EXPLORING THE FEASIBILITY OF SEAWEED BIOPLASTIC AS AN ALTERNATIVE FOR CONVENTIONAL PLASTIC

DISSERTATION SUBMITTED

In Partial Fulfillment of the Requirement for the
Award of the Degree of

MASTER'S PROGRAMME IN FASHION DESIGNING

BY

ALPHY M JOHN
(Reg. No. SM22MFD003)

DEPARTMENT OF FASHION DESIGNING

WOMEN'S STUDY CENTRE

ST. TERESA'S COLLEGE (AUTONOMOUS)

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Signature of the External Examiner	**Signature of the Internal Examiner**

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Name and Signature of the Head of the Department	**Name and Signature of the Guide**

DECLARATION

I, **Alphy M John**, hereby declare that the project entitled **“Exploring the feasibility of seaweed bioplastic as an alternative for conventional plastic”** is submitted in partial fulfillment of the requirement for the award of the degree of Master’s Programme in Fashion Designing. This record is original research done by me under the supervision and guidance of **Mrs. Dr. Lekha Sreenivas,** Associate Profesor, Department of Fashion Designing, St. Teresa’s College, Ernakulam. This work has not been submitted in part of fill or any other Degree, Diploma, Associateship/Fellowship of this or any other university

Name and signature of the Candidate   Name and signature of the Guide

Place:

Date:

ACKNOWLEDGEMENT

I humbly thank **God Almighty** whose blessings enabled me to complete this venture successfully.

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ABSTRACT

The increasing environmental concerns connected with traditional plastic production and dumping have stimulated an immediate search for sustainable alternatives. Seaweed-based bioplastics provide a solution owing to their abundance, biodegradability, and low environmental impact. This thesis explores the feasibility of seaweed as a primary resource for bioplastic production, along with the incorporation of waste fibers to improve mechanical properties. The study begins with the environmental impacts related to conventional plastics and current challenges in plastic waste management. It then searches into the potential applications and properties of seaweed-derived bioplastics, highlighting their biodegradability and renewability as key advantages.

The research methodology involves various stages including seaweed collection, cleaning, extraction of biopolymer compounds, and blending with waste fibers. Brown seaweeds are evaluated for their biopolymer content. On top of that, waste fibers from industrial, or post-consumer sources are identified and processed for integration into the bioplastic system, enhancing mechanical strength and reinforcing sustainability objectives.

The research findings help to contribute to the branch of knowledge on sustainable materials and offer practical awareness on the development of biodegradable alternatives to conventional plastics. The process of mixing waste fibers into the bioplastic system not only improves the mechanical properties but also provides a unique approach to reusing waste fibers. This thesis explores the versatility and potential of seaweed as an eco-friendly solution to address the global plastic crisis.

CHAPTER 1

INTRODUCTION

1.1. HISTORY OF PLASTIC

Plastic, despite its negative impact on the environment, has been a crucial contributor to shaping modern society. Its versatility and wide-ranging applications make it an important material. The origin of plastic can be traced back to the 19th century, with the creation of synthetic polymers. It was in 1869 that John Wesley Hyatt invented the first synthetic plastic, celluloid, as a replacement for ivory in billiard balls. This was a significant breakthrough, marking the rise of the age of plastics, leading to more innovations and the development of a wide range of synthetic polymers (Thermal Press International).

Plastic is a unique material and has many advantageous properties such as durability, flexibility, and moldability. Unlike traditional materials like wood, metal, or glass, plastic can be easily shaped and molded into various forms, making it highly versatile and adaptable for a wide range of applications. Plastic has revolutionized many industries, including packaging, manufacturing, construction, healthcare, and transportation. Its lightweight nature and low production costs make it an attractive and feasible alternative to traditional materials, leading to widespread adoption across diverse sectors.

1.2. USES OF PLASTIC

The use of plastic is universal today, from packaging to electronics, and even medical equipment. However, the threat of plastic waste is a global concern nowadays. Plastic pollution is a serious issue that requires immediate solutions. Increasing attention is given to identifying sustainable alternatives and protecting the environment from the ill effects of plastics. Governments, organizations, and individuals are working together to reduce plastic waste and promote sustainable alternatives. Bio-degradable plastics can be seen as a sustainable alternative to conventional plastics, which can be produced from renewable and natural resources including potatoes, sugarcane, seaweeds, and corn starch. Governmental initiatives like recycling programs and restrictions on plastic bags are also having a big impact on reducing plastic waste. Finding sustainable plastic substitutes and reducing the environmental impact must be the priorities of every human being. Through this we can rebuild our planet and lessen the environmental impact caused from our activities.

Still, problems associated with plastic are universal. Plastic pollution needs a solution immediately.

1.3. PLASTIC POLLUTION

Plastic has transformed all areas of innovation and advancement. It changed how we store and package goods, developed long-lasting and strong products, and opened up new business and employment opportunities. But this flexible substance has also contributed greatly to pollution and environmental damage. As a result, it is important to find a balance between environmental responsibility and the value of plastic. Our goal must be to maximize plastic's usefulness while reducing its negative environmental effects. By doing this, we can open the door for future generations to live more sustainably. For the sake of future generations, we must utilize plastic responsibly and sustainably and embrace eco-friendly methods to avoid leaving a terrible legacy.

Traditional petroleum-based plastics lead to several environmental problems, and we need to take immediate action to lessen their ill effects on the environment. Plastics are widespread and pose a threat to marine life, clog waterways, and infiltrate every part of the world. This emphasizes the need for sustainable solutions.

1.4. INTRODUCTION TO BIOPLASTIC

Since bioplastics come from renewable resources and decompose naturally over time, they can be a possible solution to the problem of plastic pollution. As opposed to being created from fossil fuels like petroleum, bioplastics are made from renewable elements like plants, cornstarch, or sugarcane. By using these renewable energy sources, we may reduce our dependence on non-renewable resources and reduce the harm to the environment caused by the extraction and processing of fossil fuels.

1.5. SEAWEED BIOPLASTIC

Amidst this crisis, one innovative solution emerges from the depths of our oceans – seaweed-based bioplastics. Bioplastics are engineered to degrade naturally. This feature enables them to break down into natural components without leaving harmful microplastics that remain for centuries in the environment. Biodegradable bioplastics hold promise for lessening plastic pollution in landfills, oceans, and various ecosystems. Unlike other fossil fuel-derived counterparts, seaweed-based bioplastics offer a promising pathway toward environmental sustainability. Seaweed bioplastic is a type of plastic made from seaweed, which is a type of algae that grows in the ocean. Seaweed is a plentiful and renewable resource that contains biopolymers that can be used to create biodegradable plastics.

Unlike traditional plastics made from fossil fuels, seaweed bioplastics are renewable and more environmentally friendly. They can be produced using seaweed harvested from oceans or cultivated in dedicated seaweed farms, reducing the reliance on non-renewable resources and mitigating the environmental impact associated with plastic production. By utilizing this abundant marine resource, we can reduce our dependence on limited fossil fuels and also address the issue of plastic pollution in our environment. The transition to seaweed-based bioplastics represents a paradigm shift in our approach to plastic production, emphasizing harmony with nature rather than exploitation of finite resources. By making use of seaweed as a raw material, we not only mitigate the environmental impacts associated with traditional plastics but also contribute to the health and vitality of our oceans. Seaweed bioplastics can be consumed by marine organisms and bacteria without causing harm to ecosystems. Additionally, seaweed bioplastics have a lower carbon footprint compared to traditional plastics, as seaweed absorbs carbon dioxide during its growth, helping to mitigate greenhouse gas emissions.

As we confront the multifaceted challenges posed by plastic pollution and climate change, the exploration of seaweed-based bioplastics stands as a beacon of hope. Through innovative research and collaborative efforts, we have the opportunity to harness the power of the sea to usher in a new era of sustainable materials. Using bioplastics derived from seaweeds not only protects our planet for future generations but also open the door to a more harmonious coexistence of humans and the environment. Biopolymers from seaweed are abundant and sustainable, and they can be effectively used to make biodegradable plastics. Using this enormous marine resource will help us fight the adverse impacts of plastic waste on nature while also reducing our need for scarce fossil fuels. This small marine plant grows along coastlines and survives in the depths of our oceans, showing its amazing adaptability to a wide range of aquatic settings.

The ecological significance of seaweed extends beyond its role as oceanic vegetation. Due to its natural qualities, seaweed can be used to manufacture biopolymers, the building blocks of biodegradable plastics. Due to its abundance of polysaccharides and other organic components, seaweed is a renewable raw material source that is ready for research and development. Concern over plastic contamination in our landfills and oceans has grown to previously unseen proportions. We do require environmentally friendly alternatives. The urgency of acting quickly and decisively is underscored by an increasing quantity of information regarding the harmful effects of plastic on animals, human health, and marine ecosystems. This means that finding sustainable materials is now more crucial than before on an international level, exceeding even environmental campaigns.

1.6. STATEMENT OF RESEARCH PROBLEM

In this project, the researcher is investigating the potential of using seaweed-based bioplastics as an alternative material for the manufacturing of various products like artist palettes, water containers, mouse pads, etc. by incorporating waste textile fibers into the biomass. Textiles are an essential part of our daily lives, not only as clothing but also as critical components in various sectors such as furniture, medical equipment, and automotive interiors. By utilizing the unique properties of seaweed, this project aims to contribute to the sustainable transformation of the textile industry.

The textile industry is a crucial part of global manufacturing as it provides essential materials for clothing, furnishings, and many other products. However, the industry's large-scale production generates a significant amount of waste fibers every year, from production offcuts to end-of-life garments. The problems of landfill overflow and environmental destruction are made worse by this textile waste. Utilizing plastics derived from petroleum just makes issues worse because these substances remain in the environment for years, damaging habitats, contributing to pollution, and changing the climate. There is an urgent need to switch to more sustainable options as the negative impacts of plastic pollution become more obvious.

To address these environmental issues, this project aims to find solution for two critical challenges simultaneously: the textile industry's waste generation and the environmental impact of petroleum-based plastics. The researcher aims to achieve this by leveraging the unique properties of seaweed-based bioplastics, which offer a sustainable alternative to traditional plastics, reducing their harmful effects on ecosystems. Additionally, this project also aims to repurpose waste textile fibers by diverting them from landfills and integrating them into the production of bioplastics. This approach not only reduces textile waste but also enhances the sustainability of bioplastic production by utilizing renewable resources.

The researcher aims to prove the feasibility and effectiveness of seaweed-based bioplastics reinforced with waste textile fibers through creative research and coordination. The researcher hopes to contribute to a more sustainable future for the textile industry and our planet by tackling these challenges straightaway. In addition, this initiative seeks to reduce textile waste to a minor degree by utilizing discarded textile fibers in the creation of bioplastics made from seaweed that are tougher and more resilient. With plastic pollution and textile waste becoming major concerns, this creative approach presents a viable path forward for a more environmentally conscious future.

There has been a growing interest in sustainable alternatives across various industries, and the arts sector is no exception. Traditional artistic palettes and water containers are often made from plastic materials that contribute to environmental pollution and harm our ecosystems. The researcher tried to find a solution to this problem by utilizing seaweed bioplastic to make an artistic palette and water container to minimize the environmental impact.

