UNDERGRADUATE FINAL YEAR PROJECT REPORT

Faculty of Engineering
Department of Textile Engineering

Title of FYDP: Development of Different Handicraft items by using Water Hyacinth (Eichhornia crassipes)

Submitted by:

Ankur Rahman **ID: 213-23-1026**	**Al Faysal** **ID: 213-23-1038**	**Md. Taohidul Islam** **ID: 213-23-1040**

Advised by:
Md. Abdullah Al Mamun
Associate Professor
Department of Textile Engineering
Daffodil International University

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Textile Engineering

Advanced in Apparel Manufacturing Technology

Spring -2025

Letter of Approval

To,

The Head

Department of Textile Engineering

Daffodil International University

Daffodil Smart City, Birulia, Ashulia–1216

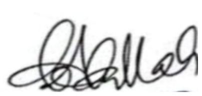
Subject: Submission and Approval of B.Sc. in TE Project Report

Dear Sir,

I respectfully submit this project report for your kind consideration and approval. The report, titled: "Development of Different Handicraft items by using Water Hyacinth (Eichhornia crassipes)" has been prepared by the students Taohidul islam bearing ID: 213-23-1040 , Ankur Rahman bearing ID: 213-23-1026, and Al-Faysal bearing ID: 213-23-1038 , respectively, in partial fulfillment of the requirements for the B.Sc. in Textile Engineering program.This project was carried out with full dedication and academic integrity. It is based on hands-on experimentation, material innovation, and practical product development. All team members were actively engaged in the fiber extraction, treatment process, design, fabrication, and testing of the final products. The report includes original findings and analytical insights that contribute meaningfully to sustainable product research.

I hereby recommend this report be considered for final evaluation.

Yours sincerely,



Md. Abdullah Al Mamun

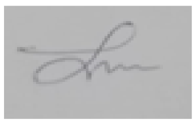
Associate Professor

Department of Textile Engineering

Daffodil International University

Author's Declaration

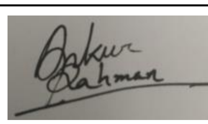
We declare that we are the sole authors of this project. This is an original work and has not been submitted elsewhere. We grant our institution the right to reproduce and distribute copies of this work in any form. This thesis paper has been done under the supervision of Abdullah Al Mamun sir, Associate Professor, Department of Textile Engineering, Faculty of Engineering, Daffodil International University.



Name: Md. Taohidul Islam

ID: 213-23-1040

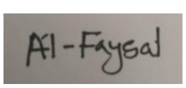
Email: taohidul23-1040@diu.edu.bd



Name: Ankur Rahman

ID: 213-23-1026

Email: ankur23-1026@diu.edu.bd



Name: Al Faysal

ID: 213-23-1038

Email: al23-1038@diu.edu.bd

Statement of Contributions

We worked as a team of Three friends on this final year project report. This thesis was jointly completed by Author 1, Author 2, and Author 3. Author 1 was primarily involved in collecting raw water hyacinth, extracting and treating the fiber, and contributing to the development of the table mats. Author 2 focused on the design and fabrication of the fruit bowls, as well as conducting strength and usability testing for all products. Author 3 led the construction and finishing of the vegan leather bags, managed data compilation, and coordinated the overall documentation process. All three authors contributed equally to the literature review, product development, report writing, and presentation preparation under the supervision of the assigned faculty advisor.

Executive Summery

For our final year project we decided to create handcrafted items like table mats, fruit bowl, and vegan leather bags. We made sure that the study covers the entire process from harvesting and preparing the plant to extracting the fibers and forming them into functional products. The results suggest that water hyacinth, often considered a problematic invasive species, holds significant potential as a renewable material for green product development. This initiative not only encourages the repurposing of natural waste but also supports environmentally responsible design practices and local craftsmanship. After the project was done we came up with the outcomes demonstrate that water hyacinth can be effectively repurposed into eco-friendly goods, contributing to environmental sustainability while encouraging the use of greener materials in design and production. By doing so, the project supports both environmental conservation and the promotion of green alternatives in product design.

Acknowledgement

"In the name of ALLAH, the most Merciful"

First and foremost, we are deeply thankful to Almighty Allah for granting us the strength and patience to successfully complete this research project.

