibacterial properties are becoming more and more popular. As a means of determining these plants' possible antimicrobial activities and pinpointing the chemicals supplying those qualities, scientists are screening these kinds of plants more frequently. Consequently, more research is imperatively needed to create environmentally acceptable antibacterial compounds derived from plants for use in textile applications. Though some natural antibacterial agents are currently on the market, their antibacterial activity on textile materials has only been the subject of a few studies. Additionally, there is a need for progressive and comprehensive data on the antimicrobial finished product of textiles, particularly in the medical cloth preparation process.

The longevity of coatings after washing is a significant concern when it comes to clothing. Despite the fact that several herbal extracts have demonstrated strong antibacterial properties when applied to textile materials, their wash ability is lacking. Therefore, the herbal extracts were fixed on the fabrics in this investigation using the microencapsulation process. Textile microcapsules are a response to the current industry interest in functionalization technologies, which endow products with attributes including antibacterial activity, insect repellence, fragrance finish, and thermal comfort. This review has focused on the use of microencapsulation techniques to create novel textiles for the textile industry. More riders will wear safety standard-approved motorcycle helmets if an attractive motorcycle helmet liner is developed.

2. An overview of Tanner's Cassia and Lemon grass in Bamboo knitted fabric.

Tanner's cassia, or *Cassia auriculata* (L), is a medicinal plant that grows wild throughout India. In Ayurvedic medicine, it is frequently used as an astringent, tonic, and treatment for ophthalmia, diabetes, and conjunctures. *Cassia auriculata* L. leaves are helpful as an anthelmintic and for persistent fever. An analysis of the metal content of *Cassia auriculata* leaves was conducted. Potassium, calcium, magnesium, manganese, iron, zinc,

copper, and phosphorus were discovered. Iron, zinc, magnesium, and manganese are the possible sources, but the amounts of calcium, sodium, and copper were determined to be minimal.

Textiles with multifunctional finishing contribute desirable biological and functional features that increase the products' value. This study set out to extract the essential oil from lemongrass and apply it as a finishing agent to conventional fabric. Using a Soxhlet extractor and n-hexane as the solvent, fresh lemongrass blades were extracted for 16 hours to produce lemongrass oleoresin, following the AATCC Method 30–25. Cotton fabric was scented using the pad-dry process with a finishing composition that included β -cyclodextrin-grafted chitosan and lemongrass oil. Through FTIR spectroscopy, the ester bond formation between cellulose and β -cyclodextrin-grafted chitosan was verified.

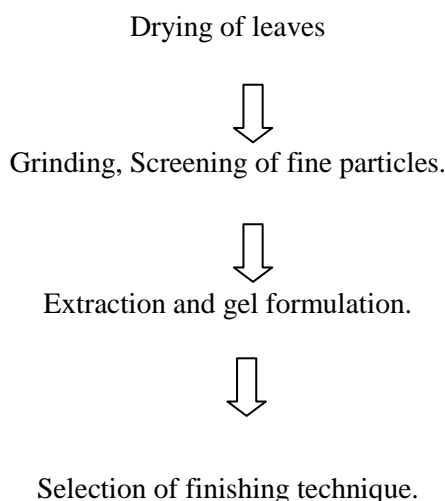
Textile innovation has highlighted plant-based alternatives, like bamboo, as a viable substitute for synthetic fibers derived from petrochemicals. Bamboo is a very sustainable and adaptable resource when used as a raw material, but the manufacturing process is where the main controversy arises, tarnishing bamboo's reputation as a sustainable material. Regardless of how they are created, bamboo products are frequently marketed as "eco-friendly," "bio-degradable," and "anti-microbial." Thus, for the goal of microencapsulation, bamboo knit fabric with a high performance rate of stretchability and moisture retention is chosen.

3. Microencapsulation for coating of fabric.

The primary focus in the textile industry has shifted to product functionality, including wrinkle resistance, water repellence, fade resistance, and resistance to microbial invasion. Interest in plants that have anti-bacterial properties is rising. In an effort to determine their potential benefit, researchers are getting more and more interested in screening the anti-bacterial effects and figuring out the components causing these plants' anti-bacterial qualities. One of the cutting-edge techniques for giving textiles functional finishes is microencapsulation. In terms of cost, energy efficiency, environmental friendliness, and substance release under control Comparing microencapsulation to traditional methods reveals additional benefits.

4. Sample preparation

The tanner's cassia leaves, and lemon grass are taken from the natural plant. The micro encapsules gel technique of tanner's cassia and lemon grass are produced by the following steps,



After gel formation, the gel is coated in the fabric by padding mangle technique.

4.1 Drying of leaves

A source of heat and an agent to remove the vapor produced by the process are often involved, here we use sunlight as source of heat.

The leaves are shadow dried (around 40 degree Celsius). Then noted the weight of leaves for a regular interval and the drying process is done once the leaves attain a constant weight.

Here we used shadow drying technique to the point of preservation of leaves ingredients, shadow method is most effective.

The Drying curve is obtained, and it is showing similar trend in drying as shown in reference 55. The drying rate increases exponentially from 0 to 180 min of the drying time and the maximum drying rate at 180 min is 1.389×10^{-3} . Similarly, the relative moisture content in the leaf attained equilibrium moisture in 4000 min and the equilibrium relative moisture content is 0.35 for the temperature 40 degree Celsius.

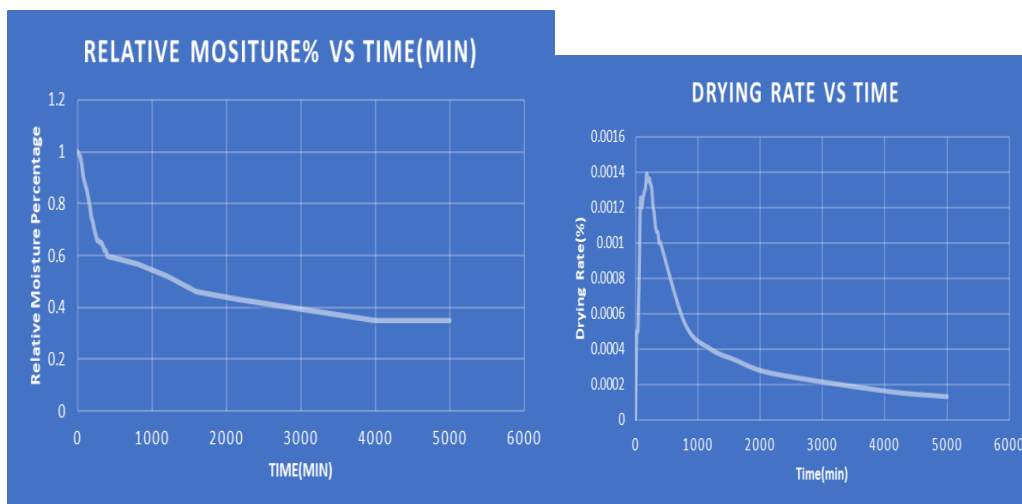


FIG 4.1.a

FIG 4.1.b

Grinding, Screening of fine particles.

The knife mill is employed to break down the leaves into smaller particles (usually in few micrometres). Multi mill is useful for functions such as wet and dry granulation and pulverization. It is also useful in industries like Pharmaceuticals, cosmetics, dyes, paints, food products, herbs, detergents, pesticides, polymers, resins, and fertilizers. Plates with holes or sieves that only let particles of a particular size pass through them. Depending on its intended use, mesh might have

different sizes in different locations. For instance, husk and stone are also separated from wheat by sifting. Here, we employ sieve plates with a larger mesh size than those used to separate flour. When the sample is sieved, it is moved horizontally. The individual particles either pass through the sieve mesh or are kept on the sieve surface, depending on their size, causing a relative movement between the particles and the sieve. To avoid sticking of particles on the mesh, we dried the leaves thoroughly. Sieve plates are used to maintain the product quality in food industry, pharmaceutical industries for grading the product quality. The fine powder is separated from the large coarse particles by using sieves with mesh number 85 (opening mesh diameter: 180 micrometres).

The main purpose to screen the powder is to avoid the formation of large lumps during the gel formulation and maintain the uniform quality of micro capsule in the gel.



FIG 4.1 c TANNERS CASSIA FIG 4.1 d LEMON GRASS

4.2 Extraction and Gel formulation:

Weighed about 1 gm of lemon grass powder and 1 gm of Tanners Cassia powder. Then add 20 ml of ethanol to dissolve the powder. Filter the solution after 72h. Then add 180 ml of water to the solution and then add 400 mg of methylparaben and 400 mg of propylparaben to the solution. Place the mixture in a water bath for 5 to 10 minutes. Then add the 750 mg of Carbopol and stir the mixture for 30 minutes with a Remi stirrer. Finally, add 5% NaOH dropwise to the solution to form a gel.



STEP 1 STEP 2 STEP 3 STEP 4

4.3 Selection of finishing technique:

The hydrolytic technique, which was developed for the padding mangle process and is the oldest and least valuable, is used to inoculate the micro capsules in the bamboo knitted fabric.

Padding mangle:

It includes a chemical trough, a guide roller, and a squeezer. The chemical finish is applied to the fabric before it is transferred to the squeeze mangle. Finish chemicals are sprayed to the cloth during this time, and the fabric is squeezed to remove any surplus chemicals.

Process:

- The Micro encapsulate Gel is dissolved in distilled water at low shear rate and placed in chemical trough.
- Fabric is dipped into the chemical trough.
- It then passes through the squeezing mangle with the help of guide rollers, where the pressure from the rollers ensures proper application of the finish.
- The speed of the roller is kept around 1 m/min to maintain uniform coating on the fabric.
- Excess chemicals are removed from the fabric during this process.
- And dried the fabric to remove the excess water and set the micro capsules on the fibre voids.

5. EVALUATION OF THE NOVEL FABRIC

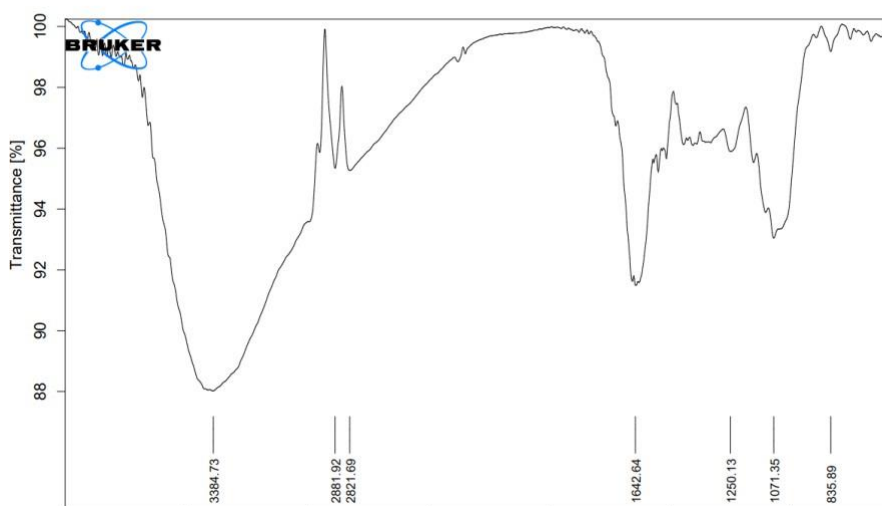
Fabrics are evaluated for its performance by the following test methods,

1. Fourier-transform infrared spectroscopy (FTIR)
2. Scanning electron microscope analysis (SEM)
3. Air Permeability
4. Moisture Regain and Content.