The methodology encircles various stages, including the sample collection and treatment of the sample, product development, etc. Each of these components is carefully structured to align with the nature of the research inquiry and to maximize the dependability and validity of the findings. The seaweeds collected from the coasts are thoroughly washed in tap water and dried in the sun. The dried seaweed samples are powdered and heated along with starch and glycerine as the plasticizer. Later the fibers are added to it to give more strength to the final product. The biomass is then spread according to the product requirements and dried.

As the world fights for the urgent need for sustainable alternatives to traditional plastics, using seaweed as a renewable resource introduces a promising method for addressing environmental concerns. In essence, this thesis seeks to contribute to the growing body of awareness on bioplastics and sustainable materials, with the terminal goal of promoting a more environmentally conscious and responsible approach to plastic manufacture and consumption. By tackling the power of nature's resources, particularly seaweed, I hope to pave the way towards a more sustainable and greener future for generations to come.

1.7. RESEARCH QUESTIONS

Based on an overall understanding of the research problem, the researcher has formulated some research questions to effectively address the underlying issues. These research questions are designed to guide the study and provide insights into key aspects related to the study's objectives.

The following are the prominent issues that the researcher aims to address through the study:

1. What are the critical issues caused by the extensive use of petroleum-based plastics?
2. How can the potential of bioplastics aid in mitigating the adverse environmental effects caused by traditional plastics?
3. How effectively seaweed, a natural resource, be used for the production of bioplastic?
4. Is the process of making bioplastic from seaweed economically viable?
5. What are the points of view of artists on the usage of plastic artistic palettes and water containers?
6. How can the use of seaweed-based bioplastic mouse pads help in mitigating the environmental impacts?

1.8. OBJECTIVES OF THE STUDY

1. Find a Solution for Plastic Waste
2. Examine the Practicality of Integrating Textile Fibers into Bioplastic
3. Identify Practical Ways to Reuse Waste Cotton Fibers
4. Inquire into the Development of Easily Biodegradable Products using Bioplastic
5. Explore the Feasibility of Seaweed as a Raw Material for Bioplastic Synthesis
6. Investigate the Economic Viability and Scalability of Seaweed Bioplastic Production
7. Find an Alternative to Plastic Artistic Palettes and Water Containers

1.9. SCOPE OF THE STUDY

The study aims to address the challenge of plastic pollution and the issue of textile waste generation by proposing a sustainable and environmentally friendly approach: producing bioplastic from seaweeds and integrating waste textile fibers to enhance its strength. By using natural resources such as seaweed and repurposing textile waste, this research offers a solution to reduce the environmental impact of conventional plastics.

The significance of this study extends beyond its immediate objectives. It underscores the potential of bioplastic as a sustainable alternative to traditional plastics in various aspects of our daily lives. From reducing dependence on finite fossil fuel resources to curbing plastic pollution in marine ecosystems, the adoption of bioplastic holds promise for creating a more environmentally sustainable future. Furthermore, the products developed during the study period serve as an example of the practical applications of bioplastics in various contexts. A wide range of utility products can be made from eco-friendly materials, these artifacts demonstrate the versatility and adaptability of bioplastic in meeting the diverse needs of artists and consumers alike.

This research helps to raise awareness about sustainable practices and approaches by sheding light on the feasibility and viability of seaweed bioplastic. Ultimately, this project aims to build sustainable relationship between the nature and human kind.

1.10. METHODOLOGY

The methodology section explains the systematic approach employed in the bioplastic production from seaweed. The section helps to understand the various methods and proportion of elements in the biomass including, sample collection, cleaning, bioplastic preparation, and product development. All the steps are carefully monitored to ensure the quality and durability of bioplastic. The researcher also employed a survey to understand the artist's opinion on the development of various utility products for their community.

CHAPTER 2

REVIEW OF LITERATURE

2.1. POLYMERS

Polymers are a diverse and extensive group of molecules, consisting of exceedingly long repetitive chains. Typically composed of carbon, they encompass a wide range of materials beyond just plastics. For example, silicones, which are based on silicon rather than carbon, are also considered polymers and are utilized in various products such as fire retardants and breast implants. Interestingly, even DNA is a type of polymer. The configuration of these molecules is responsible for the malleability of plastics, allowing them to be molded into virtually any form (BBC 17 May 2014).

2.2. ORIGIN OF PLASTIC

In the Victorian era, owning a billiard table and a set of billiard balls made of ivory were considered a status symbol for wealthy gentlemen. However, due to the overhunting of elephants in Africa and India, the supply of ivory became scarce by 1863. To combat this issue, a New York billiard-ball manufacturer offered a $10,000 prize to anyone who could invent a substitute for ivory. The prize was won by John Wesley Hyatt, a young printer from Albany, New York, and his brother Isaiah. They invented celluloid, which was one of the world's first plastics. Celluloid was a great substitute for ivory as it had similar properties and looked like ivory. Additionally, it could be molded and rolled into sheets when heated. The Hyatts made celluloid by modifying natural materials, cellulose nitrate, and camphor, through the application of heat and pressure. Celluloid became the material of choice for billiard balls and many other products. It was a plastic made by modifying natural materials, and it took over 40 years to invent the first wholly synthetic plastic. Although the Hyatts never received the prize money, their invention changed history and had a significant impact on the plastics industry (Geyer, R., 2020).

Leo Hendrik Baekeland coined the term "plastic materials" in 1909 to refer to products made from macromolecules such as resins, elastomers, and artificial fibers. He had invented the first synthetic plastic, bakelite, two years before in 1907 **(** The Journal of Field Actions).

The production of plastics on an industrial scale began in the year 1940. The final product is made up of repetitive units of monomers, combined with several other chemicals to achieve the desired characteristics like colour, flexibility, and other properties. These chemicals are collectively known as additives, which have been classified into different major groups based on their functions (Hassanpour, & Unnisa,2017).

2.3. VERSATILITY OF PLASTIC

Plastics have liberated us from the limitations of the natural world, where we were restricted by material constraints and limited supplies. This newfound elasticity has also helped break down social boundaries. The introduction of malleable and versatile materials has given producers the ability to create an abundance of new products, while at the same time expanding opportunities for people with modest means to become consumers. Plastics have promised a new era of material and cultural democracy (Freinkel S (2011). During the first 50 years of the twentieth century, the development of modern plastics witnessed the synthesis of at least 15 new classes of polymers. The success of plastics as a material can be attributed to their versatility and ability to be used in different types and forms, including natural polymers, modified natural polymers, thermosetting plastics, thermoplastics, and more recent biodegradable plastics. Plastics possess unique properties such as the ability to withstand a wide range of temperatures, being resistant to chemicals and light, and being strong and tough, yet easy to work with as a hot melt (Andrady, A. L., & Neal, M. A.,2009).

Plastic is a synthetic material that has become essential for human existence. Its lightweight, water-resistant, and expandable nature makes it a popular choice for various applications. Additionally, plastic is incredibly strong and very cheap to produce, which has contributed to its over-consumption in the manufacturing of goods (Kumar, Pundir, Mehta, & Chauhan, R.,2020).

2.4. PLASTIC CONTAMINATION

Numerous research studies have been conducted to investigate the analytical methods, sources, abundance, transport, fate, degradation, and potential risks associated with plastics in the environment. Due to their resistance to degradation, plastics have the potential to interact with other substances in the environment, posing a threat to wildlife and even human health. Researchers have focused on analytical methods, source, abundance, transport, fate, degradation of plastics in the environment, and threats to natural surroundings, wildlife, or even human health. Plastics are resistant to degradation, which likely provides the opportunity for plastics to interact with other substances in the environment (Penghui Li, Xiaodan Wang, Min Su, Xiaoyan Zou, Linlin Duan, Hongwu Zhang., 2021***).*** Plastic pollution pervades every corner of our planet, spanning from arid deserts to towering mountaintops, and infiltrating landfills and oceans on a global scale. (Matthew MacLeod et al., 2021*).* Plastic makes many products such as water bottles, coffee cups, utensils, and grocery bags. However, petrochemical-based plastics are not eco-friendly due to their high carbon footprint (Manali, Sanjukta, Himanshu A. Pandya, and Archana, 2021).

From the 1950s to the 1970s, plastic production was minimal, which meant that plastic waste was relatively easy to manage. However, between the 1970s and the 1990s, plastic waste generation more than tripled, reflecting a similar rise in plastic production. In the early 2000s, the amount of plastic waste generated increased more in a single decade than it had in the previous 40 years. Today, we produce approximately 400 million tonnes of plastic waste every year. It is a concerning fact that around the world, one million plastic bottles are purchased every minute, and up to five trillion plastic bags are used globally each year. Shockingly, half of all the plastic produced is meant for single-use purposes, which means that it is used just once and then thrown away. This practice results in a significant amount of plastic waste that is harmful to the environment. Moreover, plastics, including microplastics, are now omnipresent in our natural surroundings. They are becoming part of the Earth's fossil record and serve as a marker of the Anthropocene, which is our current geological era. This situation is alarming and calls for collective action to tackle the issue of plastic pollution (UNEP, 2017).

Plastic pollution is a severe problem that can have long-lasting effects on the environment. Some areas are considered "poorly reversible" due to slow natural mineralization processes, and it is difficult to engineer solutions to remedy this. If negative outcomes arise due to plastic pollution in these areas, they will be practically irreversible, leading to changes in carbon and nutrient cycles, habitat changes in soils, sediments, and aquatic ecosystems, co-occurring biological impacts on endangered or keystone species, ecotoxicity, and related societal impacts (MacLeod, M., Arp, H. P. H., Tekman, M. B., & Jahnke, A. 2021). Despite numerous attempts to combat plastic pollution, there is still no single, proven formula that can effectively put an end to this environmental crisis. This is because plastic pollution is a complex issue that requires a multifaceted approach (Dubois, C. 2021).

Plastic pollution is becoming a significant environmental issue globally, second only to climate change. In Asia, it is considered the most pressing problem. Many people are concerned about the impact of plastic pollution and believe that urgent action is necessary to address it

(WWF et al., 2020). Action against plastic waste is driven by various factors globally. Although many countries have plastic regulations, they are often poorly enforced (Roger Harrabin., 2018). Plastic pollution is a major problem that is caused by human society, and it is now affecting both the environment and human health. Therefore, it is our collective responsibility to take action and reverse the current trends of pollution. To achieve this, science, education, the stakeholders involved in the plastic cycle, NGOs, and the general public all have a crucial role to play in the years to come. Each of these groups can contribute essential pieces to solve the complex puzzle of plastic pollution (Sandu, Takacs, Suaria, Borgogno, Laforsch, Löder, & Florea, 2020).

2.5. BIOPLASTIC

Increasing environmental concerns and legislative pressure for plastic waste reduction, as well as the rising cost of petroleum, have led to a surge in the development of eco-friendly materials. Bioplastics are one of the most innovative and environmentally friendly materials developed in recent times (Ezgi Bezirhan Arikan and Havva Duygu Ozsoy., 2015). Bioplastics are biodegradable plastics made from natural sources and synthesized by microorganisms. They accumulate in microbial cells under stress conditions. Bioplastics are a more environmentally friendly alternative to petroleum-based plastics as they biodegrade more readily. A variety of bioplastics based on cellulose, starch, and polylactic acid (PLA) are commonly used nowadays. Starch, an inexpensive material derived from corn and other crops, is an annually renewable source (Raaz Maheshwari, Bina Rani, Sangeeta Parihar, Anju Sharma., 2013).