We would like to extend our sincere appreciation to our respected supervisor, Mr. Abdullah Al Mamun, Associate Professor, Department of Textile Engineering, Daffodil International University. We sincerely appreciate his ongoing support, encouragement, and insightful feedback during the entire duration of this project.

We are also grateful to Mr. Tanvir Ahmed Chowdhury, Assistant Professor & Head (In-Charge), Md. Manik Pavez, Lecturer, and Prof. Mahbubul Haque, Professor, Department of Textile Engineering, Daffodil International University, for their kind support, encouragement, and academic assistance during this study.

Dedication

We want to begin by thanking Allah for this report.

We dedicate this report to Abdullah Al Mamun, Associate Professor, Department of Textile Engineering at Daffodil International University, whose constant guidance and support were invaluable throughout the preparation of this report.

Lastly, we want to sincerely thank our parents for being our greatest source of encouragement and motivation. This report is a token of appreciation for their unwavering support.

Table of Contents

Letter of Approval ii

Author's Declaration iii

Statement of Contributions iv

Executive Summery v

Acknowledgement vi

Dedication vii

List of Figure x

List of Table x

List of Abbreviation xi

List of Equations xi

United Nations Sustainable Development Goals xii

Similarity Index Report xiii

Chapter 1: Introduction 1

1.1 Background information 1

1.2 Significance and Motivation 2

1.3 Objectives 2

1.4 Methodology 2

1.5 Report Overview 3

Chapter 2: Literature Review 4

Chapter 3: Materials and Methods 7

3.1 Selection and Collection of Raw Material 7

3.2 Pre-Treatment and Fiber Extraction 7

3.3 Chemical and Mechanical Treatment of Fibers 8

3.3.1 Alkaline treatment for water hyacinth fiber 8

3.3.2 water absorption test 10

3.4 Product Categories and Design Techniques 10

3.7 Testing and Evaluation Criteria 13

3.7.1 Structural Strength 13

3.7.2 Water Resistance 13

Chapter 4: Results & Discussion 14

4.1 Moisture Behavior of Treated Fiber 14
4.2 Performance of Table Mats 15
4.3 Performance of Vegan Leather Bags 15
4.4 Performance of Fruit Bowls 15
4.4 Comparative Analysis 15
4.6 Limitations and Challenges 16
4.7 Discussion 16
Chapter 5: Health, Safety, Socio-cultural, and Environmental Considerations 17
5.1 Health and Safety Measures 17
5.2 Environmental Considerations 17
5.3 Socio-cultural Impacts 18
5.4 Ethical Practices in Design and Labor 18
5.5 Contribution to Sustainable Development Goals (SDGs) 18
Chapter 6: Conclusion 20
Chapter 7: References 21

List of Figure

Figure No.	Description	Page No.
Figure 1	**water hyacinth plants**	**07**
Figure 2	**water hyacinth plants roots and leaves were carefully removed**	**07**
Figure 3	**Dried stalks of water hyacinth**	**08**
Figure 4	**Smashed fiber**	**09**
Figure 5	**Chemical modification of water hyacinth fiber**	**10**
Figure 6	**fibers after modification**	**10**
Figure 7	**Formations of table mats**	**10**
Figure 8	**Formation of Vegan leather bag**	**11**
Figure 9	**Formation of fruit bowl**	**13**
Figure 10	**Strength testing of table mat, fruit bowl ang vegan leather bag**	**13**

List of Table

Table No.	Description	Page No.
Table 1	Comparative analysis of Table mat, Fruit bowl and Vegan leather Bag	15

List of Abbreviation

SDGS – Sustainable Development Goals.

List of Equations

01	**(WAR %) = ((Ww - Wd) / Wd) × 100**

United Nations Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) comprise 17 interconnected objectives aimed at addressing global challenges across economic, social, and environmental domains. These goals encompass critical issues such as poverty eradication, gender equality, quality education, clean energy, climate action, and the promotion of peaceful and inclusive societies.