5.1. Fourier-transform infrared spectroscopy (FTIR):

FTIR stands for Fourier transform infrared, the preferred method of infrared spectroscopy. When IR radiation is passed through a sample, some radiation is absorbed by the sample and some passes through (is transmitted). The resulting signal at the detector is a spectrum representing a molecular ‘fingerprint’ of the sample. The usefulness of infrared spectroscopy arises because different chemical structures (molecules) produce different spectral fingerprints.

5.1.1 Tanners Cassia FTIR analysis:



The shadow dried and finely grinded powders of tanner’s cassia leaves are taken for FTIR analysis to check for the compounds and chemical group present in them.

As per FTIR spectra of Cassia auriculata test sample extract, the functional groups of the components were separated based on their peak ratios. The result confirmed the presence of characteristic band shows the C-H

aromatic stretching, C=O stretch carboxylic acid / Ketone group, O-H stretch group, C-H bending C-C stretch group.

The result from graph(1) confirmed the presence of characteristic band the sharp signal at 2881.92 cm^{-1} shows C-H aromatic stretching, the broad signal at 1642.64 cm^{-1} shows C=O stretch carboxylic acid / Ketone group, the Very broad signal at 2821.69 cm^{-1} & 3384.73 cm^{-1} shows O- H stretch group of carboxylic/alcohol, the peak at 1250 cm^{-1} shows C-N stretching, the peak at 1071.35 cm^{-1} C-C stretch group.

This peak may be indication of the useful phytochemicals like alkaloids, glycosides, flavonoids, saponins, dietary fibres, polysaccharides, glycolipids. And these Chemicals are responsible for the anti-bacterial activity nature of Tanners Cassia leaves.

5.1.2 Lemon Grass FTIR analysis:

The shadow dried and finely grinded powders of Lemon Grass (*Cymbopogon Citratus*) leaves are taken for FTIR analysis to check for the compounds and chemical group present in them.

FTIR spectra of lemon grass oil showed the presence of alkanes, alkenes, aldehydes, alcohols, carboxylic acids, Ethers, and aromatics. [61,62]

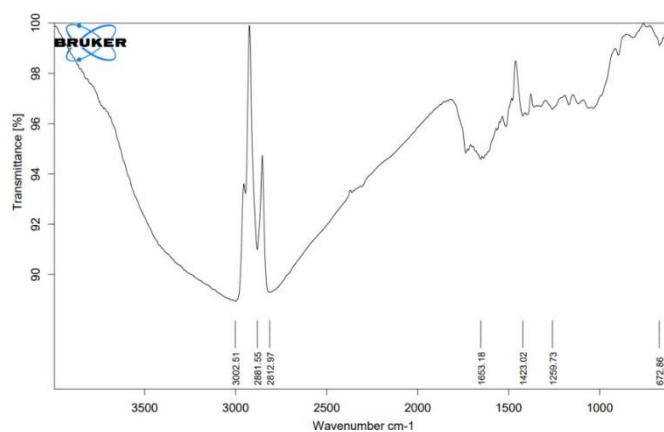


FIG 5.1.2

The graph (2) very broad peak at 3002.51 cm^{-1} shows O-H stretch group of carboxylic/alcohol group. The sharp peaks at 2881.55 cm^{-1} & 2812.97 cm^{-1} shows C-H stretching of Alkene/ Alkane. The sharp peak at 1653.18 cm^{-1} shows C=C stretching of Alkene/aromatic. The peak at 1423.02 cm^{-1} shows the C-H bending of alkanes. The peak at 1259.73 cm^{-1} shows the C- O stretching of Carboxylic acid/aldehyde/ketone. The peak at 672.86 cm^{-1} shows the =C-H stretching of aromatics group.

5.1.3 FTIR analysis of MicroCapsules:

The above graph (3) Very broad peak at 3455.66 cm^{-1} shows O-H stretch group of carboxylic/alcohol group. The sharp peaks at 2883.45 cm^{-1} & 2823.89 cm^{-1} shows C-H stretching of Alkene/ Alkane. The broad peak at 1637.48 cm^{-1} shows C=O stretching of Carboxylic/aldehyde. The peak at 1423.02 cm^{-1} shows the C-H bending of alkanes. The peak at 1259.73 cm^{-1} shows the C-O stretching of Carboxylic acid/aldehyde/ketone. The peak at 731.33 cm^{-1} shows the =C-H stretching of aromatics group. Comparing FT-IR spectra of raw materials and their micro capsules it can be identified that the changes in the -OH, i.e., hydroxyl group the peak appeared at 3002.51 cm^{-1} (Lemon Grass) & 3384.73 cm^{-1} (Tanner's Cassia) in raw material, but after encapsulation of micro capsules, the peak is narrower and shifted to 3455.66 cm^{-1} and also for -C=O of carboxylic group the peak intensity reduced after encapsulation of micro capsules. This tells us that the raw material is well encapsulated in the Carbopol polymer coat by forming hydrogen bonds.

5.2 Scanning electron microscope analysis (SEM):

The Scanning electron microscope works on the principle of applying kinetic energy to produce signals on the interaction of the electrons. These electrons are secondary electrons, backscattered electrons, and diffracted backscattered electrons which are used to view crystallized elements and photons. Secondary and backscattered electrons are used to produce an image. The secondary electrons are emitted from the specimen play the primary role of detecting the morphology and topography of the specimen while the backscattered electrons show contrast in the composition of the elements of the specimen. The raw bamboo knitted fabric and coated fabric are examined under the scanning electron microscope for analysing the structural differences. Both the samples are viewed at magnification of 250x, and very minute differences can notice. In the image we can clearly see the minute dot or thread like structure on the coated fabric, which will be shown in the below image.

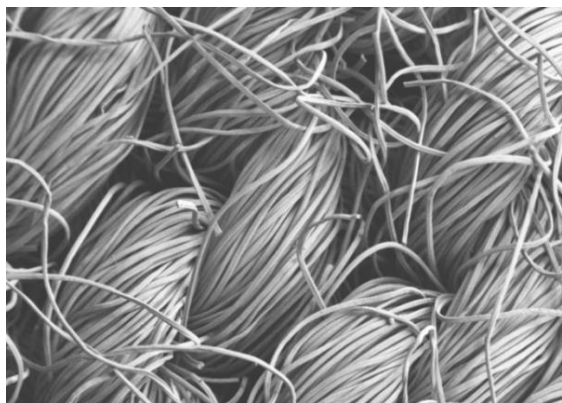


Fig 5.2(a)

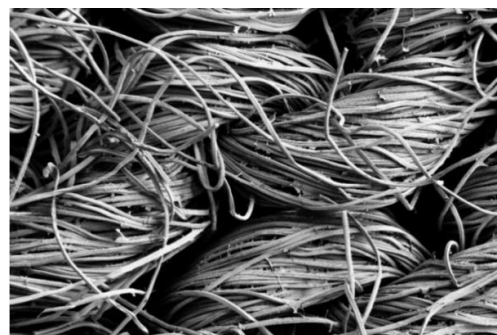


Fig5.2 (b)

Figure (a) is the uncoated Fabric and the figure (b) is the coated fabric. So, we can conclude that our micro capsules are coated on our fabric.

To test the coating performance after 25 washes, we viewed the image of coated and uncoated fabric after 25 wash cycle at 1000x and 10000x. The coating persists in the fabric even after 25 wash cycle and the higher magnified image shows that the coating provides a bridge between inter fibres, which could possibly enhance the integrity of the fabric. The main reason for this is the polymer Carbopol which turns to a mucous gel at alkaline ph., and we can see that same on the image.



Fig5.2(C)



Fig5.2 (D)

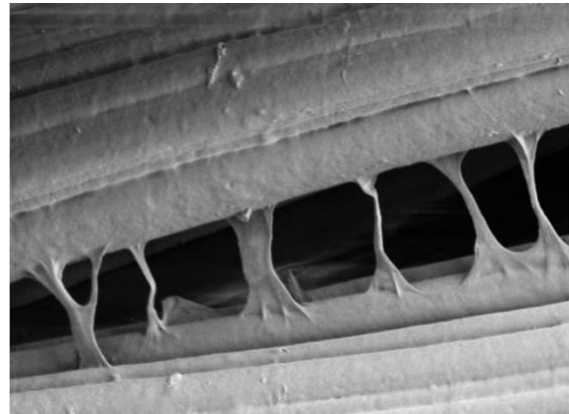
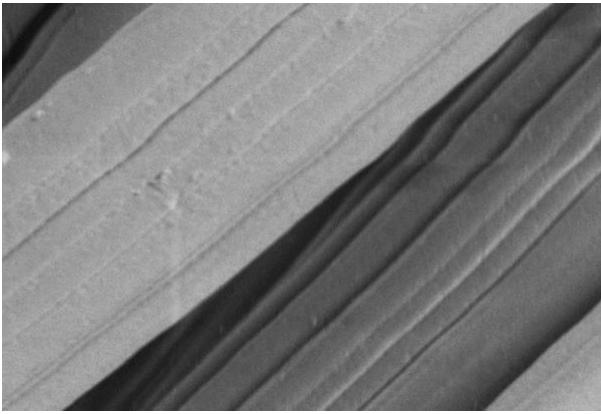


Fig 5.2(E)

Fig 5.2(F)

Fig.5.2(C) is the uncoated fabric at 1000x, and fig.5.2(D) is the coated fabric at 1000x. Fig.5.2(E) is the uncoated fabric at 10000x, and fig.5.2(F) is the coated fabric at 10000x.

NOTE: Fig.(C), (D), (E),(F) are the samples viewed after 25 wash cycles.

The capsules are well coated in the bamboo fabric in the inter fabric level as shown in the above pictures. These capsules can persist in the fabric after 25 washes, so the coated fabric has good wash durability.

5.3 Air Permeability:

The air permeability of a fabric is a measure of how well it allows the passage of air through it. The ease or otherwise of passage of air is of importance for several fabric end uses such as industrial filters, tents, sailcloth, parachutes, raincoat materials, shirting down proof fabrics and airbags.

Air permeability: The air permeability of a fabric is the volume of air measured in cubic centimetres passed per second through 1 cm² of the fabric at a pressure of 1 cm of water.

Air resistance: The air resistance of a fabric is the time in seconds for 1 cm³ of air to pass through 1cm² of the fabric under a pressure head of 1 cm of water. Air resistance is the reciprocal of air permeability.

“The porosity of a fabric is the ratio of air space to the total volume of the fabric expressed as a percentage.”

Let,

S = total volume of sample in cubic centimetres F = Total volume of fibre in cubic centimetres Air porosity,
 $P = (S-F)/S * 100$

Average Air Permeability= $84.81+76.92+80.87+71.01+78.90$

$5 = 78.5 \text{ cm}^3/\text{s}/\text{cm}^2$

The same experiment is conducted by SITRA LABS(Coimbatore)to check the reproducibility of the test. The equipment specification and operating conditions are given below:

Instrument: Textest FX 3300-III, s/n: 1198 Test pressure: 125 Pa.

Test area: 38 cm².

The equipment shows the nominal air permeability of the fabric is $77.1 \text{ cm}^3/\text{s}/\text{cm}^2$. The nominal air permeability is the arithmetic mean of 10 sample area reading. Below is the graph that shows the deviation of air permeability from its nominal value.