Bioplastics are a potential alternative solution to petrochemical polymers. They have several advantages over traditional plastics including low carbon footprint, biodegradability, and versatility (Costa, Encarnação, Tavares, Todo Bom, & Mateus, 2023). A variety of bio-based materials are being introduced into the market across different applications, and various technologies are being developed and utilized to commercialize and expand the area of bioplastics (Goel, Luthra, Kapur, & Ramakumar, 2021). The main reason for the increasing significance of bioplastic is the constantly increasing petroleum oil prices and the fact that these are manufactured from finite sources. We need to find an alternative for petroleum-based plastics (Shamsuddin, Jafar, Shawai, Yusuf, Lateefah, & Aminu, 2017).

Bioplastics can improve production efficiency. In addition to this, these are more easily biodegradable than traditional plastic. Biodegradable plastics also help in reducing greenhouse gas emissions and the energy requirement for bioplastic synthesis is much lesser than that of traditional plastic production (Arikan, & Ozsoy, 2014, May).

The environmental impact of bioplastics, although often hailed as a better alternative to conventional plastics, is highly controversial and has been the subject of much debate (Licciardello, F., & Piergiovanni, L., 2020). We can't guarantee that all bioplastics will break down easily. The degree of decomposition depends on the chemical composition of bioplastic, not on whether it comes from natural or synthetic source (Goel, Luthra, Kapur, & Ramakumar, 2021). The cost of manufacturing bioplastics is higher than that of traditional plastics which makes it a second option. Waste systems cannot differentiate between bioplastics and conventional plastics. This results in poor-quality recycled material. Additionally, bioplastics have limitations in performance, due to their low strength. Products packed in conventional plastics have a significantly longer shelf life compared to those packed in bioplastics. The processability of bioplastics presents a challenge. They are more difficult to work with compared to traditional plastics, requiring twice the amount of time for processing (Klazinga, R., 2009).

There is a lot of confusion around terms like 'degradable' and 'oxo-degradable' which seem to be subsets of bioplastics but are significantly different. To bring clarity, the European Bioplastics Association has provided definitions for all these categories. The following list will provide you with the definitions based on their guidelines.

- Bioplastic: a plastic that is biobased and/or biodegradable
- Biodegradable plastic: A plastic that can be completely biodegraded through biological activity (i.e. through the action of microorganisms such as bacteria, archaea, fungi, and algae). Under aerobic conditions, the resulting products should ultimately be biomass, CO_2, and water, whilst under anaerobic conditions the resulting products should be biomass, CO_2, methane, and water.
- Biobased plastic: A plastic that is either wholly or partly derived from biomass.
- Oxo-degradable plastic: A plastic that has additives included to accelerate its fragmentation, triggered by heat or UV radiation, typically in the presence of oxygen. The potential for such plastics to ultimately biodegrade in full to CO_2 and water is

uncertain and a cause of considerable debate, with the likelihood that residual microplastics will remain in the environment, at least for extended periods.

- Degradable plastic: Often synonymous with oxo-degradable plastic, however, the term has no specific meaning and no governing standard. It implies that the plastic breaks down but does not give information about the end products or method of degradation (Lomartire, Marques, & Gonçalves, 2022).

The worldwide production capacity for bioplastics rose from approximately 1.6 million tons in 2013 to approximately 6.7 million tons by 2018. Europe's bioplastic production is predicted to increase by 83%, bringing the figure to 511,480 tonnes (SEABIOPLAS).

2.6. TEXTILE WASTE

In recent years, the production of textiles worldwide has been constantly rising. This increase is mainly due to the growth of the global population and the improvement in living standards. As a result, textile demands have been on the rise as meeting basic needs has become essential, leading to overconsumption due to the trend of fast fashion. Improper collection and careless disposal of solid waste lead to land and air pollution, which ultimately poses a risk to human health and the environment. (Ipek Yalcin-Enis, MerveKucukali-Ozturk, Hande Sezgin., 2019). Fast fashion refers to producing trendy and affordable clothing that borrows ideas from fashion shows and celebrities. This type of fashion is produced at a rapid pace to meet the ever-increasing demand of customers. The objective is to offer the latest styles to consumers as soon as possible. Unfortunately, these clothes are often discarded after only being worn a few times. (Solene Rauturier., 2023).

2.7. INFLUENCE OF SOCIAL MEDIA ON THE TEXTILE INDUSTRY

Recent developments in the internet and social media have enabled easier consumer connectivity through online forums, communities, ratings, reviews, and recommendations. Facilitated by social media, consumers generate online social support for their peers, establishing trust within their networks (Hajli, M. N. 2014). Social media provides a platform for people to share their experiences, reviews, information, advice, warnings, and tips with their friends and connections (Prasath, P., & Yoganathen, A. 2018). The rise of social media has revolutionized marketing, as it can influence potential customers from the start of their journey to the point of purchase and beyond. Social media has a significant impact on consumer behavior, including their purchasing decisions, due to the content, visual elements, promotions, discounts, and influencers present (Clootrack).

In today's highly competitive fashion industry, fashion retailers need to constantly change their product ranges to stay ahead of the game. This has led to an increase in the number of clothing seasons, with retailers now offering new collections for every season of the year (Bhardwaj, V., & Fairhurst, A., 2010). The global textile industry produced around 92 million tons of waste in 2014, with most of it ending up in landfills or being incinerated. Only a small portion of this waste is reused or recycled (Pensupa et al., 2017). Approximately 577,000 tons of waste are generated by the apparel and fabric mills in Bangladesh, of which 250,000 tons, almost half of the total, is 100% recyclable cotton waste valued at approximately 100 million USD (Pavarini, 2021). Global textile waste is predicted to increase by 60% annually, generating an additional 57 million tons of waste each year, reaching 148 million tons per year by 2030. (Niinimamp et al., 2020 ; Shirvanimoghaddam et al., 2020).

The rapid increase in global populations, along with advancements in living standards and income has fueled a remarkable growth in the production and consumption of textile fibers in the past few decades. However, this growth has underlined severe environmental concerns. The textile industry, distinguished by its high demand for natural resources and energy-consuming processes, has played a pivotal role in the escalating accumulation of post-consumer wastes. The particular concern is the existence of these man-made fibers including natural fibers within this waste stream, many of which can take decades to decompose. For instance, polymer-based clothing items may persist in landfills for up to 200 years before breaking down (Shirvanimoghaddam, K., Motamed, B., Ramakrishna, S., & Naebe, M., 2020).

2.8. COTTON FIBER

Cotton fiber reigns as the principal natural raw material in the textile industry, standing as a foundation of the global economy. Belonging to the genus Gossypium in the family Malvaceae, cotton is among the angiosperm species that underwent genome-wide replication around 1.5 million years ago (Qin, Y. M., & Zhu, Y. X., 2011). As the world population explodes, so does the need for cotton, particularly for lightweight clothing fabrics in tropical regions. The prominence of cotton in the textile industry stems from its distinctive properties: as mature fibers dry, they naturally twist, permitting the production of fine, long-lasting threads. Remarkably, cotton fibers undergo noteworthy elongation during development, stretching to lengths surpassing 1000 to 3000 times their diameter (Basra, A. S., & Malik, C. P., 1984).

The textile and garment trade is 425 billion US dollars in today's global economy. Amidst the pressures of globalization, Asia, particularly India and China, rise as the new powerhouse in world manufacturing. However, the recent dominance of Asia as the leading textile manufacturer is not a novel incident. Before the Industrial Revolution in the late 18th century, India and China held eminent positions as economic giants, particularly in their proficiency in cotton textile manufacturing. Their skills excel in that of Europe, with Asia producing vast quantities of vibrant, printed, and painted cotton textiles. These textiles were not limited to local markets but were traded across the Indian Ocean, reaching faraway places such as Japan and Europe. They fascinated consumers as exotic and fashionable commodities, displaying Asia's rich heritage and craftsmanship (Riello, G., 2013***).*** The environmental impact of cotton cultivation is primarily attributed to water consumption and pesticide intake, posing notable concerns. Particularly trouble is the extensive use of pesticides in various developing nations. It has been estimated that cotton cultivation accounts for 11% of the world's pesticide consumption despite occupying only 2.4% of the global cultivatable land. 25% of the world’s pesticides are used for cotton crop cultivation which is a substantial portion (Bevilacqua, Ciarapica, Mazzuto, & Paciarotti, C., 2014).

2.9. SUSTAINABILITY

The Food and Agriculture Organization of the United Nations defines sustainable development as "the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry, and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable" (FAO). Sustainability rests on a fundamental principle: Our survival and flourishing hinge on the health of our natural world. Embracing sustainability means fostering a balance where humanity and nature thrive together, ensuring a legacy of abundance for generations to come (EPA).

In the pursuit of a more sustainable environment, there is a growing interest in the development of biodegradable materials that can effectively replace or enhance existing artificial and natural materials. Emerging technologies, including genetic engineering, biotechnology, nanotechnology, and microelectronics, are being leveraged to create innovative fibers. These efforts aim to introduce novel materials that not only meet the demands of modern applications but also degrade more efficiently, reducing environmental impact (Ozgen, B., 2012). Biodegradable textiles are a groundbreaking innovation in the clothing industry, providing a sustainable and environmentally friendly substitute to conventional synthetic fibers. These textiles are produced from biopolymers obtained from natural sources, such as plants, bacteria, or algae (Sharma, Aditya, & Jha, Adarsh., 2023).

2.10. SEAWEEDS: IMPORTANCE AND USES

As we look to unlock the potential of our seas and oceans as a reserve of much-needed resources to sustain our planet, while also protecting and improving them to increase their value to the economy, society, and the environment, cultivation of seaweed can provide massive amounts of nutrient-rich food for human consumption. Ocean farms are more sustainable compared to land-based agriculture because the cultivation of seaweeds doesn't require fresh water, chemical fertilizer, or land, which are significant negative factors of land-based cultivation. Apart from being an excellent source of food, seaweeds can also be a substantial feedstock for biomass, biofuel production, and animal feeds (Tiwari, B. K., & Troy, D. J., 2015).

Seaweeds are considered to be one of the most important marine resources. They have been used as a source of food and nutrition for centuries in both the Eastern and Western world. In India, seaweeds are also utilized for industrial purposes such as agar and alginate production, as well as in fertilizers. However, the potential of seaweeds remains largely untapped due to a lack of awareness among the general public. Seaweeds have a unique structure and rich biochemical composition, which makes them valuable across different domains such as food, energy, medicine, and cosmetics. By harnessing their multifunctional properties, significant advancements can be made in these fields (Dhargalkar, V. K., & Pereira, N., 2005).

Seaweed contains a large amount of vitamins, minerals, and fiber, and it can be delicious as well. The Japanese have been using a type of seaweed called nori to wrap raw fish, sticky rice, and other ingredients to make sushi rolls for over 1,500 years. They have been known for their medicinal properties for thousands of years, and many of them contain anti-inflammatory and anti-microbial agents. The ancient Romans used seaweeds to treat wounds, burns, and rashes, and there is anecdotal evidence that the ancient Egyptians used them to treat breast cancer. Seaweeds have also played an important role in economic growth. They have various uses in manufacturing, including as binding agents (emulsifiers) in toothpaste and fruit jelly, and as popular softeners (emollients) in organic cosmetics and skin-care products (NOAA, 2024). Over 95% of the seaweed that is used for human consumption is farmed rather than harvested from the wild. Seaweed grows rapidly, with some marine algae being ready to harvest in just six weeks. While it grows, it also absorbs CO_2, making it a valuable carbon sink. Additionally, algae can absorb excess nutrients like nitrogen and phosphorus, and create new habitats for marine life (WWF, 2019).