In this project, we worked with natural water hyacinth fiber to create eco-friendly products such as table mats, fruit bowls, and plant-based leather bags. Our effort supports several Sustainable Development Goals set by the United Nations. One of the key goals addressed is SDG 11: Sustainable Cities and Communities. Using locally available, renewable materials like water hyacinth helps reduce environmental waste and encourages sustainable production practices. These products can be handmade in local communities, promoting cleaner production methods and supporting local artisans. This product was fully designed and developed by us. In most cases, buyers supply the designs and sellers only handle the manufacturing. But in our case, we created the design ourselves. This gives us the opportunity to set better pricing and improve our income. Therefore, our work also aligns with SDG 8: Decent Work and Economic Growth, as it encourages entrepreneurship and self-reliance. By choosing natural, biodegradable materials instead of synthetic ones, we also contribute to SDG 12: Responsible Consumption and Production. Furthermore, by removing and reusing water hyacinth which harms aquatic ecosystems this project indirectly supports SDG 13: Climate Action by helping improve environmental balance.

Similarity Index Report

213-23-1026

ORIGINALITY REPORT

10%	9%	3%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	3%
2	Submitted to Daffodil International University Student Paper	1%
3	Submitted to Higher Education Commission Pakistan Student Paper	1%
4	Submitted to University of Trinidad and Tobago Student Paper	1%
5	Francesc Fusté-Forné, Asif Hussain. "The Routledge Handbook of Regenerative Tourism", Routledge, 2025 Publication	1%
6	www.coursehero.com Internet Source	1%
7	meljol.org Internet Source	<1%
8	www.ventia.com Internet Source	<1%
9	Submitted to University of Plymouth Student Paper	<1%
10	Ping Li, Bin Wang, Yun Liu, Ping Zhu. "Eco-friendly Modal/alginate knitted fabrics with intrinsic flame retardancy and wearability", Cellulose, 2023 Publication	<1%

11	erepository.uonbi.ac.ke Internet Source		<1 %
12	ulspace.ul.ac.za Internet Source		<1 %
13	aujet.adelekeuniversity.edu.ng Internet Source		<1 %
14	dspace.library.uvic.ca Internet Source		<1 %
15	journal.gnest.org Internet Source		<1 %
16	hildok.bsz-bw.de Internet Source		<1 %
17	patents.google.com Internet Source		<1 %
18	themimu.info Internet Source		<1 %
19	wiki.lyrasis.org Internet Source		<1 %
20	www.dhgpharma.com.vn Internet Source		<1 %
21	api.elsevier.com Internet Source		<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		

Chapter 1: Introduction

1.1 Background information

Water hyacinth (Eichhornia crassipes) is one of the fastest-growing aquatic plants, often labeled as an ecological threat due to its ability to rapidly cover water surfaces. In countries like Bangladesh, its widespread growth blocks waterways, disrupts biodiversity, and negatively affects fishing and farming communities. While this plant is commonly treated as a nuisance, its fibrous stem structure presents a unique opportunity to turn a problem into a potential solution. This research explores how water hyacinth fibers can be transformed into usable, sustainable materials suitable for handmade household items. The plant's stems contain cellulose-rich fibers that, when properly processed, offer flexibility, moderate strength, and biodegradability traits desirable in eco-friendly product development. In recent years, global awareness about sustainability and waste reduction has pushed industries to rethink the materials used in design and manufacturing. Consumers are increasingly demanding products that align with environmental ethics, especially in sectors such as home decor and fashion. This shift has encouraged innovation using natural, renewable sources like jute, hemp, banana fiber and now, water hyacinth. Traditionally, rural artisans in South and Southeast Asia have utilized water hyacinth for crafting items such as baskets, mats, and ropes. However, this project aims to take that concept further by using water hyacinth in the development of more modern, functional products—namely table mats, fruit bowls, and vegan leather bags. These items reflect both creative design and sustainable manufacturing practices.

This research is grounded in textile engineering principles. It examines how natural fibers can be treated, processed, and applied in product design while considering factors like strength, moisture behavior, usability, and durability. The study also highlights how low-cost, biodegradable materials can be used to create value-added goods in local economies.

In short, this thesis reimagines a common environmental problem as a resource. By converting unwanted water hyacinth into handcrafted products, it not only reduces ecological waste but also encourages sustainable material use, rural innovation, and small-scale entrepreneurship.

1.2 Significance and Motivation

This research embodies the principles of sustainability and circular design by transforming an overabundant natural waste material into valuable handcrafted products. Beyond its environmental contribution, the initiative holds social significance by demonstrating the potential for community-level income generation through eco-friendly handicrafts. It highlights a dual benefit conserving ecosystems while encouraging local entrepreneurship.