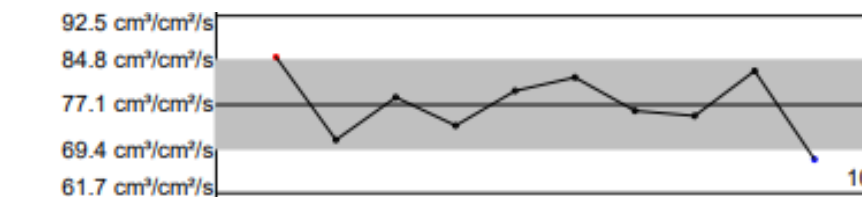


Figure 5.3

So, we get a reduction in air permeability around 3% to 11% to the fabric before encapsulation. This reduction in the air permeability may be due to microcapsules that entrapped in the voids of the fabric. The reported air permeability of the fabric is still in the acceptable range of cooling fabric, also this indicated that this fabric would have good water vapour resistance compared to cotton fabric and many commercial fabrics.

5.4 Moisture Regain and content:

Test Procedure:

The testing standards we used is IS 199:1989 RA 2020 to determine the moisture content and regain of the fabric. And the procedure is discussed below:

1. Sampling: Samples from the fabric for testing shall be selected to be representative of the whole fabric. For this we taken 2 test specimens from various part of the fabric.
2. Apparatus: Drying Oven, capable of maintaining a temperature of $105 \pm 3^\circ$.
3. From the sample under test (see 1) draw at least 2 test specimens each weighing approximately 3 g. Take one test specimen and weigh it accurately in a clean and dry tared weighing vessel. Place the weighing bottle containing the test specimen in the drying oven and dry the specimen at $105 \pm 3^\circ\text{C}$ to constant mass (see Note) and determine the oven-dry mass of the test specimen.

Note: The mass may usually be regarded as constant if the loss between two successive weighing, taken at an interval of 20 minutes, does not exceed by 0.1 percent of the first of the two values.

Fig 5.4



Calculation:

The below is the sample calculation for the uncoated bamboo knitted fabric. Weight of the cloth sample=3g=a

Weight of vessel=70 g

Weight of vessel + cloth sample=73g=b

Weight of oven dried sample + vessel=72.72g=c Weight of the water present = b-c=73-72.72=0.28 g Weight of oven dried sample=3-(b-c) =2.72g=d

Moisture content (%) = ((b-c)/a) *100= (0.28/3) *100=9.34% Moisture Regain (%) =((b-c)/d) *100= (0.28/2.72) *100=10.3%

Similarly, calculation is done for coated fabric for a set of 2 and taken the mean value as moisture regain and moisture content of the fabric.

The mean average moisture content of the uncoated fabric= (9.33+9.67)/2=9.5% The mean average moisture regain of the uncoated fabric= (10.29+10.7)/2=10.495% The mean average moisture content of the coated fabric= (9.1+9.6)/2=9.35%

The mean average moisture regain of the coated fabric= (10.01+10.62)/2=10.315%

The moisture content and regain did not changed much after coating and before coating. Moreover, there is a decrement in moisture content by 0.15% and decrement in moisture regain by 0.18% after coating. This means that the coating improves the lightness of the fabric avoiding the moisture.

6. Conclusion

The tested fabrics were analysed and their functional properties were observed by wearing as the inner layer of the helmet. It is observed that the use of Tanners cassia and lemon grass in the form of gel, penetrates into the Bamboo fabric by the padding mangle method gives good moisture content and regain value. An one week observational study was done and noticed that , coated Bamboo fabric provides comfort to the wearer with its aesthetic performance and balances its comfort property when it is in contacts with head . Also the natural property present in fabric such as cooling properties prevents hair from heat and cold. Our novel helmet fabric could be sustainable and provide comfort to the wearer. Thus, we can bring out new innovations in the field of eco textiles to protect our environment and also we can support the increasing demand for safety and hygiene among consumers.

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90 PRODUCTION OF ANTIBIOTICS BY USING BACILLUS SPECIES ISOLATED FROM HOSPITAL SAMPLE

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Abstract:

The comprehensive study of antibiotic is derived from Greek term antibiosis, which literally means "against life. The antibiotics are widely distributed in the nature, where they play an important role in regulating the microbial population of soil, water, sewage and compost. Of the several hundred naturally produced antibiotics that have been purified, only a few have been sufficiently non-toxic to be of use in medical practice. Those that are currently of greatest use have been derived from a relatively small group of microorganisms belonging to the genera *Penicillium*, *Streptomyces*, *Cephalosporium*, *Micromonospora* and *Bacillus*. The period from the 1940s to the late 1960s is referred to as the "golden era" of antibiotic research because research in this period resulted in the identification of a robust arsenal of effective agents from natural sources to treat microbial infections. Antibiotics, either of natural or synthetic origin are used to both prevent proliferation and destroy bacteria. Antibiotics are produced by lower fungi or certain bacteria. Antibiotics are the secondary metabolites produced by the microorganisms via enzymatic catproduced by microorganisms are responsible for the regulation and control of microbial population in soil, compost and water. Majority of such antibiotics are toxic in nature and only few find a use in medicine for treatment of multiple ailments due to high margin of safety . Such antibiotics are mainly produced by *Penicillium*, *Streptomyces*, *Cephalosporium*, *Micomonospora* and *Bacillus* accounting formore than 5,000 compounds. Theseantibiotics are low molecular weight polypeptides produced by ribosomal ornon ribosomal mechanisms .The *Bacillus* species are known for the synthesis of secondary metabolites with remarkable diversity both in structure and function . For instance cerecin, Tochicin, Thuricin 7, thuricin 439 and entomocidus and few may be ribosomal in origin including sublancin , subtilosin A , subtilin and TasA are highly active against variety of microorganisms .The bacterial activity of bacitracine is the result cell wall inhibition

Keywords: Antibiotics, *Cephalosporium*, *Entomocidus*, *Micromonospora*, *Penicillium*, *Streptomyces*

1 Introduction

Bacillus-derived peptides have shown antibacterial, antifungal, antiviral, antitumor, antiamebocytic, and antimycoplasmic activities. Several *Bacillus* species, such as *B. Subtilis*, *B. Clausii*, *B. Cereus*, *B. Coagulans*, and *B. Licheniformis* have been used as probiotic supplements in both animals and humans. Several peptide antibiotics that are of pharmaceutical importance, such as bacitracin, polymyxin, gramicidin, tyrocidine, subtilin, and bacilysin, are produced by *Bacillus* species. Bacteriocins are proteinaceous antibacterial compounds that exhibit bactericidal activity against species closely related to the producer strain (de vuyst and vandamme, 1994). Bacteriocins from a variety of gram-positive species have been biochemically and genetically characterized, including staphylococci (navaratnaet al., 1998; oliveiraet al., 1998) and coryneform bacteria (valdes-stauberet al., 1991; motta and brandelli, 2002). The latter bacteriocins have been grouped into four distinct classes defined by chen and hoover (2003). Bacteriocins belonging to class i, also called the antibiotics, are characterized by the presence of unusual thio-ether amino acids, generated through post-transnational modification. Class ii bacteriocins represent small (610 kda), heat-stable and membraneactive peptides. Bacteriocins belonging to class iii consist of large (s30 kda) and heat labile proteins, while class iv represents complex bacteriocins that contain essential lipid or carbohydrate moieties in addition to a proteincomponent (ahernet al., 2003)hence the work predominantly focuses on the production of antibiotics to enhance the yield of egg and meat products. Antibiotics can be defined as a type of antimicrobial drug which is used for the treatment and prevention of bacterial infections by inhibiting the growth of the bacteria. The

discovery of antibiotics was a success in controlling infectious pathologies and increasing feed efficiencies. Antibiotics are the secondary metabolites produced by the microorganisms via enzymatic catalysis. Involving a series of biosynthetic pathways (9). Naturally the antibiotics produced by microorganisms are responsible for the regulation and control of microbial population in soil, compost and water. Majority of such antibiotics are toxic in nature and only few find a use in medicine for treatment of Multiple ailments due to high margin of safety . Such antibiotics are mainly produced. By penicillium, streptomyces, cephalosporium, micomonospora and bacillus accounting formore than 5,000 compounds. Theseantibiotics are low molecular weight polypeptides produced by ribosomal ornon. Bacitracin is most important cyclic polypeptide antibiotic produced Bacillus species and is primarily active against the Gram-positive bacteria. The bacitracin is used as anti-infective agent in a variety of pharmaceutical preparations including aerosols, topical lotions, skin ointments and creams. The bactericidal activity of bacitracin is the result of cell wall inhibition. The purpose of this study was to isolate antibiotic producing Bacillus strain from extreme conditions (saline soil) and suggest the optimum conditions for maximum activity.

2. Materials and Methodology

Isolation of Bacterial Cultures

Collection of sample:

A handful of Hospital waste water containing was collected from a Hospital water, Coimbatore, in a plastic bag and transported to the laboratory. From the, 1 ml of sample underwent serial dilution and spread plate technique was used to transfer the bacteria to nutrient agar media. The plate showing distinct colonies of bacteria was chosen for further work. Microscopic observation The bacterial isolate underwent microscopic observation after different staining methods.

Gram staining

A bacterial smear was prepared on a clean glass slide. It was allowed to air dry and heat fixed by passing the slide through the flame of a Bunsen burner very swiftly. At first it was stained with crystal violet for 1 minute and washed. Gram's iodine was added and washed off. After that it was decolorized with 95% ethyl alcohol. The smear was stained again with safranin for 45 seconds and washed. The smear was then observed under the microscope with 1000X magnification

Cultural characterization :

Microscopic Studies

4.3.1. Gram staining

A loopful of overnight broth culture was subjected to Gram staining procedures and the experts were recorded. Gram staining of freshly grown (incubated for 16 ± 2 h at 37°C) native isolates was carried out as per the standard staining procedure (Cappuccino and Sherman, 2002) using the following three processes: staining with a water-soluble dye called crystal violet, decolorization and counterstaining with safranin.

4.4. Bio chemical studies

a. Indole test

The colony from the nutrient agar was inoculated into the indole medium and incubated at 37°C for 24 hours. The formation of red ring upon the addition of 1 ml of indole reagent indicates positive reaction.

b. Methyl red test

The colony was inoculated into the MR-VP broth tubes and incubated at 37°C for 24-48 hours. Formation of red colour due to the addition of methyl red indicator indicates positive reaction.

c. Voges Proskauer test

The colony was inoculated into the MR-VP broth tubes and incubated for 48 h (Cappuccino and Sherman, 2002). After incubation, Barritt's reagent consisting of a mixture of alcoholic α -naphthol and

40% potassium hydroxide solution was added to the tubes and shaken. The tubes were allowed to stand for 15 min. Development of a deep rose color in the culture 15 min following the addition of Barritt's reagent indicated the presence of acetoin and represented a positive result. The absence of rose color was documented as a negative result.

D. Citrate utilization test

Aseptically bacterial culture was streaked on Simmons citrate agar slants and incubated for 48 h (Beishir, 1991). Positive results were scored for bacterial cultures which showed growth on slant and as well as changing the medium from green to blue (pH indicator). No color change and no growth on the slant was an indication of negative result.

e. Carbohydrate utilization test

It is used to determine whether or not a bacteria can utilize a certain carbohydrate. It tests for the presence of acid or gas produced from it if not the tube will remain red if the bacteria cannot ferment the carbohydrate.

f. Catalase production

A loopful of freshly grown (incubated for 16 ± 2 hr) culture was smeared on to clean glass slide, to which a drop of 3% H₂O₂ was added and allowed to react for 30 seconds (Cappuccino and Sherman 2002). The presence and absence of effervescence was recorded as catalase positive and negative, respectively. Optimization of cultural conditions for protease production Different cultural parameters including incubation temperature, broth pH, incubation period, carbon and nitrogen sources and their concentrations were optimised for maximum protease production based on ‘One parameter at a time approach’. Protease activity was determined for different ranges of each parameters tested by the above mentioned protease assay procedure using only the alkaline buffer. Optimum temperature for protease production was checked in the range of 10° C to 65° C. Ranges of the broth pH checked include 3 to 11. Protease production was determined at various incubation time intervals such as 12, 24, 36, 48, 60 and 72 h. Effect of different carbon sources on protease production was checked by adding 1% w/v of glucose, lactose, fructose, maltose, sucrose, starch, galactose and glycerol.