2.11. SEAWEED CATEGORIES

Typically, seaweeds are classified into three main groups: brown seaweeds, consisting of more than 2000 species belonging to the Phaeophyceae class; red seaweeds, encompassing over 7200 species within the Rhodophyta class; and green seaweeds, with over 1800 species classified under the Chlorophyta class.

Farmed brown seaweed has various applications, especially for human consumption. Additionally, cultivated brown seaweed is a valuable resource for various objectives, including (i) animal feed production, (ii) extraction of hydrocolloids like alginate for numerous biorefineries, (iii) manufacturing of biofertilizers or biostimulants, (iv) incorporation into cosmetic or pharmaceutical formulations, and (v) development of biodegradable bioplastics. Brown seaweeds are olive-greenish to dark brownish due to the presence of fucoxanthin pigments, which mask the original colour of chlorophyll.

Red seaweeds represent 52.65% of the worldwide seaweed cultivation, with Asia itself contributing 99.17% of this production in 2019. The red seaweed (Rhodophyceae) is distinguished by its unique red or pink hue due to the presence of phycoerythrin and phycocyanin pigments. These seaweeds grow in depths from 40 to 250 meters.

Green seaweed cultivation is relatively limited and has shown a decrease in trend since the 1990s. In 2019, six seaweed species achieved an average cultivation yield of over 500 kilograms of green seaweed. These cultivated green seaweeds are often used as ingredients in salads, adding nutritional value and flavor diversity. Green seaweeds bear photosynthetic pigments, including carotenoids and chlorophyll A and B. The chemical composition of seaweeds fluctuates significantly among species and across seasons because of variations in environmental conditions (Farghali, M., Mohamed, I. M., Osman, A. I., & Rooney, D. W., 2023).

Seaweed can play a significant role in mitigating climate change by absorbing carbon emissions, regenerating marine ecosystems, and creating biofuel, renewable plastics, and marine protein. However, growing seaweed on a global scale poses ecological risks. Excessive seaweed growth could impact the amount of light that reaches other species, affecting photosynthesis processes and potentially having harmful effects on ecosystems by removing too many nutrients from wild ecosystems (Melissa Godin, 2020).

2.12. SEAWEED BIOPLASTIC

Polysaccharides are the key component of seaweed used in the production of bioplastics. Carrageenan, agar, floridean starch, and alginate are some of the seaweed polysaccharides. Although seaweed-based bioplastics can be expensive, they have become increasingly important due to their significant advantages over other biological sources.

Seaweed-based bioplastics are a biodegradable and eco-friendly alternative to conventional plastics. Exploring bioplastic production could play a significant role in shaping the economic viability of seaweed-based products (Rajendran, Puppala, Sneha Raj, Ruth Angeeleena, & Rajam, 2012). Seaweed extracts are being used to create eco-friendly bioplastics that could reduce global plastic pollution by over 300 gigatonnes annually. These extracts have antimicrobial and antioxidant properties that enhance the shelf life of water, medications, and food items. Seaweed is also being explored as a resource for creating safe, recyclable, and hygienic packaging solutions. These innovative materials could revolutionize the market by catering to consumers seeking sustainable options and contributing to eco-friendly packaging practices that preserve and enhance the quality of perishable goods (Arghali, M., Mohamed, I. M. A., Osman, A. I., & Rooney, D. W., 2023).

Seaweeds can be a viable alternative for the production of bioplastics due to their high biomass and ability to grow in a wide range of environments, making them more accessible than other sources such as plants, animals, and microbial sources. They can be cultivated naturally, which is more suitable than the specific environments required for other microbial sources. Additionally, seaweeds are cost-effective, have minimal impact on the food chain, and are chemical-independent (Rajendran, N., Sharanya Puppala, Sneha Raj M., Ruth Angeeleena B., and Rajam., 2012). Seaweed-based bioplastic is an environmentally friendly alternative to traditional plastic. It is biodegradable in soil, has great mechanical properties, and a shorter shelf life, making it a better option for reducing plastic pollution (Shravya S C, Vybhava Lakshmi N, Pooja P, Kishore Kumar C M, Sadashiva Murthy B M., 2021).

Seaweed hydrocolloids, such as alginate and carrageenan, can be extracted from brown and red algae and could be used to create bioplastics. The hydrocolloid found in seaweed can produce a substance known as carrageenan, which can create a film layer. This substance can be used for making bioplastics. However, the alginate and carrageenan-based bioplastics are brittle and inelastic. To improve their properties, plasticizers like glycerol, sorbitol, and polyethylene glycol can be added to the formulation (Budiman, M. A., & Tarman, K., 2022). Seaweed-based bio-plastics have become increasingly important due to their benefits over other biological sources, despite their potential for being expensive. These eco-friendly and biodegradable alternatives to traditional plastics offer a solution to environmental issues. The production of seaweed-based bio-plastics is still being researched, with biotechnological and genetic engineering techniques playing a key role in feasibility and sustainability studies (Murugan, Rajendran, Josephat, Thirumalaiyachi, Naadiya, 2023).

The concept of bioplastics can be quite complex to grasp. It refers to a type of plastic that is either biobased or biodegradable or both. It's important to note that plastic doesn't necessarily have to be both biobased and biodegradable to be considered bioplastic. For instance, bioplastics can range from plastics that are biobased but not biodegradable, such as bioderived polyethylene (BioPE), to plastics that are non-biobased but biodegradable, such as polycaprolactone (PCL), to plastics that are both biobased and biodegradable, such as starch, polyhydroxyalkanoates (PHAs), and polylactic acid (PLA) (Dilkes-Hoffman, L., Ashworth, P., Laycock, B., Pratt, S., & Lant, P., 2019). The use of seaweeds in commercially available bioplastic coatings and films could lead to an increase in the demand for seaweed. This is because more polymer will be needed from seaweed, which will prompt farmers to grow more seaweed to meet the demand (Philippines Department of Agriculture., 2018).

Seaweed possesses massive potential as a renewable source for biopolymers. These biopolymers show remarkable characteristics suitable for multiple applications, owing to their extraordinary film-forming capability and splendid mechanical properties. It is possible to enhance these properties even further through a range of modification techniques such as reinforcement and blending. The utilization of seaweed as a filler in polymer composites offers compelling evidence for intensifying the thermal, physical, and mechanical attributes of synthetic polymer matrices (Jumaidin, R., Sapuan, S. M., Jawaid, M., Ishak, M. R., & Sahari, J., 2018).

2.13. SINGLE-USE PLASTICS

The increasing awareness and adoption of environmentally wide awake practices have remarkably contributed to environmental protection efforts in Western societies. However, regardless of this progress, certain unsustainable practices continue, often leading to considerable environmental impacts that go unseen by many (Foteinis, S., 2020). Single-use plastics, such as take-away packaging and food packaging materials have detrimental effects on the environment, with implications for both human health and overall wellbeing (UNEP, 2014). However, in recent years, there has been a noticeable shift towards adopting agricultural residues like bagasse, rice straw, wheat straw, and rice husk, along with recyclable packaging solutions such as cotton bags, jute bags, and paper bags. Companies are actively exploring leak-proof sustainable cup options that are environmentally friendly. While these efforts are still in the experimental phase, such sustainable cups hold promise as a potential solution for the future (Ved Krishna, 2023).

2.14. SUSTAINABLE ALTERNATIVES

With the fast growth and development in every field, engineers are faced with several challenges when it comes to designing containers that can stand the pressure and uneasiness of transportation while protecting the goods. The task of making such containers becomes even more complicated when dealing with goods that are sensitive to both physical handling and environmental conditions. To meet these challenges, engineers must carefully select design elements, materials, and construction methods that not only provide enough protection but also lessen environmental impact. There has been a noticable shift in the focus towards eco-friendliness of packaging materials and sustainability. This in depth inspection is a response to growing environmental concerns and a desire to minimize the carbon footprint associated with packaging production and disposal. The choice of packaging material plays a crucial role in gaining these dual objectives of product protection and environmental sustainability. Engineers are now looking for a wide range of options, including recyclable plastics, biodegradable materials, and innovative composites derived from renewable sources. Along with that, improvements in design and construction techniques, such as improved insulation and shock-absorption systems, are being employed to enhance the performance of packaging solutions while lessen material usage and waste. The evolving landscape of distribution challenges demands a comprehensive approach to container design and construction. By exploring a diverse range of materials, innovative design strategies, and sustainable practices, engineers can develop containers that not only safeguard goods during transit but also contribute to a more environmentally conscious supply chain ecosystem (Singh, Chonhenchob, & Singh, J., 2006).

The conversion away from single-use plastics in favor of reusable items introduces many challenges. Single-use plastics provide high levels of safety and hygiene, crucial for sustaining the freshness of packaged food and minimizing food waste. While bioplastics offer a potential substitute, their universal adoption faces certain hurdles. The current production volume of bioplastics is inadequate to fully address the needs of the sector when compared to traditional plastics. Moreover, bioplastics are generally more expensive than non-compostable substitutes, undoubtedly leading to increased prices. This poses a challenge as both public and private users are often unwilling to pay higher costs (Genovesi, Aversa, Barletta, Cappiello, & Gisario, 2022).

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

The growing urge towards sustainability has escalated the hunt for eco-friendly substitutes to conventional plastics derived from fossil fuels. Bioplastics have become a promising solution among these alternatives because of their biodegradability and renewable sourcing. Seaweed, a marine macroalgae abundant in coastal regions worldwide, presents an especially attractive feedstock for bioplastic production due to its rapid growth rate, low requirement of resources, and carbon segregation capabilities.

This methodology section describes the systematic approach employed in the synthesis of bioplastic from seaweed. This section aims to provide a complete understanding of the experimental framework and accuracy underpinning the research by explaining the procedural steps and methods employed. The methodology encircles several key stages, including the collection of seaweed and pretreatment, extraction of biopolymer components, polymerization processes, and process of product development. Each stage is carefully designed to increase the yield, durability, and performance of the bioplastic product while minimizing environmental impact.

3.1. PILOT STUDY

An experimental investigation was undertaken to understand the precise proportions of constituent elements required for the synthesis of bioplastic, preceding the standard production procedure. Through systematic testing and analysis, the study aimed to determine the optimal combination of materials necessary for efficient and sustainable bioplastic fabrication. This step seeks to enhance the understanding of the intricate balance between various components, such as seaweed, glycerine which is the plasticizer, and additives like corn starch and coconut oil, in achieving desired material properties while minimizing environmental impact. By rigorously examining different compositions and their effects on bioplastic characteristics, the exact proportional relationship between the ingredients is established.

3.2. SURVEY

The researcher conducted a survey aimed at understanding the perspectives of the artistic community on the development of foldable, easily carryable, and biodegradable artistic palettes and water containers. From this survey, the researcher was able to understand different concepts, preferences, and needs of artists from various backgrounds, demography, and disciplines. The survey aimed to gain an understanding of their expectations and desires regarding these innovative tools, which hold the potential to transform both the practical and environmental aspects of artistic practice.

Through the survey, the researcher aimed to unravel the basic motivations driving their interest in foldable and biodegradable artistic palettes and water containers. The researcher explored the current challenges and problems with traditional palettes and water containers, as well as their hopes for improvements in terms of portability, sustainability, and usability. This survey provides an opportunity for artists to express their opinions, preferences, and concerns openly, enabling the researcher to gain precious ideas that would help in the design and development of future artistic tools. I hope that my efforts in creating foldable and biodegradable palettes and water containers will truly resonate with the needs and values of the artistic community.