1.3 Objectives

- To obtain usable fiber from water hyacinth plants.
- To design and develop table mats, fruit bowls, and a vegan leather bag using the extracted fiber.
- To evaluate the durability, usability, and consumer perception of these products.
- To promote sustainable, plant-based alternatives in textile and design sectors.

``

1.4 Methodology

The initial phase of the project involved brainstorming feasible product ideas that could be crafted using water hyacinth. This chapter outlines the systematic approach followed to transform water hyacinth into sustainable handcrafted products. The entire process was structured in several key stages: collection, fiber extraction, treatment, product design, and final evaluation. Each step was carefully executed to maintain consistency, ensure material integrity, and reflect the principles of sustainable textile engineering. We collected fresh water hyacinth plants and cleaned them thoroughly before the stems were separated for fiber extraction. To improve the quality and usability of the fibers, a mild alkaline treatment using a 10% NaOH solution was applied. This process helped eliminate surplus lignin and pectin, resulting in softer, more pliable fibers suitable for crafting purposes in future. We employed simple molding and weaving techniques to create each product prototype. Three products were developed in this study: table mats, fruit bowls, and vegan leather bags. The mats were handwoven using parallel fiber placement techniques. The bowls were molded using stem pieces and finished with natural oil coatings. For the vegan leather, pulp from crushed fiber was blended with biodegradable binders and dried into flexible sheets. All development and testing were carried out using accessible tools and resources in our university laboratory setting. Each product was assessed for appearance, moisture resistance, surface finish, and basic durability. Observational analysis and user feedback were used to draw conclusions about practical usability. The methodology ensured a balance between traditional handicraft practices and scientific material evaluation within the scope of textile engineering.

1.5 Report Overview

The initial chapters of this project are organized as follows: Chapter 2 presents prior research. Chapter 3 explains the materials and fabrication process. Chapter 4 covers observations and analysis. Chapter 5 discusses ethical and environmental considerations. Finally, Chapters 6 and 7 offers conclusions and references.

Chapter 2: Literature Review

Water hyacinth (Eichhornia crassipes) is widely regarded as one of the most aggressive aquatic plants, often spreading rapidly and disrupting ecosystems across various regions. While traditionally seen as an environmental nuisance, recent research has explored its potential as a renewable raw material for sustainable product development. As the global focus shifts towards eco-friendly alternatives, water hyacinth has gained attention for its fibrous composition, which makes it suitable for crafting and low-strength textile applications. The structure of its stems and petioles contains cellulose-rich fibers, which, when treated correctly, can be used in making various household and fashion items. Researchers such as Chattopadhyay and Kothari have emphasized that natural fibers, including those from aquatic plants, possess qualities like biodegradability, moderate strength, and flexibility making them ideal for use in products like mats, bags, and baskets.

Various rural communities, particularly in South and Southeast Asia, have long used water hyacinth for making traditional crafts Alam and Hossain highlighted how community-led programs in Bangladesh empowered women by providing training to create baskets, mats, and decorative items from water hyacinth . These projects not only contributed to rural employment but also offered an environmentally responsible way to manage the plant's overgrowth. Beyond craft uses, some researchers have explored the potential of water hyacinth in producing paper, packaging, and bio-composites. However, to make the fibers usable, proper retting and treatment processes are essential. Alkaline treatments, as supported by studies like those of Yadav et al., help remove lignin and pectin, thus softening the fiber and improving its compatibility with binders or other components. The retting process in clean water followed by thorough drying enhances the fiber's flexibility and durability, which are crucial for producing consistent, high-quality end products.

The adaptation of water hyacinth in sustainable product development has opened up new opportunities within textile engineering. As industries look for renewable resources and biodegradable inputs, non-traditional fibers like those from water hyacinth offer both material innovation and environmental benefits. Textile engineering plays a key role in transforming such raw plant fibers into usable forms through processes like mechanical or chemical treatment, blending, testing, and finishing. The development of finished goods such as table mats, fruit bowls, and vegan leather bags using water hyacinth aligns with modern goals of sustainable design and product diversification within the textile sector. These products are not only eco-friendly but also fulfill functional and aesthetic demands when processed properly.