The optimised carbon source was again tested for its optimum concentration in a range of 0.25% to 4%. Different organic and inorganic nitrogen sources at a concentration of 1% were checked for maximum protease production including casein, soya bean meal, yeast extract, peptone, beef extract, meat extract, skim milk powder, ammonium acetate, sodium nitrate, ammonium chloride and potassium nitrate. The optimised nitrogen source was again tested for its optimum concentration in a different range.

g. Effect of initial pH:

The effect of initial pH was accessed in the 7.0 producing lipase using shake flask cultures. The medium containing 0.5% Olive oil and with Tween 20 induce the lipolytic activity was increased.

h. Effect Of Temperature:

The effect of different types of temperature were incubated in bacterial plate by lipase production was tested in 37°C, 50°C, and 70°C while keeping the pH of fermentation media constant along with the optimum concentration of either of 0.5% Olive oil and with Tween 20.

i. Lipase assay:

To determine the lipase activity on the basis of olive oil hydrolysis 28. The sample were mixed with 1.0ml of substrate containing 10.0 ml of 10% homogenized olive oil in 10% gum Arabic (Neem), 2ml of 0.6% of CaCl₂ solution and 5ml of 0.2mol.

Identification and characterization of the isolate Colony morphology: Colonies are large, opaque, irregular, producing green colour pigment. Based on the results of morphological studies and biochemical tests conducted, the isolated organism L-3 was identified as Bacillus species.

Ion Exchange Chromatography:

Procedure :

Washing Of Deae Cellulose

Take about 1.5 g of DEAE cellulose in a beaker and add 20 ml of 1M NaCl containing 0.1M NaOH

Shake well for few minutes and filter through a glass sintered funnel. Continuous washing till the filtrate becomes colourless. Then wash the filter cake with the distilled water extensively used till the pH becomes neutral. Transfer the filter cake into a beaker and suspended in 20 ml of 0.1N HCl and mix well. The excess of acid is removed by washing with water as before till the filtrate neutral. Suspend the material in 20 ml of buffer to be used in the experiment.

Column Packing

Mount a column syringe on a stand vertically. The suspension of the DEAE cellulose is poured in to the column slowly through the sides; avoid any trapping of air bubbles. Simultaneously open the column outlet (packed with a little cotton) so the absorbent settles at the bottom. Pass through the column about 40ml of the buffer pH 3.5 to ensure equip liberation. Load the protein solution(100ml) carefully on the column without disturbing the top surfaces.

Production Media

About 10% inoculum of the isolate was added in separate flask, containing 100 ml synthetic media for checking the antibiotic production. Synthetic media contained (g/L), Glutamic acid 5.0; KH₂PO₄ 0.5; K₂HPO₄ 0.5; MgSO₄.7H₂O 0.2; MnSO₄.H₂O 0.01; Na Cl 0.01; FeSO₄.7H₂O 0.01; CuSO₄.7H₂O 0.01; CaCl₂.2H₂O 0.015; Glucose 10; pH 7. Flask was incubated at 30°C in an orbital shaker at 150 rpm. After every 24 hours, samples were taken up to 144 hours, centrifuged to get cell free super nuts, which were sterilized through 0.2 µm filter paper.

Well Diffusion Method

Antibacterial activity was performed by agar diffusion method. The stock culture of bacteria (E.coli and Streptococcus) were received by inoculating in nutrient broth media and grown at 37oCfor 18 hours. The agar plates of the above media were prepared. Each plates was inoculated with 18 hours old cultures the bacteria were swab in the sterile plates. Cut the 5 wells Pour the extract in ratio 25 µl, 50 µl 75 µl and 100 µl. All the plates were incubated at 37oC for 24 hours and the diameter of inhibition zone was noted in Cm. The test was performed against the following bacteria,

Results And Discussion

Bacterial Colonies:

1 gram of the poultry fecal sample was diluted in distilled water. And the sample solution was undergone serial dilution. Serially diluted sample with different concentrations, were spread on the agar using spread plate technique. After 24 hours of incubation, the bacterial colonies were observed.

The cultures were used for further enumeration, screening, enrichment and selection of microorganism

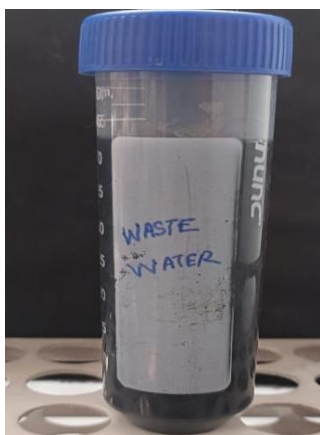


Figure.1.Waste water sample

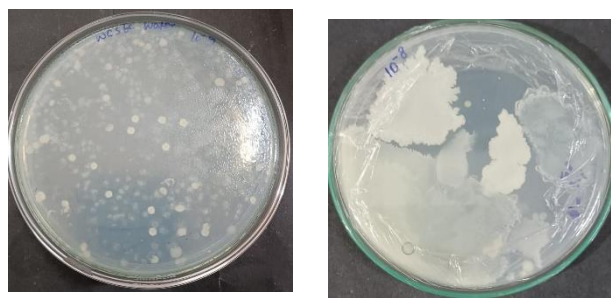


Figure.2. Bacterial colonies on the culture

Gram Staining:

As a part of identification of the isolated bacteria, staining method was performed. Gram's staining has been done according to the protocol and was examined under the microscope. It was found that the strain remained Purple and an irregular rod shape was observed. As the stain remained purple, the isolated bacteria were confirmed with the presence of Gram positive bacterial species.

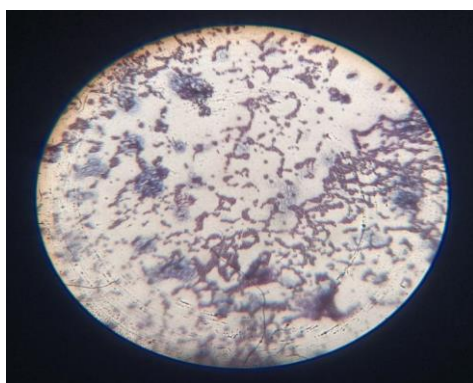


Figure.3. Gram staining of the isolated bacterial colony.

Biochemical Characterization Test:

Biochemical characterization test was done to identify the isolated bacteria based on its metabolic process. The changes of the test were observed with a reference of control in a test tube. It helps to identify the bacterial species based on its metabolic activities.

Optimization Of Antibiotic:

Carbon Source:

A gradual increase in the activity of the Antibiotic was observed by increasing the glucose concentration and maximum inhibitory zone was recorded at 50 % of the glucose but after wards a decline in the activity was noted Like wise maximum activity was observed 24 to 36 hrs hours of incubation

The effect of temperature on the growth and secondary metabolites (antibiotics) synthesis was determined by incubating the strain GU 057 at various temperatures. The strain showed encouraging results at the 40°C after 48hours of incubation. This may be the thermophilic nature of the strain (1, 12). Significantly lower levels of zones of inhibitions were observed at all other temperatures (30, 35, 45, 50 and 55°C). Similarly the effect of pH on zones of inhibition produced by Bacillus strain was not un surprising. The widest inhibitory zone was reported at pH 8 after 48 hours of incubation. This activity is the result of extremophilic nature of the strain (saline soil) as reported earlier Comparatively much lesser inhibition was reported at pH 4, 5, 6 and 7 as the time of incubation was increased from 49 to 192 hours as observed previously The results of present study confirm the Bacillus sp. GU 057 strain isolated from saline soil, as producer of peptide antibiotic (bactitracin).(Esikova et al.,2002)

Klebsiella pneumoniae(Gram negative bacteria)

Escherichia coli (Gram negative bacteria)

Streptococcus sp. (Gram positive bacteria)

Staphylococcus aureus (Gram positive bacteria)

The photographs for visual representation are attached below



Figure.4. *Klebsiella pneumoniae* (Gram negative bacteria)

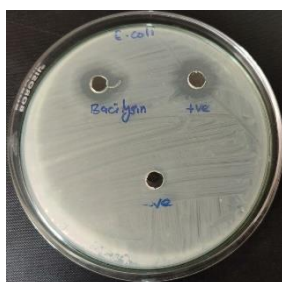


Figure.5. *Escherichia coli* (Gram negative bacteria)

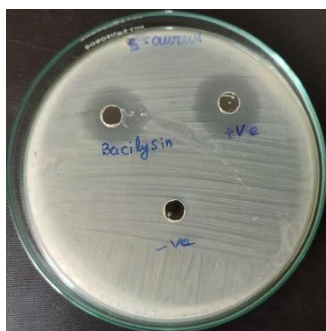


Figure.6. *Staphylococcus aureus* (Gram positive bacteria)

With the help of another agar well, the minimum inhibitory concentrations of the extracts against Gram positive, Gram negative bacteria was found and the findings are tabulated below.

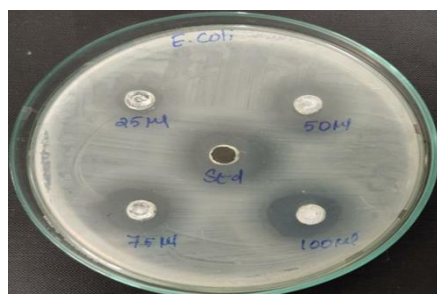


Figure.7. The zones of inhibition against *E. coli* was found to be 25 µl - 0.3 cm; 50 µl- 0.4 cm; 75 µl- 0.5 cm; 100 µl-0.7 cm;

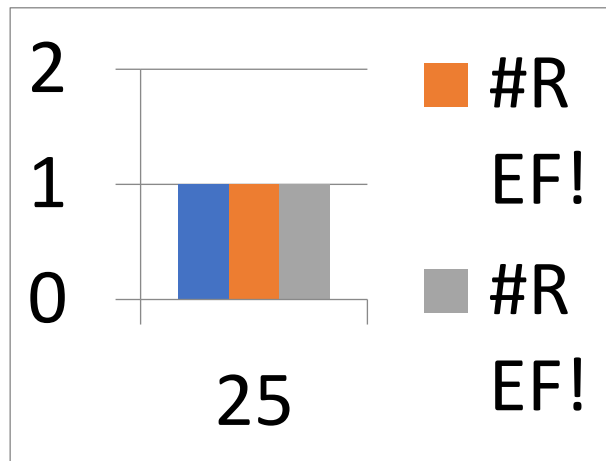


Figure.8. The zones of inhibition for *Staphylococcus aureus* was found to be 25 µl - 0.2cm; 50 µl- 0.3 cm; 75 µl- 0.4 cm; 100 µl-0.6

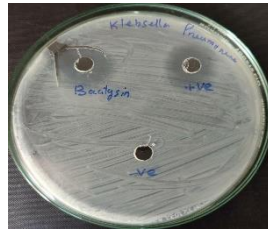


Figure.9. *Klebsiella pneumoniae* (Gram negative bacteria)



Figure.10. *Escherichia coli* (Gram negative bacteria)