This survey was conducted among different people who engaged themselves in any kind of artistic practice in various age groups and disciplines. The number of respondents was 30.

3.3. BIOPLASTIC PRODUCTION

The process of bioplastic production from seaweed involves several key steps, each contributing to the conversion of seaweed biomass into a sustainable alternative to conventional plastics. This process can be described in detail as follows:

3.4. SEAWEED COLLECTION AND CLEANING

Seaweeds, collected from coastal regions, undergo a careful cleaning process to eliminate any external matter that may compromise the purity of the biomass.

Plate. 3.1 **Plate. 3.1**

Collected Seaweed Samples

At first, the collected seaweed samples are carefully examined, making sure that only the highest quality specimens are selected for the further process. Afterward, they are exposed to numerous rinses with fresh tap water, a critical step aimed at dislodging and removing all unwanted impurities, dirt, and sand particles that hold on to the surface.

3.5. DRYING COLLECTED SEAWEED

Once cleaned thoroughly, the seaweed samples are dried under shade, a natural and environmentally friendly practice that guarantees optimal conservation of the inherent properties of the seaweed. Do not expose the samples to direct, strong sunlight. This drying process continues until the seaweed attains a state of complete dryness, thereby preventing any moisture content that could compromise upcoming processing steps.

Plate. 3.2

Plate. 3.2

Dried Seaweed Samples

3.6. GRINDING DRIED SEAWEED SAMPLES

After drying, the dehydrated seaweed specimens are carefully transformed into fine powder through a precise grinding process. This powdering stage is important as it facilitates the efficient breakdown of the dried seaweed specimen into smaller, more manageable particles, thereby improving its accessibility for subsequent steps. The powdered seaweed, now in a refined state, is stored in a controlled environment, ensuring its integrity and purity until it is ready for further processing.

Plate. 3.3

Grinded Seaweed Samples

This stage sets the basis for followingt stages of the bioplastic manufacturing process, ensuring that the powdered seaweed is suitable for optimal utilization in synthesizing eco-friendly biopolymer materials. Through these preparatory procedures, the seaweed biomass is transformed from its raw, natural state into a refined, finely powdered form, ready to go through the complicated processes involved in the production of bioplastics. Each step is carried out with precision and care, laying the groundwork for the sustainable usage of seaweed as a renewable resource in the pursuit of eco-conscious alternatives to traditional plastics.

3.7. PREPARING OF BIOPLASTIC

To initiate the synthesis process, accurately 15 grams of powdered seaweed is carefully combined with 150 milliliters of water in a mixing bowl. To this, 75 grams of corn starch are poured into the aqueous mixture, ensuring a homogenous blend of the primary biopolymer components. Keen attention is paid to maintaining an optimal temperature throughout the heating process, an important parameter that influences the following polymerization reaction. Under controlled heating, the mixture goes through a gradual transformation, slowly thickening to form a cohesive biomass. The heating process is carefully observed to prevent overheating or burning, ensuring the conservation of the required properties of the biopolymer matrix.

Once the required consistency is obtained, the heated biomass is allowed to cool down to room temperature, making it easy for the incorporation of plasticizing agents. An accurately measured volume of 25 milliliters of glycerin, known for its plasticizing properties, is added to the cooled biomass, intensifying its flexibility. Additionally, 5 milliliters of coconut oil are introduced into the mixture, to improve its properties.

Plate. 3.4

Preparation of Bioplastic

Thorough mixing of biomass is a critical step in the bioplastic production process, as it makes sure the uniform distribution of plasticizing agents within the biopolymer matrix. This blending promises consistency in material properties and improves the overall performance of the bioplastic. Moreover, by achieving a homogenous distribution of plasticizing agents, such as glycerine or other additives, throughout the biomass, the resulting bioplastic exhibits improved flexibility, durability, and resistance to degradation.

To further improve the structural integrity of the bioplastic, cotton fibers are introduced into the biomass during mixing. These fibers act as reinforcing agents, strengthening the material and enhancing its tensile strength and flexibility. Through thorough blending, the cotton fibers become evenly dispersed within the biopolymer matrix.

3.8. MOLDING FINAL PRODUCTS

Once the biomass, plasticizing agents, and reinforcing fibers are thoroughly mixed, the resulting mixture is ready for shaping. Depending on the desired final product, the mixture can be spread onto a flat surface to create sheets of bioplastic or molded into the desired shape, such as cups, containers, or other products.

In this innovative application, the properties of seaweed-based bioplastic are utilized to make both functional and aesthetically pleasing items—an artistic water container or palette and a mouse pad which is enough to demonstrate the depth of possibilities within sustainable material design.

To create the mouse pad, begin with the careful dispersion of seaweed biomass onto a flat surface, shaped into a circular form. Precision is given, ensuring a flawlessly even surface that facilitates seamless mouse movement. Through skillful manipulation, the bioplastic material is expertly spread and molded, guaranteeing optimal usability and comfort for users.

For the manufacturing of an artistic water container, the pliable bioplastic material is skillfully draped and molded around a water glass, gradually assuming its distinctive shape. With careful attention to symmetry and form, the container with a graceful shape, and flexibility can be obtained. Through these creative endeavors, the inherent versatility and adaptability of seaweed-based bioplastic are showcased. As these artisanal creations find their place in daily uses, they serve as reminders of the countless potential of seaweed bioplastic.

Plate. 3.5

Dispersion Of Seaweed Biomass

Plate. 3.6

Molding of Seaweed Biomass

The formed bioplastic sheets are then subjected to a controlled drying process, through which excess moisture is removed, leaving behind a thin, resilient film of seaweed-based bioplastic.

Plate. 3.7

Final Product: Mouse Pad

Plate. 3.8

Final Product: Artistic Water Container

After completion of the drying process, the resulting bioplastic sheets exhibit notable tensile strength. These bioplastic sheets with eco-friendly attributes and biodegradability, hold promise as sustainable alternatives to conventional plastics. These developed bioplastic samples are foldable and show a decent degree of flexibility that is somewhat compatible with conventional plastics.

CHAPTER 4

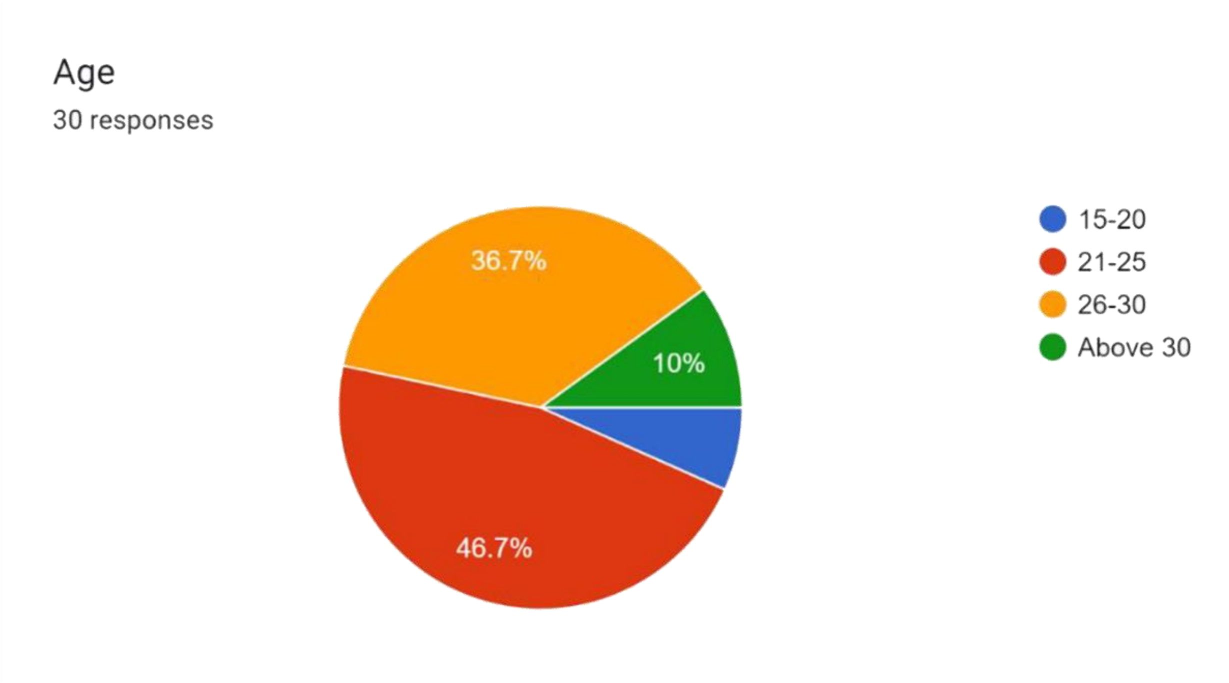
RESULT AND DISCUSSION

In this thesis, the exploration of seaweed bioplastic as an eco-friendly alternative for artistic water containers, palettes, and mouse pads was undertaken with immense attention to detail. The study aimed to assess the viability of seaweed bioplastic in replacing traditional petroleum-based plastics commonly used in artistic accessories, with a focus on environmental sustainability and artistic functionality.

Through a combination of literature review, experimentation, and analysis, it was determined that seaweed bioplastic exhibits favorable characteristics for the intended applications. The research findings indicate that seaweed-based materials possess suitable properties such as flexibility, durability, and biodegradability, making them suitable candidates for water containers, palettes in artistic settings, and mouse pads. Bioplastics are naturally biodegradable, reducing environmental impact and pollution and contributing to sustainable waste management practices.

In conclusion, this thesis adds to the growing body of knowledge on sustainable materials in artistic applications by presenting seaweed bioplastic as a viable alternative to traditional petroleum-based plastics. The findings offer valuable insights for artists, designers, and environmentalists interested in adopting eco-friendly practices in their work. Moving forward, continued research and development in this field are encouraged to further optimize the performance and scalability of seaweed bioplastics for a wide range of artistic accessories and beyond.