Recent developments in sustainable material science have further strengthened the case for utilizing water hyacinth in product design. For instance, Sharma et al. (2021) investigated the structural integrity of hyacinth fibers when blended with natural binders, finding that treated fibers showed improved dimensional stability and durability. Other studies have explored enzymatic and microbial treatments as alternatives to traditional alkaline retting, offering eco-friendlier methods to extract and refine fibers (Singh & Bhattacharya, 2020). Moreover, research in product prototyping has demonstrated the viability of using water hyacinth pulp combined with plant-based adhesives to form sheet-like composites, which are comparable to synthetic leather in appearance and flexibility. These findings suggest a growing potential to develop scalable, eco-conscious alternatives to petroleum-based products, especially in lifestyle and home décor segments.

From an economic perspective, the utilization of water hyacinth as a raw material presents low-cost and locally available alternatives for craft-based industries, particularly in developing regions. Several grassroots initiatives across Southeast Asia, including projects in Thailand, the Philippines, and India, have successfully integrated water hyacinth into income-generating activities for rural women and artisans. According to Nair and Thomas (2020), these community-driven efforts not only reduce environmental waste but also help diversify income sources for households that traditionally rely on agriculture or seasonal labor. By promoting skill development, market linkage, and value-added product creation, water hyacinth-based handicrafts have emerged as a model for circular economy practices at the village level. This approach aligns with the broader goals of sustainable development, particularly in supporting SDG targets related to responsible consumption, gender equality, and economic growth.

When compared to more conventional natural fibers such as jute, hemp, or banana fiber, water hyacinth shows moderate tensile strength but excels in terms of flexibility and lightweight structure. Studies conducted by Das et al. (2018) evaluated the mechanical properties of water hyacinth fibers, revealing that while their strength is comparatively lower than that of bast fibers, their pliability and ability to bond with natural binders make them highly suitable for non-woven applications and molded forms. The average cellulose content in water hyacinth stems ranges between 60–70%, which supports adequate performance for crafting items like mats, bowls, and biodegradable leather alternatives. Moreover, blending water hyacinth with stronger fibers or biodegradable polymers has been shown to enhance product integrity, as supported by preliminary textile testing involving tensile load, elongation at break, and moisture absorption capacity. This comparative perspective reinforces the idea that, while water hyacinth may not replace stronger natural fibers entirely, it holds substantial promise as a complementary or alternative material in sustainable product innovation.

This growing body of research highlights the multifaceted benefits of water hyacinth, from material innovation and environmental management to rural empowerment. As this thesis aims to explore the development of table mats, fruit bowls, and vegan leather bags using water hyacinth, it contributes to an emerging area of sustainable design and textile engineering that bridges ecological responsibility with functional product creation

While several studies touch upon traditional uses of water hyacinth, there remains a lack of comprehensive academic research linking it directly to engineered textile applications. Few published works have explored performance parameters such as tensile strength, water absorption rate, surface treatment effectiveness, or lifespan of water hyacinth-based products. For example, molded bowls can benefit from surface finishing with natural oils like linseed or coconut oil, improving both moisture resistance and visual appeal. Similarly, creating flexible sheet-like materials from hyacinth pulp mixed with biodegradable resins has been attempted to simulate the properties of vegan leather. These innovations are still in early stages, and more focused research is needed to evaluate their long-term performance and commercial viability. This thesis aims to contribute to that gap by not only exploring product development but also analyzing material behavior and crafting methods using water hyacinth in a structured, textile-engineering approach.

Chapter 3: Materials and Methods

3.1 Selection and Collection of Raw Material

After selecting table mats, fruit bowls, and a vegan leather bag we started to find Fresh and matured water hyacinth plants and somehow we collected the plants from ponds from Gazipur. The plants selected were mature, thick and acceptable surface damage. All samples were gathered manually and transported for use.

Figure 1: water hyacinth plants

3.2 Pre-Treatment and Fiber Extraction

After collection, the stalks were washed thoroughly to remove soil and impurities. The roots and leaves were trimmed off, keeping only the stems

Figure 2: water hyacinth plants roots and leaves were carefully removed

After that, fibers were manually stripped, rinsed in clean water, and dried in sunlight for 2–3 days. Once fully dried the fibers were gathered into bundles.

Figure 3: Dried stalks of water hyacinth

3.3 Chemical and Mechanical Treatment of Fibers

3.3.1 Alkaline treatment for water hyacinth fiber

To enhance the quality and usability of water hyacinth fiber for sustainable product development, a combination of chemical and mechanical treatments was applied which we carried out in our university lab. Our motive was to extract fiber from stalks and find the water absorption rate.