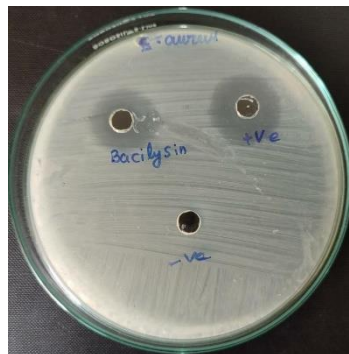


Figure.11. *Staphylococcus aureus* (Gram positive bacteria)

With the help of another agar well, the minimum inhibitory concentrations of the extracts against Gram positive, Gram negative bacteria was found and the findings are tabulated below

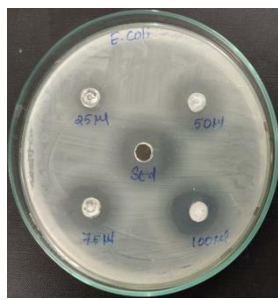


Figure.12. The zones of inhibition against *E. coli* was found to be 25 µl - 0.3 cm; 50 µl- 0.4 cm; 75 µl- 0.5 cm; 100 µl-0.7 cm;

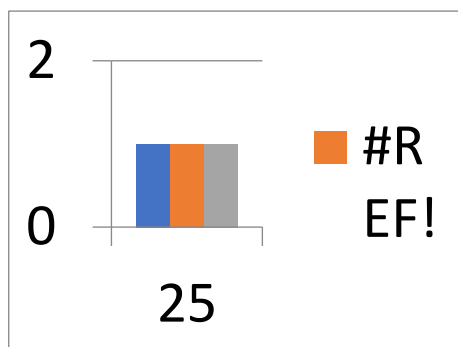


Figure.13. The zones of inhibition for *Streptococcus aureus* was found to be 25 µl - 0.2cm; 50 µl- 0.3 cm; 75 µl- 0.4 cm; 100 µl-0.6

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91 FUNGAL STRAIN IMPROVEMENT FOR MAXIMAL LACCASE PRODUCTION AND PRODUCTIVITY ANALYSIS IN LAB FERMENTER LEVEL

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Abstract

Laccase is used in a wide variety of industries, including medicine, textiles, and food. And the use case of laccase enzyme with the industrial oriented application comes at a higher rate starting from the Pollutant elimination and generating ecofriendly mode to improve the already existing fields. However, in this study, a cost-effective mode of laccase production with a novel polypore fungal strain, *Trametes versicolor*, under submerged fermentation is investigated, and by simulation studies are used to scale up a pilot-scale process to an industrial scale. Submerged fermentation of agricultural lignocellulosic products in rice husk and wheat bran with steam explosion technique for raw substrate treatment. The process parameters were statistically optimized to get a good yield. And finally, we are going up for the confirmation with the fermented product with the presence of the desired enzyme in it and also, we can go with the comparative study between the wild strain and UV given Strain.

Keywords: Laccase, Polypore, Submerged fermentation, Lignocellulosic products, Yield parameters.

1 INTRODUCTION

Laccases are enzymes belonging to the family of multi-copper oxidases, widely distributed in nature and known for their ability to oxidize a variety of phenolic and non-phenolic substrates (Leticia Arregui et al., 2017). These enzymes have gained significant attention due to their potential applications in various industrial processes, including bioremediation, biobleaching of pulp and paper, textile dye degradation, and synthesis of organic compounds. *Trametes versicolor*, commonly known as the turkey tail fungus, is a prolific producer of laccase. It is a white-rot fungus found in many parts of the world and is particularly valued for its enzymatic capabilities in lignin degradation. The fungus secretes laccase into its surroundings as part of its natural metabolic processes, making it an ideal candidate for industrial enzyme production. Laccases (EC 1.10.3.2) are monomeric glycoproteins typically composed of 500-700 amino acid residues with four copper atoms per molecule. They belong to the multicopper oxidase family and are capable of oxidizing a wide range of phenolic and non-phenolic substrates by utilizing molecular oxygen as the electron acceptor. The catalytic cycle involves four redox-active copper centers (Type 1, Type 2, and two Type 3) that facilitate electron transfer reactions, leading to the oxidation of substrates. The industrial importance of laccases stems from their ability to catalyze the degradation of lignin and various synthetic dyes, which are notoriously difficult to degrade using conventional chemical methods. Laccases offer a sustainable and environmentally friendly alternative for the detoxification of industrial effluents and the production of high-value compounds, such as fine chemicals and biofuels.

1.1 Fungal Strains and Chemicals

T. versicolor Fig 3.1.1 had been stored in the culture media which is of the potato dextrose broth with the presence of guaiacol and other trace minerals. Fungus was sub cultured and stored at room temperature were routinely made up to 35days.



Fig 2.1.1 *Trametes versicolor* Wild Strain

1.2 Media and cultures.

This fungal culture was sub cultured into the broth and agar plates for the purpose of various studies. For the means of broth potato dextrose broth being used and for the purpose of agar potato dextrose agar being used. It has been period of 8 days and then it has been used for the other studies Fig 3.2.4. Both preparation of agar and broth has been done for the process of mutation. Both the cultures in broth and agar have been sub cultured with Potato dextrose agar and potato dextrose broth and the incubation time for both the cultures have been kept for a whole period of 8 days Fig 2.2.1, Fig 2.2.2, Fig 2.2.3.

1.3 Mutation Studies

For the process of Mutation studies, we are depending upon the UV as a source for pretreatment method to induce mutation in the *T. versicolor* white rot fungus. In this process of pretreatment approach we are using Ultra violet source of nearly 200-250nm as a primary source for inducing mutation in the wild strain Fig 3.3.1, in this process of UV mutation we are making the wild strain that we had harvested from the broth and agar and sub cultured with the potato dextrose agar plate and induced for the Ultraviolet study in this process of study we are giving exposing the light for different time interval and with the closed environment after that we are allowing the plate to be in a idle environment for a whole period of 25min in a complete dark environment.



Fig 2.2.1 30 min UV treated Culture, grown in Pototo Dextrose Bro

1.4 Fermentation in the Pilot scale reactor

After the process of flask fermentation being setup for the wild strain cultivation, we are going up for the process of fermentation with the UV mutated strain in the pilot scale reactor. In this process the UV pretreated strain which have been stored already, being subcultured is used. For this whole process we are going up for the use of 4hrs UV pretreated culture and subcultured it in the modified Olga medium at a fixed composition of various contents in it. For this process the 4hrs UV exposed pretreated strain that is cultured in the potato dextrose broth is being taken and it is being subcultured with the Modified Olga medium. Thus, the



whole set up is being allowed to run for a whole period of 8 days at a regular interval of 24hrs samples are withdrawn to estimate the yield coefficient and the agitator speed is set to a 100rpm to avoid cell injury due to the shear stress created if rotated at a high rpm. Pressure knobs are regularly monitored to avoid any sort of discharge; thus, the whole setup is allowed to run at a fixed temperature of 28°C which can mimic the room temperature. Thus, samples at regular interval are drawn for the analysis purpose Fig 3.7.1

1.5 Microfiltration Techniques for the Separation of Enzymes

The whole process was conducted at the room temperature of nearly 28°C - 30°C.. Thus, Ultra filtration was carried out at the same temperature similar to that of the membrane. Thus, the permeate is then divided into 4 parts and being introduced into the membrane for the first time the 4 parts were introduced to the 10KDa Unit and the retentate is thus collected after that the samples are then divided into the parts and being introduced to the 100KDa unit. Finally using the Citrate phosphate buffer at a definite pH of 5.3 is being used for the process of removal of loosely bound particles to the membrane. Thus, samples were collected and isolated for the analysis purpose Fig 3.7.2.1 After the process of completion of the experiments the instrument is being washed up with the solution as discussed in their manual

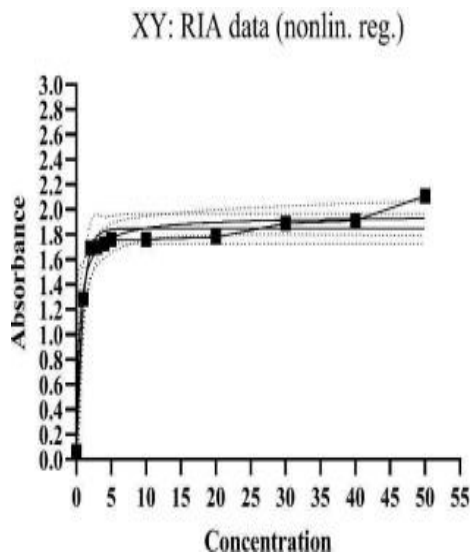


Fig 2.5.1 Ultrafiltration of fermented sample

2. RESULTS AND DISCUSSION

2.1 Fermentation in the Pilot scale reactor

The process of fermenting a UV- mutated strain in a pilot scale reactor follows the setup of the wild strain cultivation in flask fermentation. The process begins with the use of a 4 hour UV pretreated culture that has been stored previously. This culture is subcultured with the Modified Olga medium, which has a fixed composition of various contents as



Graph 3.1 Lowry's method graph showing the protein concentration upon fermentation with the pilot scale reactor

In this process of pilot scale reaction with the fermenter the total protein concentration was found to be at a rate of 2.11 So, from this we can get an overall idea about the benefits of pretreatment when it comes with the process of Mutation.

2.2 ABTS Assay for the means of protein detection

The activity of the laccase enzyme using the ABTS assay is usually used to found out the results. In this we are using 100mM ABTS with the concentration of sodium acetate (NaOH) at an appropriate volume of 100mM thus the buffer is made upto the concentration of pH 5. The presence of laccase is confirmed with the presence of bluish green color upon adding of ABTS. 30 Spectrophotometer and with the volume we are making it to a various level of substrate.

2.3 SDS PAGE CONFIRMATION

In this process we are going up for the confirmation of laccase enzyme with the protein marker 10 – 100 KDa, and the samples are loaded in the sample wells. As this confirms that usually the laccase enzyme lies between the molecular weight of nearly 50 – 80 KDa. And in this fermented product the enzyme lies between the weight of 60 -70 which confirms the present of laccase enzyme in the product. And the Images are given below in Fig 4.5.1.

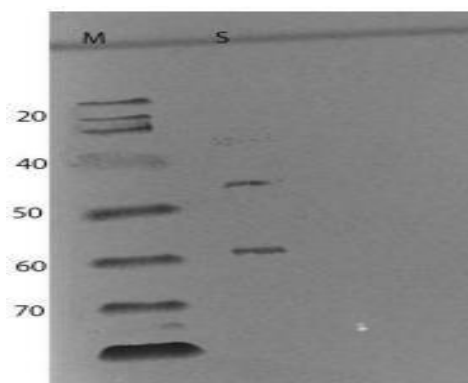


Fig 3.3.1 SDS PAGE results of fermented product.

3. DISCUSSION

In this study we are going for the utilization of wild strain for the reactor level cultivation of Enzyme and we are going for Comparative study between the wild strain cultivation in the flask method vs the reactor-based method of laccase enzyme cultivation. Finally, from this we can come to end that the UV strain produces some increase in the concentration of the laccase enzyme when in comparison with the wild strain without subjected to the process of UV treatment.