The survey findings depict the growing interest and potential for seaweed bioplastics as an eco-friendly alternative for artistic water containers, palettes, and mouse pads. The findings can be summarised as follows:



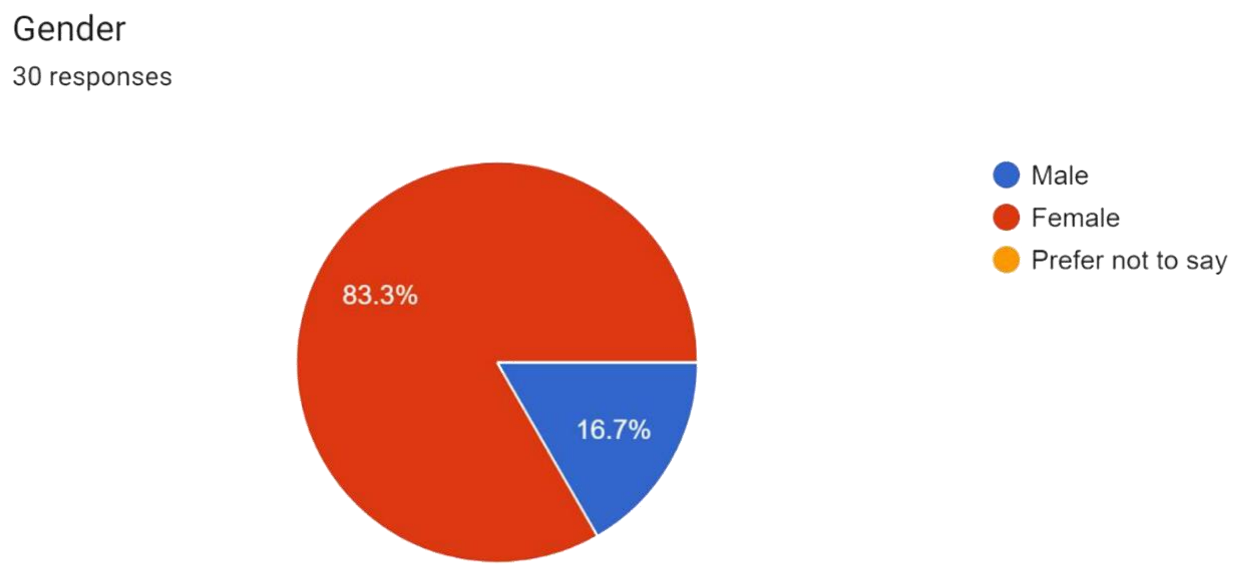
Graph. 4.1

The age group of respondents

The findings from the survey on the age group of the respondents are as follows:

The major portion of the respondents, comprising 46.7%, are under the age group of 21-25. 36.7% of the respondents fall under the 26-30 age group, while 10% of the respondents are above the 30 age group. Respondents who fall under the 15-20 category is the minor portion comprising 6.5%.

The age distribution implies that the survey encircles a significant amount of respondents who are in their early to mid-adulthood.



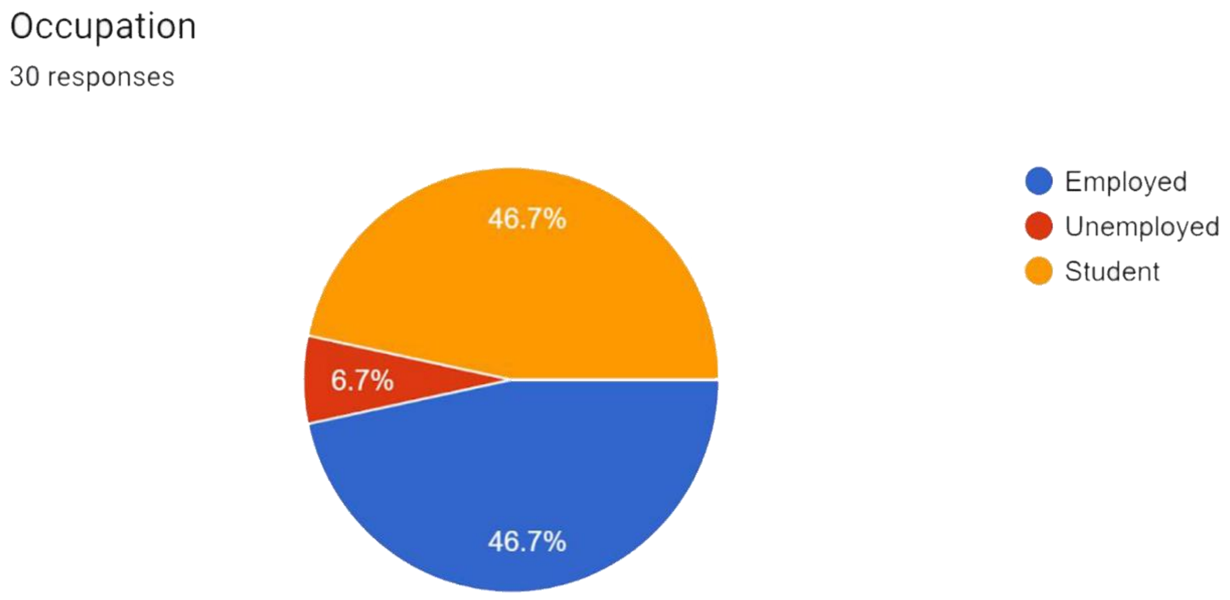
Graph. 4.2

Gender of respondents

The gender distribution is as follows:

The majority of the respondents identify themselves as women comprising a large proportion of 83.3%. The percentage of male respondents who participated in the survey is 16.7%. All the respondents identify themselves as either male or female and there are no respondents who refused to disclose their gender.

It is clear from the data that the majority of the participants are female.



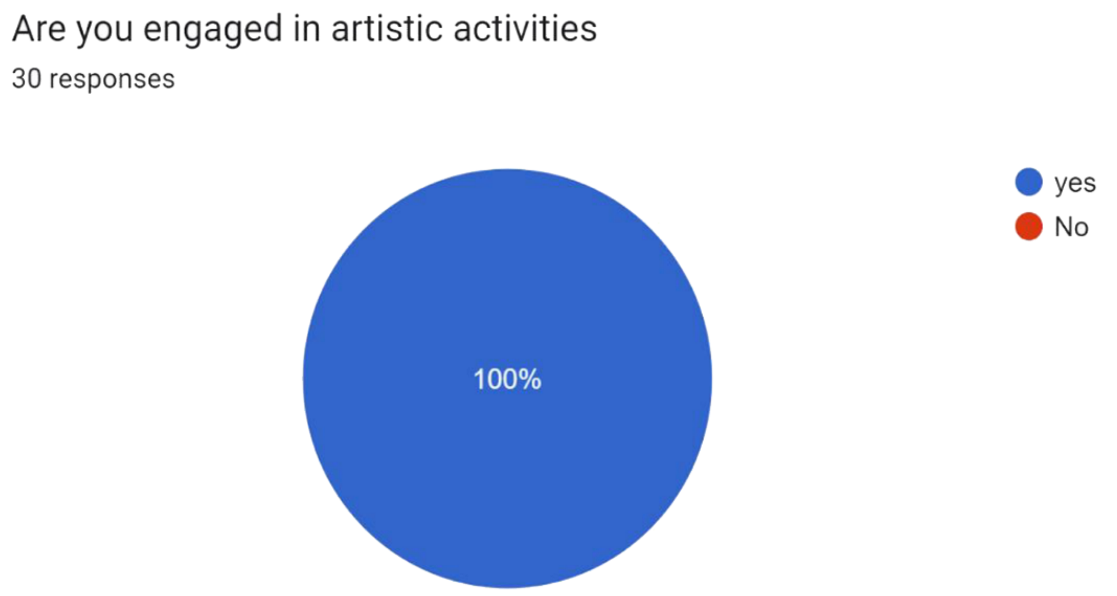
Graph. 4.3

Occupation of respondents

Based on the occupation of the respondents, the survey findings can be interpreted as follows:

The percentage of respondents who are working and are students is the same comprising 46.7%. A minority of respondents who are not working during the period constitute the unemployed category.

This implies that the survey gathers opinions from both students and working people along with non-working people.



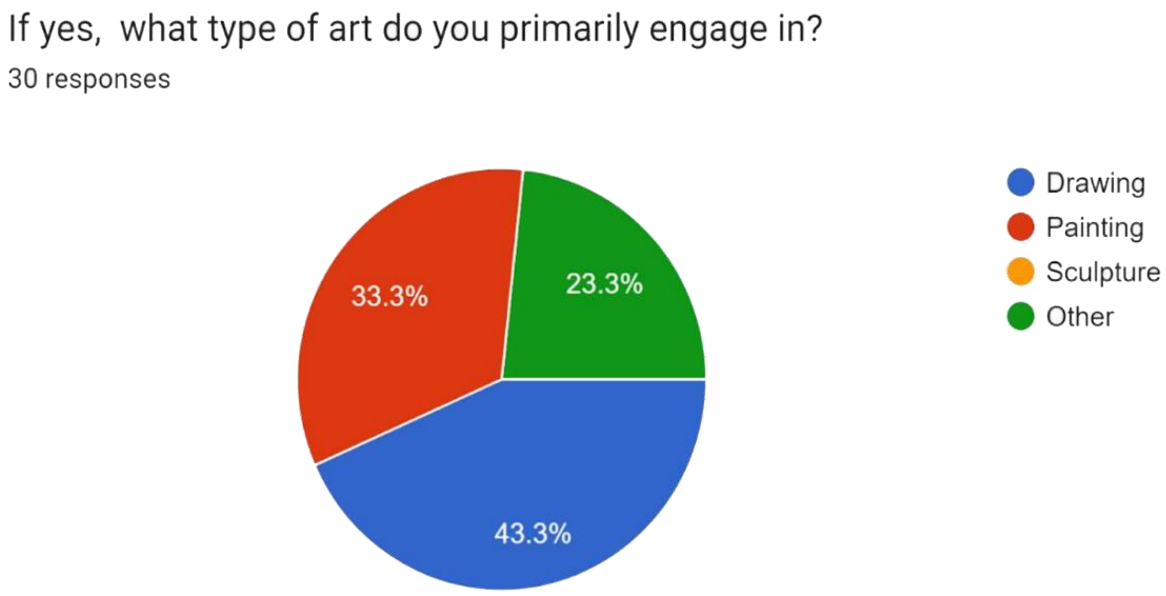
Graph. 4.4

Engagement in Artistic Activities

The findings from the survey regarding engagement in the artistic activities are:

The survey is carried out among artists and 100% of the respondents are artists. There is no indication that any of the respondents selected ‘no’ for engagement in artistic activities.

The finding suggests that all the respondents are artists and thus the information obtained from the survey truly adds value to the thesis.



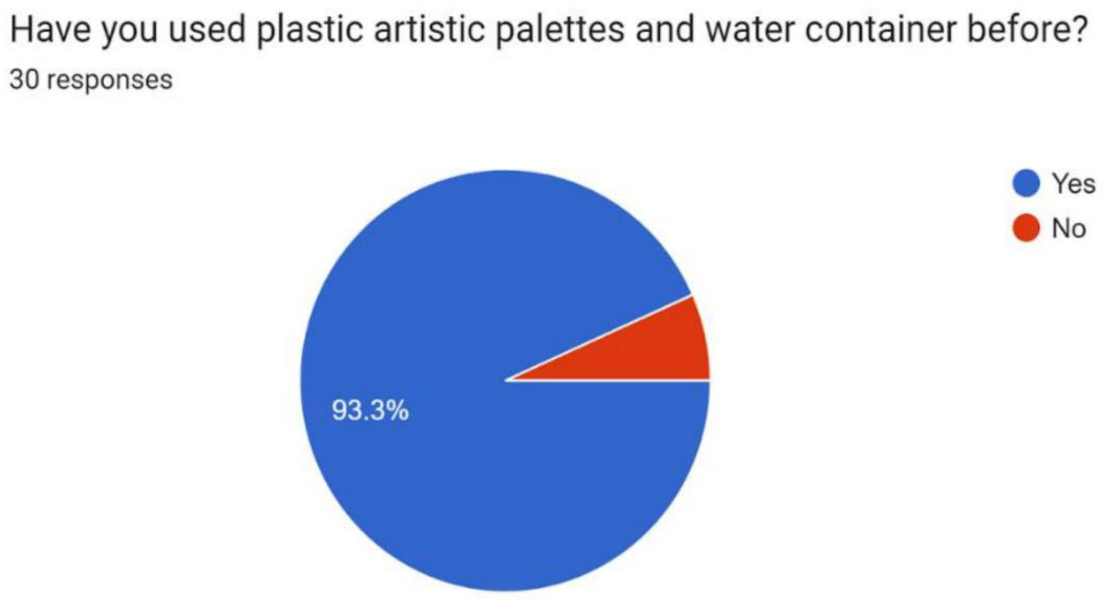
Graph. 4.5

Type of Art Primarily Engaged in

When it comes to artistic endeavors, the survey participants who are involved mainly create the following kinds of art:

43.3% of respondents said that their primary activity is drawing. The primary activity of 33.3% of respondents is painting. No responders listed sculpture as their primary activity. Of the respondents, 23.3%, their primary artistic endeavors are not included in the list of alternatives.