At first we extracted some fiber, smash it and the fibers were combed and straightened manually using a fine-bristled brush

Figure 4: Smashed fiber

For chemical modification, a 5-gram sample of dried water hyacinth fiber was treated with an alkaline solution to partially remove lignin and soften the fiber structure.

Figure 5: Chemical modification of water hyacinth fiber

A 10% sodium hydroxide (NaOH) solution was prepared by dissolving 5 grams of NaOH in 100 mL of distilled water. The solution was heated to a temperature range of 60°C to 80°C, and the fibers were soaked for approximately 45 minutes with intermittent stirring.

Figure 6: fibers after modification

Mechanically, to remove remaining impurities. These steps helped improve the uniformity, texture, and workability of the fiber for subsequent product development.

3.3.2 water absorption test

In this study, a 5g sample of fiber were treated with 10% sodium for analysis. After immersion in distilled water for 24 hours, the sample’s weight increased to 9g. Using the WAR formula, the absorption capacity was found to be 80%, indicating a significant affinity for moisture, which is beneficial for biodegradable applications.

If a **5.00 g** sample of dry fiber is soaked in water for 24 hours and its wet weight becomes **9.00 g**, then:

$$\text{WAR (\%)} = \frac{9.00 - 5.00}{5.00} \times 100 = \frac{4.00}{5.00} \times 100 = 80\%$$

After the test and calculation we found the absorption rate of this fiber was 80%

3.4 Product Categories and Design Techniques

A. Table Mats making

- Fibers were hand weaved and woven into rectangular formats
- Once the table mat was woven into its final form we trimmed any protruding ends and adjusted the weave to ensure a uniform appearance. We gently pressed and shaped the mat to lie flat, then applied a natural finish using coconut oil.

Figure 7: Formations of table mats

B. Vegan Leather Bags

- Fibers were pulped, pressed into flexible sheets and bonded with plant-based glue
- Once the vegan leather bag formed using compressed and treated water hyacinth fiber sheets, we carefully trimmed the edges to ensure a neat and uniform shape.
- To improve its water resistance and flexibility, we applied a light layer of natural coconut oil. The treated bag was then left to dry 24 hours.
- Sheets were cut and stitched by hand to form bag components (base, sides, straps).

- For bag mouth we attached zipper by stiching.

Figure 8: Formation of Vegan leather bag

B. Fruit Bowls

- The crafting process start with the formation of the base coil. Stems were twisted and coiled tightly
- As the process of coiling was continued in an upward spiral, gradually forming the walls of the bowl.
- We applied natural coconut oil for finish and to enhance visual appeal

Figure 9: Formation of fruit bowl

3.7 Testing and Evaluation Criteria

3.7.1 Structural Strength

Each item was tested by applying incremental weights. Table mats were loaded with kitchen utensils; fruit bowls held up to 1 kg mango. Vegan leather bags were tested by adding up to 500 grams of carried contents

Figure 10: Strength testing of table mat, fruit bowl ang vegan leather bag

3.7.2 Water Resistance

The products were lightly sprayed with water. Vegan leather bag treated with natural plant oil exhibited no water penetration. Untreated mats absorbed some moisture but dried without warping.

Chapter 4: Results & Discussion

4.1 Moisture Behavior of Treated Fiber

The ability of a fiber to absorb and retain moisture plays a critical role in determining its usefulness in sustainable applications. In this study, attention was given to how chemically treated water hyacinth fiber responds to moisture exposure. After undergoing alkaline treatment, fibers often experience structural changes that can either increase or decrease their affinity for water.

To examine moisture behavior, a dried sample weighing 5.00 grams was fully immersed in distilled water and kept at room temperature for 24 hours. Following the soaking period, the fiber was carefully patted to dry to eliminate surface moisture and weighted again to assesses the level of water absorption.

We calculated the water absorption rate by using the following formula :

Water Absorption Rate (WAR %) = $((W_w - W_d) / W_d) \times 100$

Where:

- Wd means fiber's original dry weight in grams

- Ww means the weight after the fiber was soaked in water

Example Calculation:
Dry Weight (Wd) = 5.00 g
Wet Weight (Ww) = 9.00 g
WAR = $((9.00 - 5.00) / 5.00) \times 100 = 80\%$

This result shows that the treated fiber absorbed 80% of its own weight in water. Such a high absorption rate suggests that even after chemical treatment, water hyacinth fibers retain a strong hydrophilic nature. This property can be advantageous in applications where moisture interaction is required, such as biodegradable packaging or compostable products. However, it also highlights the need for water-resistant finishes when developing products intended for longer use or exposure to humidity.