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92 *IN VITRO* PRODUCTION OF ATROPINE FROM *DATURA METEL*

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ABSTRACT

The study involved the comprehensive analysis of *Datura metel*, focusing on the extraction and characterization of phytochemical compounds from both the crude plant material and callus extracts. After identification, leaves, internodes, and fruits underwent thorough cleaning and drying before being finely ground into powder. Extraction involved a precise process of mixing the powder with sterile water, gentle heating, filtration, and centrifugation, yielding a clear supernatant for further analysis. Phytochemical screening revealed the presence of various compounds like tannins, alkaloids, saponins, and flavonoids, with variations observed among plant parts and extracts. The rich phytochemical profile of *Datura metel*, suggesting its potential medicinal applications. Tests on crude plant and callus extracts provided insights into their chemical compositions. The callus extracts exhibited higher atropine content than normal plant extracts, hinting at the potential for in vitro culture to enhance atropine production. Variations in atropine content across different plant parts, providing valuable insights for pharmaceutical research and medicinal applications. This research highlights on the diverse phytochemical composition of *Datura metel*, warranting further exploration of its medicinal properties and cultivation techniques. The amount of atropine in each source varies: 1.25 mg/g of atropine is found in stem calli, 1.09 mg/g is found in leaf calli, 1.53 mg/g is found in fruit calli, and 1.12 mg/g is found in flower calli. that the amounts of atropine vary according to the tissue from which the calli originate, with the highest concentration found in calli produced from fruit, followed by calli originating from stems, flowers, and leaves. These studies urge for more study into the therapeutic effects of *Datura metel* and advance our awareness of its potential in pharmaceutical applications.

Keywords : *Datura metel*, atropine , phytochemical , tannins , alkaloids, saponins, flavonoids.

1 INTRODUCTION

In the field of pharmaceuticals, the search for innovative and effective ways to produce drugs has prompted researchers to look at natural sources for important molecules. One such substance of importance is atropine, an essential alkaloid with a variety of medicinal uses, including the treatment of certain heart disorders and usage as a mydriatic agent. The in vitro synthesis of atropine, especially from *Datura metel* a plant with a high alkaloid content has garnered a lot of attention in recent years. This project offers a viable path to the sustainable and regulated manufacture of atropine, avoiding the drawbacks of conventional extraction techniques and perhaps offering a more economical and ecologically friendly solution. Atropine, as a naturally occurring compound, is conventionally extracted from various plants belonging to the Solanaceae family, notably *Atropa belladonna* and *Datura* species. These extraction processes often encounter obstacles such as limited availability of plant material, variations in alkaloid content, and environmental concerns regarding the cultivation and harvesting of these plants. In vitro production offers an alternative route to overcome these challenges by employing biotechnological methods to synthesize atropine in controlled laboratory conditions. The use of *Datura metel* as a primary source for in vitro production of atropine presents several advantages. This plant species is known for its high alkaloid content, including hyoscyamine and scopolamine, which are precursors to atropine. By utilizing tissue culture techniques, such as cell suspension culture or organ culture, researchers can stimulate the production of atropine in a controlled environment, independent of seasonal variations and geographical constraints. Moreover, in vitro production eliminates the need for extensive land use and reduces the environmental impact associated with traditional cultivation practices. The scalability of in vitro production allows for consistent and reliable yields of atropine, ensuring a stable supply for

pharmaceutical purposes. With advancements in biotechnological methods and genetic engineering, researchers can enhance the biosynthetic pathways involved in atropine production, potentially increasing yield and purity while minimizing production costs. Additionally, *in vitro* production offers opportunities for the synthesis of novel derivatives and analogs of atropine with tailored pharmacological properties, opening new avenues for drug discovery and development. Atropine, first isolated from *Atropa belladonna* in the early 19th century by Mein and Bell, has a rich history in both traditional and modern medicine. Its pharmacological properties, particularly its ability to block the action of acetylcholine at muscarinic receptors, have made it indispensable in various medical applications. Notably, during World War II, atropine was widely used to treat soldiers affected by nerve agent poisoning 1. Despite its therapeutic benefits, traditional methods of atropine extraction from plants such as *Datura metel* are beset with challenges. The variability in alkaloid content among plant samples, dependence on seasonal factors, and the need for large-scale cultivation pose significant logistical hurdles. Moreover, the extraction process itself can be laborious and environmentally taxing, often involving the use of organic solvents and generating substantial waste 2. Biotechnological approaches offer a promising solution to the challenges associated with traditional atropine extraction. By harnessing the inherent metabolic pathways of plants and optimizing growth conditions *in vitro*, researchers can control and enhance the production of atropine in a more sustainable and efficient manner. *In vitro* production also enables the cultivation of plant cells in controlled bioreactor systems, allowing for continuous and reproducible production throughout the year 3.

2 MATERIALS AND METHODS

2.1 Plant Collection and Identification

The raw material used for this research was *Datura metel*. The *Datura metel* was collected from nearby village Varapalayam, Tiruchengode at Namakkal District. After the plant components were identified using the protocol, the herbaria was put in Liatris Biosciences LLP's Life Sciences Department in Cochin. 4.

2.2 Plant Material Preparation

After giving the fruits, leaves, and internode, a good washing with running tap water two or three times, they were allowed to air dry in the shade. The plant components were ground in a mixer once they had completely dried in shade, and that powder stored in little polythene bags with appropriate labeling.

2.3 Plant Material Extraction

5g of powdered plant material, for example, were weighed using an electronic scale and combined with five grams of crushed plant material in twenty-five milliliters of sterile water. Following a 60°C heating step, this mixture was filtered with Whatman no.1 filter paper. Once collected, the filtrate was stored at 5°C in sterile bottles. And centrifugation at a speed of 2500 rpm for a duration of 15-20 minutes 5.

2.4 Preliminary Phytochemical Analysis

The crude powder of *Datura metel L* was subjected to a qualitative phytochemical study using the techniques outlined by 6. The results of the numerous phytochemical tests, including those on alkaloids, tannins, saponins, flavonoides, proteins, and so forth 7, are displayed below.

2.4.1 Antacid Reagent Test

10% ammonium hydroxide arrangement (NH₄OH) is the sole reagent required for the Soluble Reagent Test, which is utilized to recognize the phenols in plant extricate. To decide whether phenols were display in the plant extricate, a small (2 ml) test of the extricate was treated with a 10% ammonium hydroxide solution.

2.4.2 Benedict's test

Benedict's Test approves the presence of carbs. After including 0.5 ml of Benedict's reagent to 0.5 ml of extricate, the blend was cooked for two minutes over a bubbling water bath.

2.4.3 Borntrager's Test

The Borntrager's Test may recognize quinones. The essential reagents are fluid alkali (NH_3), sodium hydroxide (NaOH), and diethyl ether ($(\text{C}_2\text{H}_5)_2\text{O}$). To recognize quinones, blend 1 milliliter of diethyl ether ($(\text{C}_2\text{H}_5)_2\text{O}$) with 1 milliliter of extricate. At that point, include 2 milliliters of sodium hydroxide (NaOH) and 2 milliliters of watery smelling salts (NH_3).

2.4.4 Ferric Chloride Test

By including a few drops of a unbiased 5% ferric chloride (FeCl_3) arrangement to 5 milliliters of plant extricate, the ferric chloride test may be utilized to recognize tannins.

2.4.5 Flavonoids

It employs concentrated sulfuric corrosive (H_2SO_4) and smelling salts arrangement (NH_3) as reagents. The test included including 1 ml of plant extricate to 5 ml of weakened alkali arrangement (NH_3), at that point 1 ml of concentrated sulfuric corrosive (H_2SO_4) 8.

2.4.6 Foam Arrangement Test

The froth era test confirms the nearness of saponin. The extricate was combined with 110 milliliters of refined water in a test tube and well shaken. To confirm the nearness of saponin, steady froth arrangement is utilized.

2.4.7 Iodine test

To confirm that there were carbohydrates (starch) in the plant extricate, a small sum of iodine arrangement (0.1 M potassium iodide) was included. The improvement of a blue-black tint confirms the starch's existence.

2.4.8 Keller-Kilani Test

The nearness of glycosides in the plant extricate was decided utilizing the Keller-Kilani measure. A arrangement of FeCl_3 comprising 1-2% was combined with 2 milliliters of frigid acidic corrosive and unrefined extract. After that, the blend was exchanged to a moment test tube that included two milliliters of concentrated H_2SO_4 . A brown ring shapes in the interphase, demonstrating the nearness of cardiac glycosides.

2.4.9 Libermann-Burchard Test

Libermann-Burchard To find out the nearness of steroids in the plant extricate, a test is conducted utilizing reagents such as acidic corrosive anhydride ($\text{C}_4\text{H}_6\text{O}_3$) and sulfuric corrosive (H_2SO_4). 0.5 ml of extricate was blended with 2 ml of acidic corrosive anhydride ($\text{C}_4\text{H}_6\text{O}_3$) arrangement, and at that point 2 ml of sulphuric corrosive (H_2SO_4) arrangement was presented down the test tube divider 9.

2.4.10 Mayer's Test

To decide the alkaloids in the plant extricate, utilize Mayer's Test. The chemicals utilized are Mayer's reagent (potassium mercuric iodide arrangement) and weakened hydrochloric corrosive (HCl). Five milliliters of extricate were blended with a few milliliters of weakened hydrochloric corrosive (HCl) and disturbed. To decide if alkaloids are show in this arrangement, a drop or two of Mayer's reagent is included by the test tube's sides 8.

2.4.11 Million's Test

Protein substance in the plant extricate may be decided with the utilize of Million's Test. To confirm that there were proteins in the extricate, 2ml was blended with a few drops of Million's reagent 10.

2.4.12 Salkowski Test

To test terpenoids, utilize the Salkowski Test. Concentrated sulfuric corrosive (H_2SO_4) and chloroform (CHCl_3) were the chemicals utilized. In arrange to distinguish the terpenoids, 1 milliliter of the plant extricate, 2 milliliters of chloroform (CHCl_3), and 3 milliliters of absolutely blended concentrated sulfuric corrosive (H_2SO_4) were included to deliver a layer.

2.4.13 Whistler and BeMiller's Test

To decide which gums are display in the plant extricate, utilizing the Whistler and BeMiller's Test. The sole reagent required is outright (99%) ethanol. 5 milliliters of 100% (99%) ethanol (C₂H₅OH) are included to 3 milliliters of plant extricate amid testing, and the blend is ceaselessly whirled 11.

2.5 Aseptic Cultures Establishment

Explants taken from plants grown in the field typically include a variety of microbes. They were repeatedly rinsed in sterile water after being cleaned for 25 minutes using popular sterilizing agents such 3% NaClO, 90% ethanol, and 1% HgCl₂. This was done to remove any surface impurities. Surface sterilizing agents were also used, such as detergent ,0.3% carbendazim (C₉H₇N₃O₂), 0.5% streptomycin (C₂₁H₃₇N₇O₆) and 1% benomyl (C₁₄H₁₆N₄O₃) .

2.6 Basic Culture Medium

All of the major and minor plant nutrients that are necessary, vitamins, plant growth regulators, and carbohydrates as a source of carbon are included in nutrition media, along with other organic materials that are helpful additions. The most often used ingredient in the preparation of solid and semi-solid culture medium is agar powder. Throughout, in vitro propagation was conducted using the MS basal medium formulation described by Murashige and Skoog in 1962, which included 30 g/L commercial white table sugar, 0.1 g/L α-cysteine, 10 mg/L calcium pantothenic acid, 2.0 mg/L asparagine, 2.0 mg/L arginine, and 6 g/L agar. After adjusting the medium's pH to 5.8, it was autoclaved for 20 minutes at 1.1 kg/cm² (12° C).

2.7 Growth agent

Plant growth regulators affect callus development, differentiation, and the beginning of roots and shoots, all of which are critical to the success of tissue culture. Gibberellins promote the production of calluses, although auxins and cytokinins' relative concentrations in the culture media tightly control these activities 12.