The respondents' varied artistic interests are shown by this split, with painting and drawing being the most preferred mediums for artistic expression.



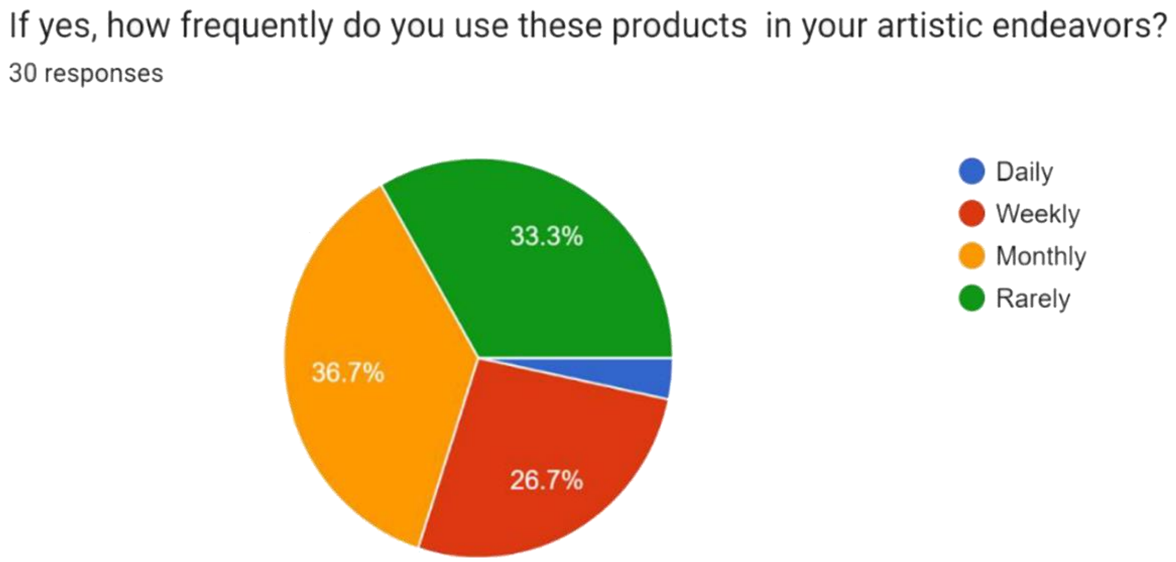
Graph. 4.6

Usage of Plastic Containers and Palettes

The following are the survey's findings about the usage of plastic water containers and palettes:

According to 93.3% of respondents, they have used plastic water containers and palettes before. 6.7% of the respondents said that they have not udes plastic water container and palettes.

This suggests that the majority of the artists are using plastic plaettes and water container for their artistic endevours.



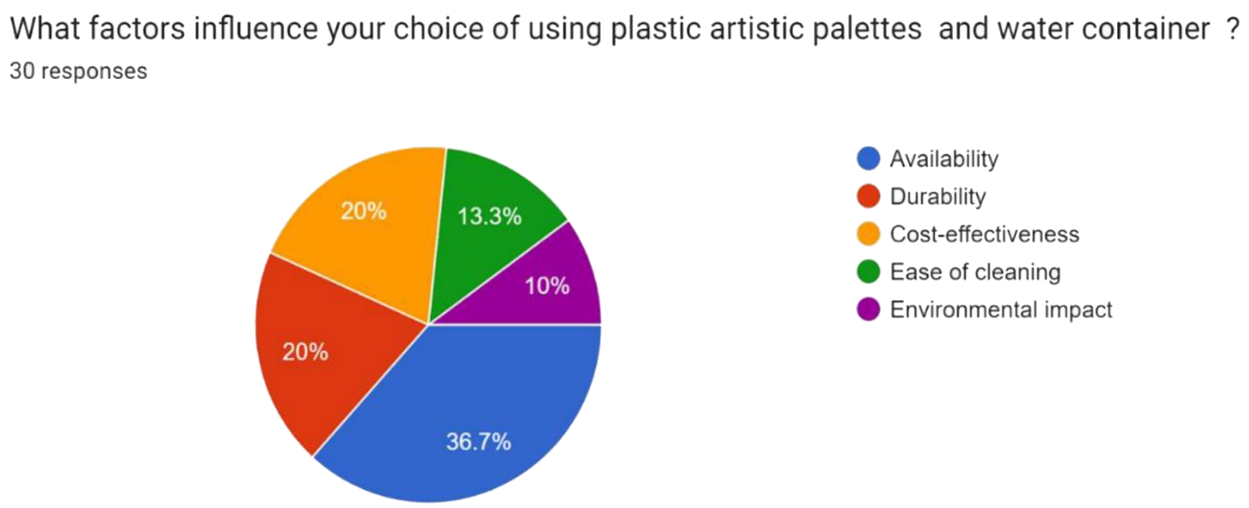
Graph. 4.7

Frequency of Usage of Plastic Water Containers and Palettes

This shows the frequency of use of plastic palettes and water containers in artistic pursuits among respondents who have previously used them:

No precise percentage is given for daily consumption. A total of 26.7% of participants report using these goods once a week. Of those surveyed, 36.7% said they use these goods once a month. 33.3% of those surveyed said they use these goods infrequently.

According to this breakdown, a considerable percentage of respondents use plastic palettes and containers less frequently—weekly, monthly, or occasionally—than others who use them frequently in their artistic endeavors.



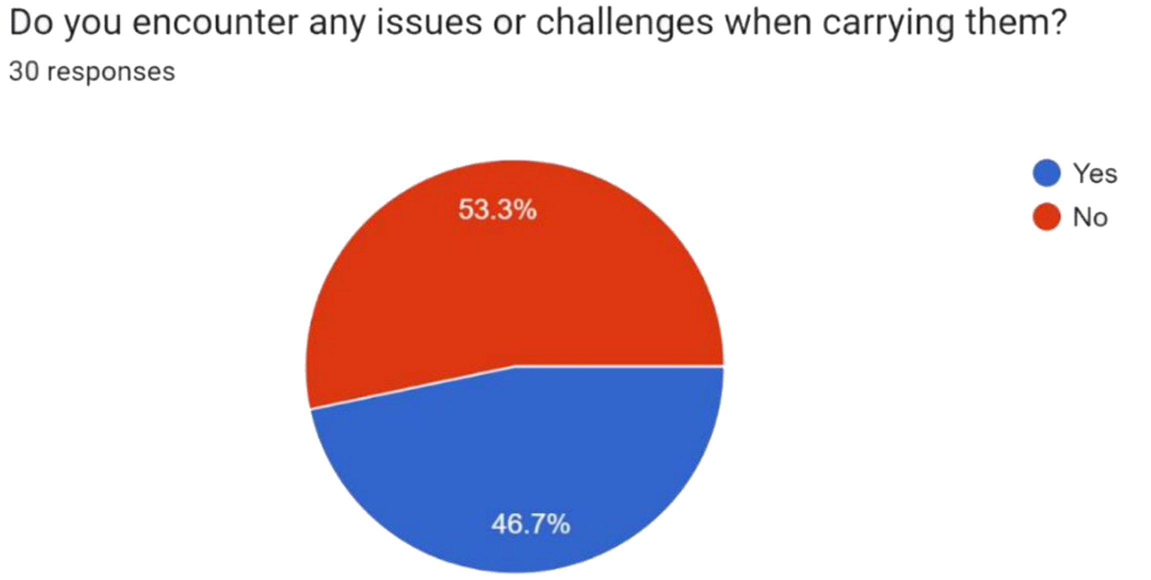
Graph. 4.8

Factors Influencing the Choice

The following elements influence the respondent's decision to use plastic water containers and palettes:

The accessibility of plastic palettes and water containers affects 36.7% of responders. 20% of those surveyed said that durability affected their decision. 20% of respondents said that the affordability of plastic palettes and water containers influenced their purchase decision. Cleaning easiness is a top priority for 13.3% of respondents when selecting these products. 10% of the respondents said that they think about the environmental effects of using plastic water containers and palettes.

This analysis shows that cost-effectiveness and durability are the next most important factors affecting the decision to use plastic water bottles and palettes, after availability. Still, a sizable minority of responders exist.



Graph. 4.9

Difficulty in Carrying the Water Container and Palette

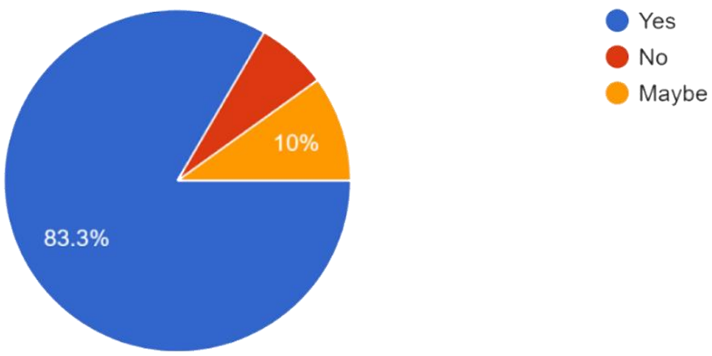
The following are the survey's findings about the difficulties faced by people in transporting these products.

Carrying these goods presents problems or challenges for 46.7% of respondents. While 53.3% of respondents said they carry them without any problems or difficulties.

This suggests that although a considerable proportion of participants have challenges when transporting plastic palettes and water bottles, a little greater proportion do not face any problems.

Would you be interested in using a palette or water container that can be folded and carried like fabric?

30 responses



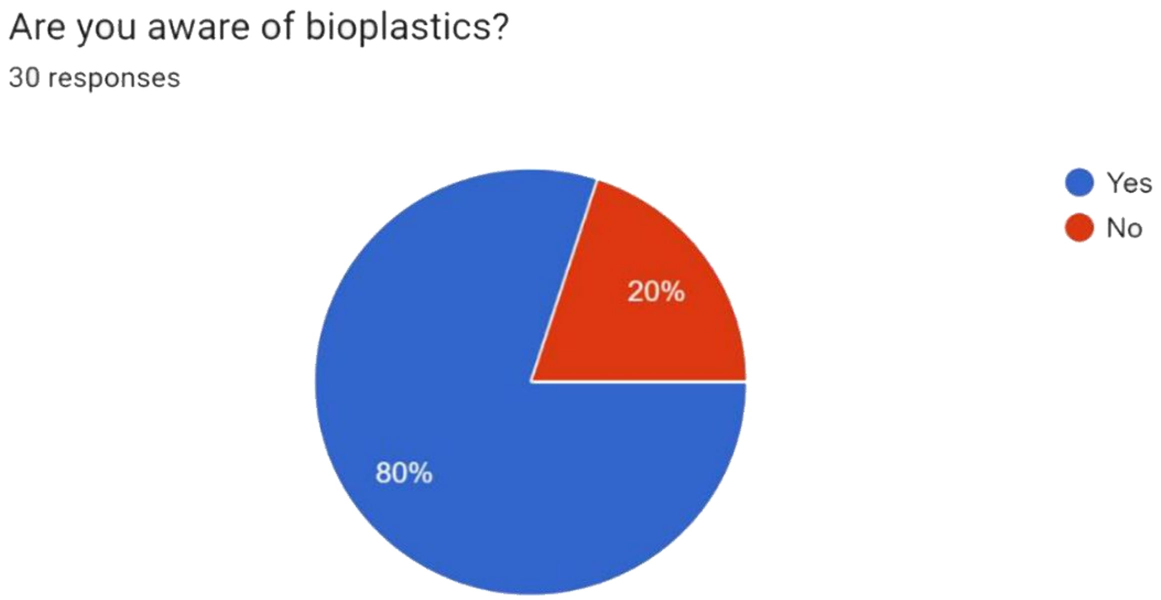
Graph. 4.10

Respondents Interest in Using Foldable Palette or Water Container

According to study results, the following people would be interested in utilizing a palette or water container that folds up and can be carried like fabric:

Indeed, according to 83.3% of respondents, they would use such a product. 6.7% of those surveyed said they wouldn't use the product. 10% of respondents are unsure or have conflicting opinions on utilizing this kind of goods.

This shows that most respondents were very interested in using a portable, foldable palette or water bottle; very few said they were not interested.

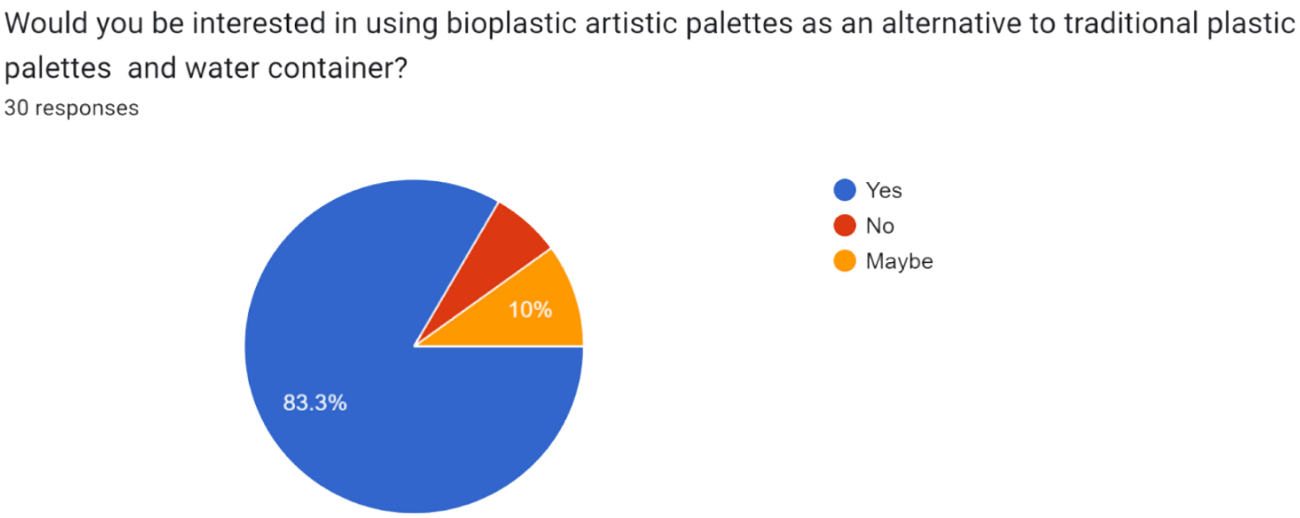


Graph. 4.11

Awareness of Bioplastic

The following are the findings of the survey on bioplastics awareness:

Bioplastics are known to 80% of responders. 20% of those surveyed had no idea what bioplastics were. This suggests that while a lower percentage of respondents are unaware of bioplastics, a sizable majority of them are aware about them.



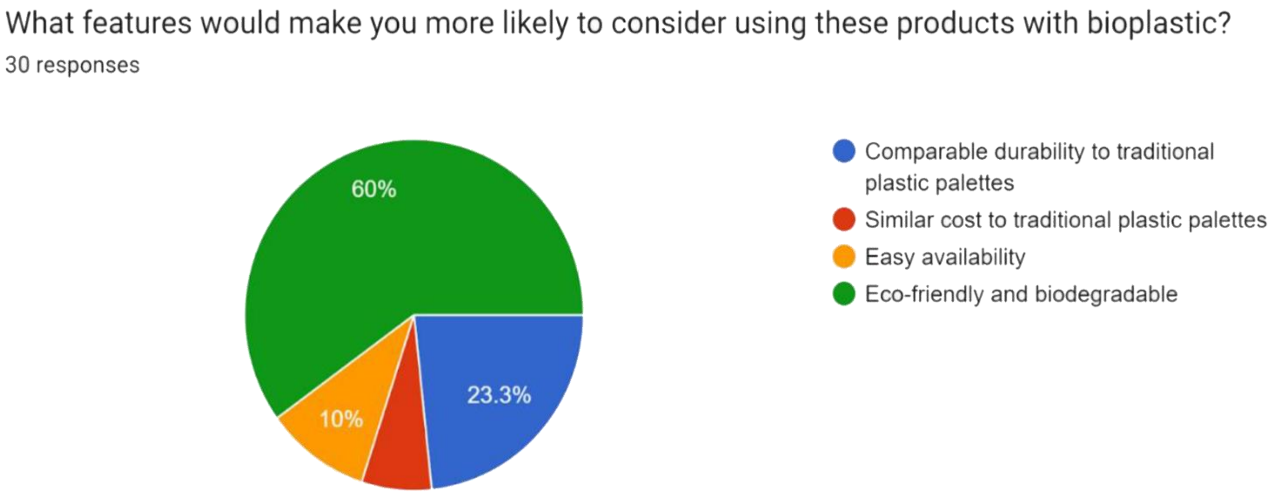
Graph. 4.12

Respondents interst in Switching From Conventional Plastic

The following are the results of the study on interest in switching from conventional plastic palettes and water bottles to bioplastic creative palettes:

83.3% of respondents say they would be interested in using artistic palettes made of bioplastic. According to 10% of respondents, they would not use artistic palettes made of bioplastic. 6.7% of respondents are unsure or have conflicting opinions regarding the use of artistic palettes made of bioplastic.

This shows that most respondents were very interested in using bioplastic artistic palettes instead of typical plastic ones, with very few saying they were not interested.



Graph. 4.13

Features Considering While Using Bioplastic

The characteristics listed below are those that would encourage respondents to think about utilizing bioplastic products, particularly creative palettes:

If bioplastic goods have the same level of durability as conventional plastic palettes, 23.3% of respondents said they would be more inclined to use them. In comparison to regular plastic palettes, 6.7% of respondents indicated that they would be more inclined to choose bioplastic items if the prices were comparable. If bioplastic items were easily accessible, 10% of respondents said they would be more inclined to use them. 60% of the respondents said they would be more inclined to use bioplastic items if they were both environmentally friendly and biodegradable.

This suggests that the majority of the respondents are aware of the eco-friendliness and biodegradability of bioplastic.

- ❖ Investigate the Economic Viability and Scalability of Seaweed Bioplastic Production: Conduct a comprehensive economic analysis to assess the feasibility of seaweed bioplastic production, including cost-benefit considerations.

The total expenses for the production process of bioplastic from seaweed were meticulously recorded and comprehensively analyzed. The breakdown of these expenses is detailed below:

1. Raw Materials:
    a. Seaweed Biomass: Costs associated with collecting seaweed biomass, including sourcing, transportation, and storage, were added to the total expenses. The total expense relating to collecting seaweed is 540 rupees.
    b. Glycerine: Glycerine, a common additive in bioplastic production, used as a plasticizer was priced at 70 rupees per 100 milliliters.
    c. Corn Starch: Corn starch, another essential component in the formulation of bioplastic, was priced at 25 rupees per 100 grams.

So the total expense is 635 rupees. The cost analysis serves as a valuable resource for people interested in advancing sustainable alternatives to conventional plastics.

CHAPTER 5

CONCLUSION

In conclusion, the exploration of seaweed bioplastic as an eco-friendly alternative for artistic water containers, palettes, and mouse pads represents a significant step towards sustainable innovation in the arts and beyond. Through an interdisciplinary approach that integrates principles of materials science, environmental sustainability, and artistic design, this thesis has shed light on the potential of seaweed-derived bioplastics to address the environmental challenges posed by conventional plastic materials.

The findings of this research have highlighted the versatility and feasibility of utilizing seaweed bioplastic in artistic applications, offering artists and creators a renewable and biodegradable alternative to traditional petroleum-based plastics. By harnessing the natural properties of seaweed biomass, such as its abundance, renewability, and biocompatibility, we can reduce our reliance on finite fossil fuel resources and mitigate the ecological footprint associated with plastic waste generation. Moreover, the development of seaweed bioplastic artistic tools has broader implications for promoting sustainability and environmental consciousness within the arts community. By adopting these eco-friendly alternatives, artists can not only reduce their environmental impact but also inspire others to embrace sustainable practices in their creative endeavors.

However, it is essential to recognize that the journey towards widespread adoption of seaweed bioplastic in the arts is still in its infancy. Further research and development efforts are needed to optimize production processes, improve material properties, and expand the range of artistic applications. Collaboration between scientists, artists, industry stakeholders, and policymakers will be crucial in driving innovation and overcoming the challenges associated with scaling up seaweed bioplastic production.

As we look to the future, it is clear that seaweed bioplastic holds immense promise as a sustainable material platform for artistic expression and beyond. The possibility of using seaweed bioplastic as an alternative for conventional plastic is widespread. The bioplastic can be molded into a large variety of utility products. The products that the researcher created is just an example of the various possibilities of utilizing seaweed bioplastic in our day- today life. By continuing to explore, innovate, and collaborate, we can harness the power of nature to create a more sustainable and vibrant artistic landscape for generations to come.

In closing, let us embrace the potential of seaweed bioplastic as a catalyst for positive change in the arts, paving the way toward a greener, more sustainable future.

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APPENDIX

The questionnaire of the survey conducted during the study is as follows:

- Mail id:

- Name :

- Age
  - 15-20
  - 21-25
  - 26-30
  - Above 30

- Gender
  - Male
  - Female
  - Prefer not to say

- Occupation
  - Employed
  - Unemployed
  - Student

- Are you engaged in artistic activities?
  - Yes
  - No

- If yes, what type of art do you primarily engage in?
  - Drawing
  - Painting
  - Sculpture
  - Other

- Have you used plastic artistic palettes and water containers before?
    - Yes
    - No

- If yes, how frequently do you use these products in your artistic endeavors?
    - Daily
    - Weekly
    - Monthly
    - Rarely

- What factors influence your choice of using plastic artistic palettes and water containers?
    - Availability
    - Durability
    - Cost-effectiveness
    - Ease of cleaning
    - Environmental impact

- Do you encounter any issues or challenges when carrying them?
    - Yes
    - No

- Would you be interested in using a palette or water container that can be folded and carried like fabric?
    - Yes
    - No
    - May be

- Are you aware of bioplastics?
    - Yes
    - No

- Would you be interested in using bioplastic artistic palettes as an alternative to traditional plastic palettes and water containers?
    - Yes
    - No
    - May be

- What features would make you more likely to consider using these products with bioplastic?
    - Comparable durability to traditional plastic palettes
    - Similar cost to traditional plastic palettes
    - Easy availability
    - Eco-friendly and biodegradable