2.8 Conditions of Incubation

Incubating cultures requires a certain amount of light and warmth. It is often advised to spend 11–15 hours a day under cool, white fluorescent lamps that emit 35–50 μmolm⁻²s⁻¹ of light. The temperature of the incubation environment is kept constant at 25°C±1.

2.9 Preparation of Explants

8 to 10 week old *Datura metel* plants were gathered from Namakkal district in order to prepare explants. The explants were well cleaned with tap water, then soaked for 10 to 15 minutes in a 0.1% (v/v) fungicide solution, and finally rinsed three to four times with sterile distilled water. They were then chopped into single node stem pieces that were around 11–15 mm long and surface sterilized for 20–25 minutes using a commercial chlorine bleach solution containing 4.5% chlorine. This was followed by four rinses with sterile distilled water.

2.10 Stimulation of Callus from Vegetative Tissues

In order to stimulate callus from vegetative tissues, 8–10 week old plantlets from cultivation fields were evaluated for their stem (10 mm long), leaf (6 mm x 6 mm), fruit, and flower (5 mm long). These fragments were cultivated on MS medium treated with 1.0 mgL⁻¹ of IBA, NAA, and 2,4-D separately. The control was the medium devoid of plant growth regulators. The combination of plant growth regulators and explant type with the highest callus development percentage was shown to be the most appropriate. After two weeks, the callus quality was evaluated. The explants were injected into glass vials (20 mm × 80 mm) holding 15 ml of treatment material.

2.11 Preparation of Callus extract

All four types of explants (stem, leaf, seed, and flower) had their calli aseptically cut. 10g of each callus were then carefully weighed and finely minced on aluminum foil with a razor blade. Following the transfer of the minced callus tissues to a mortar, 30ml of sterile water were added, and the combination was pounded with a pestle to a fine slurry. This slurry was filtered through Whatman No. 1 filter paper after being heated to 65°C. After the filtrate was produced, it was centrifuged for 15 to 20 minutes at 2500 rpm. The supernatant was then collected in sterile bottles and kept chilled at 5 to 10°C until it was needed 5.

2.12 Extraction of Atropine

Some tropical *Datura* species include fruits that are the primary source of glycol alkaloids for atropine production, which has led to attempts to grow these plants as industrial crops. Recovering glycol alkaloids from *Datura metel* plant material may be done in two ways:

1. The sequential extraction of dried plant material using methanol and petroleum ether, followed by crystallization.
2. Direct extraction of fresh materials using acetic acid (2–5%).

Using a Waring blender, 500 g of fresh plant tissue (leaves) and 750 ml of 3% aqueous acetic acid were homogenized for the latter technique. A filter cloth was used to filter the thick slurry that was produced. After adding equal parts of ethanol to the filter and washings, stirring for two to three hours, and centrifuging the mixture, the filtrate was discarded. A second time, the brown residue was suspended in 250 milliliters of ethanol and extracted for ninety minutes. After adding ammonia to make the alcoholic concentration alkaline (pH 9.5), it was cooled. A precipitate occurred after two days, and it was centrifuged. To remove the bulk of the glycol alkaloids from the precipitates generated from the combined extracts, hot 50 ml ethanol was used for three to four subsequent extractions. A Buckner funnel was used to filter the ethanol extracts after they had been refluxed with one to two grams of activated charcoal. The filtrate was made 3N by adding concentrated HCl. It was then refluxed for 45–1 hour to extract the alcohol by distillation. The alkaloid crystallized as a light brown solid after cooling 13.

2.13 Preparation of Standard Solution of Atropine

A precise dosage of 10–15 mg of pure atropine was dissolved in 30 milliliters of 20% A.R. acetic acid. The solution was then further diluted 10–12 times with 20% acetic acid after an aliquot was taken. This led to the creation of a solution with a 45 mg/ml concentration. 6.55 g of sodium acetate A.R. and 2.40 ml of acetic acid were dissolved in water to create Acetate Buffer pH 4.7. After that, the volume was adjusted with water to 100 ml. Methyl Orange (0.05%) was made by diluting it with water.

2.14 Standard Curve Preparation

The 40 mg/ml standard solution was pipetted into 0, 1.5, 2.5, and 3.5 ml of four appropriate separators. After that, 20% acetic acid was added to each separator to bring its volume to 10 ml. Each separator was then filled with 1.5 ml of methyl orange and 10 ml of acetate buffer. Ten milliliters of chloroform were added after 20 seconds of shaking. After stopping, the separators were shook for three to five minutes. The chloroform layers were allowed to rest for a few minutes before being removed into dry test tubes, dried with a tiny quantity of anhydrous Na_2SO_4 , and the absorbance was measured using 10 mm cells at 540 nm on a spectrophotometer. On the basis of these results, a standard curve was created.

2.15 Estimation of Atropine

In order to determine the amount of atropine, 200 grams of fresh plant tissue (either callus or leaves) were blended into a fine pulp using a suitable blender and 200 ml of 2% acetic acid. After adding 600 ml of 2% acetic acid to the pulp, it was put into two 500ml conical flasks and agitated for three to four hours. The alkaloid was precipitated by adding 1:2 ammonia to water until the pH reached 9–9.5 after the volume was measured and placed into a 250 ml beaker and heated to boiling. Next, the material was put into conical centrifuge tubes holding 100 ml, and the tubes were spun at 2000 rpm for 20 minutes. 1N HCl was used to dissolve the precipitate after the supernatant was extracted using a vacuum or decanter. After that, 1N HCl was used to adjust the solution to the correct level in a 100 ml volumetric flask. After filtering through filter paper into a dry vessel, 10 ml was pipetted into a tiny flask and refluxed for two to three hours on a water bath heated to 100°C for hydrolysis. After adding 10 milliliters of 1N NaOH and 25 milliliters of concentrated acetic acid to the flask, the contents were poured into a 100 milliliter volumetric flask and leveled with water. This solution equated to 10 mg of fresh plant tissue per milliliter. The process for the standard curve was followed after 3 to 5 ml of this solution were put into a separator.

3 RESULTS AND DISCUSSION

3.1 Plant Collection and Identification

The methodology employed for collecting and preparing samples of *Datura metel* involved several meticulous steps. Fresh plant materials were carefully sourced from dry and shaded regions within Namakkal district and identified using a standardized protocol. Subsequently, leaves, internodes, and fruits underwent thorough cleaning with running tap water followed by air drying in the shade.

3.2 Preparation and Extraction of Plant Material

Once dried, the plant materials were finely ground into powder using a mixer and stored in appropriately labeled plastic bags. For extraction, a measured quantity of the powdered material was mixed with sterile water and gently heated before filtration through filter paper. The filtrate was centrifuged, producing a clear supernatant which was collected into sterile bottles and refrigerated for further use.

3.3 Preliminary Phytochemical Analysis

Following the analytical study, the diverse phytochemical constituents analyzed from *Datura metel* are presented in Table 1. The findings indicate an abundance of Tannins in the extract of *Datura metel*, while alkaloids, saponins, tannins, and flavonoids are moderately present. Moreover, the results suggest a high protein content in the leaf extract of *Datura metel*. The screening of phytochemical constituent in the leaf extract of *Datura metel* demonstrates the presence of alkaloids, saponins, tannins, flavonoids, proteins, among others. The preliminary phytochemical analysis of the crude powder of *Datura metel L* suggests the presence of various phytochemical compounds.

1. Alkaloids were detected using Mayer's test, showing positive results in the plant extract.
2. Flavonoids were identified through the ammonia and concentrated sulphuric acid test, with positive outcomes observed in both the plant extract and callus extract.
3. Terpenoids, detected via the Salkowski test, were absent in both extracts. Quinones, assessed using Borntrager's test, were not detected in either extract.
4. Phenols, determined by the alkaline reagent test, were present in the plant extract but absent in the callus extract.
5. Resins, identified using Whistler and BeMiller's test, were found in both extracts.
6. Steroids, examined through the Libermann-Burchard test, were absent in both extracts.
7. Tannins, analyzed using the Ferric chloride test, showed positive results in the plant extract only.
8. Saponins, confirmed by the foam formation test, were present in both extracts.
9. Protein content, as indicated by Million's test, was higher in the plant extract compared to the callus extract.
10. Carbohydrates were detected in both extracts through Benedict's test and the iodine test, with positive results obtained.
11. Glycosides, identified using the Keller-Kilani test, were present in both extracts, showing positive reactions.



Figure .1. Phytochemical Analysis of Plant Extract

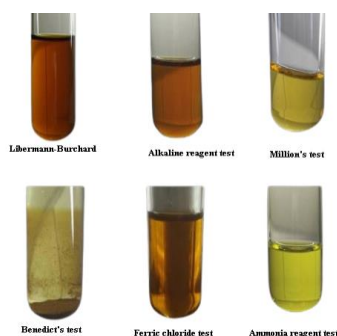


Figure .2. Phytochemical Analysis of Callus Extract

The analgesic, antispasmodic, and antibacterial properties of basic therapeutic substances, such as pure isolated alkaloids and their synthetic derivatives, are well known 14. These substances have noteworthy physiological action when given to animals. The new study suggests that *Datura metel's* widely recognized therapeutic qualities may be due to its reported alkaloid content, while the exact mode of action is yet unknown. A subclass of glycosides known as saponins is distinguished by its soapy properties 15. Red blood cells can precipitate and coagulate due to their aptitude to do so. According to 16, notable characteristics of saponins are their bitterness, hemolytic activity, ability to bind cholesterol, and ability to create foams in aqueous solutions. These characteristics provide *Datura metel* leaf extract a considerable amount of therapeutic efficacy 17.

Table 1: Qualitative Phytochemical Screening of *Datura metel* and its callus

Sl. No	Tests	Compounds for detection	Crude plant extract	Callus extract
1.	Alkaline Reagent Test	Phenols	Moderate	Moderate
2.	Ammonia reagent test	Flavonoids	Moderate	Present
3.	Benedict's test	Carbohydrate	Present	Present
4.	Borntrager's Test	Quinones	Nil	Nil
5.	Ferric chloride test	Tannins	Abundant	Nil
6.	Foam formation Test	Saponins	Present	Present
7.	Iodine test	Carbohydrate	Present	Present
8.	Keller-Kilani test	Glycosides	Present	Present
9.	Libermann-Burchard Test	Steroids	Moderate	Moderate
10.	Mayer's Test	Alkaloids	Abundant	Abundant
11.	Million's test	Protein	Abundant	Present
12.	Salkowski Test	Terpenoids	Nil	Nil
13.	Whistler & BeMiller's Test	Resins	Present	Present

The table outlines various biochemical tests conducted on crude plant extract and callus extract to detect different compounds present in them. In the alkaline reagent test, both the crude plant and callus extracts show moderate presence of phenols. Flavonoids are detected in moderate amounts in the crude plant extract but are present in the callus extract. Carbohydrates are present in both extracts as indicated by Benedict's test and iodine test. Quinones are absent in both extracts according to the Borntrager's test. Tannins are abundantly present in the crude plant extract but absent in the callus extract according to the ferric chloride test. Saponins are present in both extracts based on the foam formation test. Glycosides are detected in both extracts as per the Keller-Kilani test. Steroids show a moderate presence in both extracts according to the Libermann-Burchard test. Alkaloids are abundant in both extracts as revealed by Mayer's test. Protein is abundant in the

crude plant extract but only present in the callus extract according to the Million's test. Terpenoids are absent in both extracts based on the Salkowski test. Resins are present in both extracts according to Whistler & BeMiller's test. It indicates variations in the presence of different compounds between the crude plant extract and callus extract, highlighting potential differences in their biochemical composition.

Tannins often called tannic acid have antibacterial qualities. Proteins can precipitate as a result of these water-soluble polyphenols, which can be present in many plant diets. They precipitate microbial proteins, making them inaccessible to nutrients, which is known to impede microbial growth 18. According to observations, tannins prevent the development of bacteria, viruses, yeasts, and fungus 19. In phytotherapy, nonspecific diarrhea, mouth and throat inflammations, and mild skin lesions are treated using plants that contain tannins 20. The presence of tannins may help heal wounds and soothe irritated mucous membranes.

According to 21, flavonoids show solid anticancer activity and anticipate cell harm caused by oxidants by acting as effective water-soluble cancer prevention agents and foragers of free radicals. The stomach related tract contains flavonoids that lower the hazard of heart malady. These plants' flavonoids, which work as cancer prevention agents, have anti-inflammatory qualities 14. This may offer assistance to clarify why *Datura metel* has long been utilized to recuperate burns, ulcers, and wounds in home grown treatment. The tall protein substance of *Datura metel* takes off is connected to numerous of the plant's helpful qualities in expansion to these auxiliary metabolites. It has been found that a assortment of bioactive proteins extricated from therapeutic plants are useful against specific illnesses 22. According to a few analysts²³, the nearness of these phytochemical constituents likely clarifies the wide extend of restorative properties credited to both species in treating ailments and afflictions like hack, liver issues, stomachaches, skin illnesses, aggravation, jaundice, and toothaches.

3.4 Callus Stimulation

After three weeks of culture, 2,4-D, NAA, and IBA at 1.0 mg/l caused callus production from *Datura metel*'s leaf, flower, seed, and stem tissues (Figure 3). On the other hand, in the medium lacking PGR (control), these explants did not develop callus. In comparison to 1.0 mg/l IBA or 2,4-D, a larger percentage of explants developed callus in the media supplemented with 1.0 mg/l NAA. Around the borders of the sliced explant tissue region, callus began to develop.

Table 2 : *Datura metel* Callus Growth (g) on Various PGR

Plant Growth Regulator	Stem	Fruit	Leaf	Flower
IBA	69	65	41	43
NAA	38	36	18	21
2,4-D	63	61	42	57

The table 2 illustrates the callus growth (measured in grams) of *Datura metel* tissues cultivated with different plant growth regulators (PGRs) - IBA, NAA, and 2,4-D. The data shows the varied response of different tissue types including stem, fruit, leaf, and flower to these growth regulators. For instance, under the influence of IBA, the highest callus growth was observed in stem tissue (69g) followed closely by fruit tissue (65g), while leaf and flower tissues showed relatively lower callus growth (41g and 43g respectively). NAA, on the other hand, resulted in comparatively lower callus growth across all tissue types, with the highest observed in stem tissue (38g) and the lowest in leaf tissue (18g). In contrast, 2,4-D induced robust callus growth in all tissue types, with the highest values observed in flower tissue (57g) and stem tissue (63g), indicating its effectiveness in promoting callus formation across *Datura metel* tissues.

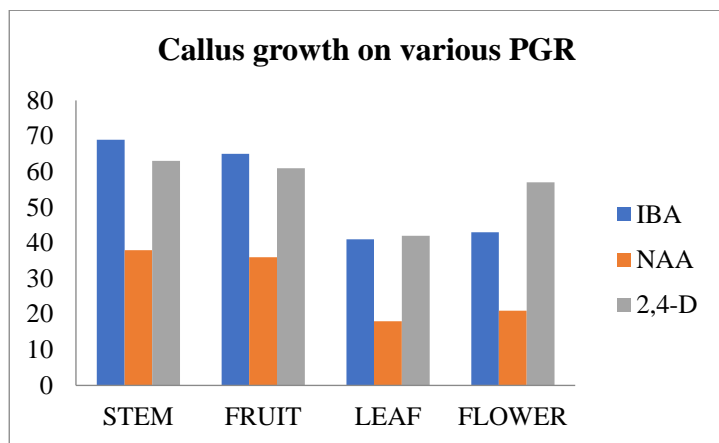


Figure .3. *Datura metel* Callus Growth (g) on Various PGR



Figure 4. Callus from *Datura metel*'s Leaf Figure 5. Callus from *Datura metel*'s Fruit



Figure 6. Callus from *Datura metel*'s Flower Figure 7. Callus from *Datura metel*'s Stem

The stem explant yielded the highest percentage of white compact callus, as illustrated in above figures. In contrast, the petiole produced brownish friable callus, while the other two explants produced greenish friable calli with high vacuolation. A small concentration of the growth regulator NAA had a significant effect on the callus mass of *Datura metel*. Among the three concentrations tested (0.5, 1, and 2 mg/L), the smallest concentration (0.5 mg/L) demonstrated a greater ability to induce callus mass in *Datura metel* compared to the higher concentrations across all plant parts studied, as shown in above Figures .

Table 3 : Percentage of callus formation on the effect of NAA Concentration on *Datura metel*

NAA Concentration	0 mg/l	1.5mg/l	2.5mg/l
Stem	72	69	61
Fruit	61	57	53
Leaf	65	61	56
Flower	57	42	37

Table illustrates the percentage of callus formation in response to varying concentrations of NAA on different tissues of *Datura metel*. The concentrations tested include 0 mg/L (no NAA), 1.5 mg/L, and 2.5 mg/L. Across all tissue types, including stem, fruit, leaf, and flower, there is a general trend of decreasing callus formation percentage with increasing NAA concentration. For instance, in stem tissue, callus formation decreased from 72% at 0 mg/L NAA concentration to 61% at 2.5 mg/L. Similarly, in fruit tissue, callus formation decreased from 61% to 53% over the same concentration range. Leaf and flower tissues also exhibited a similar pattern of decreasing callus formation with increasing NAA concentration, indicating the inhibitory effect of higher NAA concentrations on callus induction in *Datura metel* tissues.

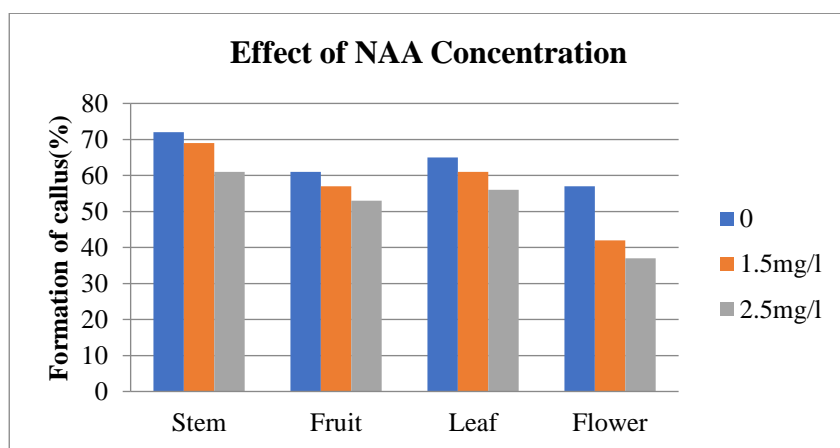


Figure 8. Effect of NAA Concentration on *Datura metel* Callus Growth

3.5 Atropine contents:

At 540 nm, the spectrophotometric strategy was utilized to degree the atropine concentration of the rough extricate that was extricated from callus tissues. As appeared in Fig. 8, the discoveries appeared that in spite of the fact that stems had the biggest extent of callus, the rough extricate taken from callus developed from takes off had the most elevated Atropine concentration. It was clear that the calli's add up to calline substance was much bigger than the plant extract's normal sum. It is apparent from this that in vitro culture has the capacity to increment the blend of atropine.

Table 4 : Atropine Content in Various Sources of Calli (mg/g Dry Weight)

Sl No.	Source of Calli	Atropine Content
1.	Stem	1.25
2.	Leaf	1.09
3.	Fruit	1.53
4.	Flower	1.12

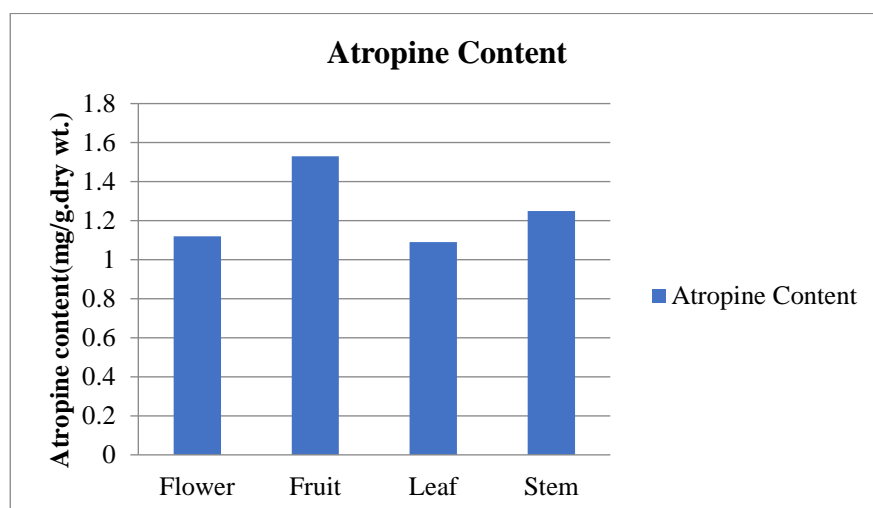


Figure 9. Atropine from various *Datura metel* Callus

In the table 4 the atropine content in different sources of calli obtained from *Datura metel*, measured in milligrams per gram of dry weight. The atropine content varies among the sources: stem calli contain 1.25 mg/g, leaf calli contain 1.09 mg/g, fruit calli have the highest atropine content at 1.53 mg/g, and flower calli possess an atropine content of 1.12 mg/g as shown in figure 9. That the atropine levels differ depending on the

tissue source of the calli, with fruit-derived calli exhibiting the highest concentration, followed by stem, flower, and leaf-derived calli.

4 CONCLUSIONS

The comprehensive analysis conducted on *Datura metel* extracts and callus cultures provides significant insights into their phytochemical composition and potential medicinal applications. Thorough collection and preparation of plant samples ensured the integrity of the experimental process, facilitating accurate analysis. The phytochemical screening revealed varying levels of alkaloids, saponins, flavonoids, tannins, and proteins in both the crude plant extract and callus extract, shedding light on the diverse bioactive compounds present in *Datura metel*. Tannins were abundant in the plant extract, while alkaloids exhibited a higher concentration in the crude extract compared to the callus. These researches underscore the pharmacological potential of *Datura metel*, particularly in traditional herbal medicine. The successful induction of callus from various plant tissues demonstrated the feasibility of in vitro culture techniques for mass production of bioactive compounds. Callus derived from leaf tissue exhibited the highest atropine content, indicating the efficacy of callus cultures as a potential source of medicinal alkaloids. The spectrophotometric analysis provided quantitative data on atropine content, highlighting the potential for optimizing in vitro culture conditions to enhance alkaloid yield. The alkaloid content in the crude plant extract was notably higher than compared to the callus extract, indicating the importance of optimizing culture conditions to maximize alkaloid production. The presence of tannins, flavonoids, and saponins in both extracts suggests their potential pharmacological significance in *Datura metel*. The results of the callus induction experiments further emphasize the feasibility of using tissue culture techniques to manipulate and enhance the production of bioactive compounds in *Datura metel*. The quantitative estimation of atropine content in callus tissues provides valuable data for future optimization studies aiming to upscale alkaloid production through in vitro culture methods.

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