4.2 Performance of Table Mats

The handmade mats withstood regular household usage. During load testing, they supported plates, cups, and small pots without deforming. Their braided structure gave enough flexibility to lie flat, while the treated fibers maintained their integrity over repeated use.

4.3 Performance of Vegan Leather Bags

One of the most notable achievements was the successful creation of leather-like sheets using plant-based materials. After pressing and treating the fibers with natural oils, the resulting material had a smooth texture and adequate flexibility. The bags could hold up to 500 grams of weight during testing without tearing at seams. They also resisted mild water splashes due to the plant-oil finish. Users noted the lightweight feel, raw elegance, and minimalistic appeal of the design. Some commented that with better stitching and lining, they could match basic market-quality bags.

4.4 Performance of Fruit Bowls

The fruit bowls showed excellent structural strength and stability. With resin coating, they supported weights up to 1 kg of fruit without cracking. The bowls also passed splash tests, remaining water-resistant and stain-free after surface exposure.

4.4 Comparative Analysis

Table 1: Comparative analysis of Table mat, Fruit bowl and Vegan leather Bag

Feature	Table Mats	Fruit Bowls	Vegan Leather Bags
Load Capacity	Moderate (1kg)	High (1.5kg)	High (1kg)
Water Resistance	Low (unless coated)	High (resin-treated)	Moderate (oil-treated)
User Aesthetic Rating	7.5/10	8.5/10	9/10
Market Readiness	Moderate	High	Emerging (prototype stage)

4.6 Limitations and Challenges

- Manual Labor Intensive: Fiber processing and shaping required significant time and effort.
- Finish and Consistency: The handmade nature led to variations in texture and edge quality.
- Water Sensitivity: Items that weren't treated showed poor performance against moisture exposure.
- Vegan Leather Processing: Achieving uniform sheet thickness was difficult without machines.

4.7 Discussion

This project demonstrates that water hyacinth fiber can be successfully used into high-value goods. Although still in early stages, vegan leather bag development offers a good and effective future alternative in the eco-fashion sector. By improving consistency and exploring natural limitations.

Chapter 5: Health, Safety, Socio-cultural, and Environmental Considerations

5.1 Health and Safety Measures

- During every stage of the research, necessary precautions were followed to ensure health and safety.
- Protective gloves were worn while handling retted water hyacinth to prevent skin irritation.
- Sharp instruments used for cutting and processing were handled cautiously, with proper training on safe use.
- Fiber drying and resin application took place in well-ventilated areas to avoid moisture buildup and minimize exposure to fumes.
- No health hazards or accidents occurred throughout the project.

5.2 Environmental Considerations

This project was designed with the environment in mind at every level

- Raw Material: The use of water hyacinth helps reduce its overgrowth in local ecosystems, thereby improving biodiversity and water flow in affected regions.
- Processing Techniques: Fiber treatment was done using biodegradable and safe chemicals to eliminate toxic waste.
- Waste Management: All organic waste generated during retting and trimming was composted or dried for reuse as fuel.
- Final Products: Each product is biodegradable or recyclable, creating no long-term environmental impact.
- By promoting renewable, plant-based materials over plastic or leather, this work actively contributes to a more circular economy.

5.3 Socio-cultural Impacts

The use of locally available materials like water hyacinth revives and strengthens traditional handcraft practices. This aligns well with the cultural heritage of Bangladesh, where rural communities have long relied on natural resources for livelihood.

Moreover:

- The crafting process is accessible and does not require advanced machinery, making it suitable for cottage industries.
- Women in rural areas can particularly benefit from participating in the production of items like mats, bowls, or bags, leading to potential economic empowerment.
- The aesthetic and functional nature of the products also makes them attractive in both local markets and export scenarios that value ethical and handmade goods.

5.4 Ethical Practices in Design and Labor

- Sourcing Ethics: No exploitation of land or resources took place. Water hyacinth was harvested from naturally overgrown areas, requiring no cultivation.
- Fair Work Environment: The process was done in an academic setting, following fair use of labor and materials.
- Animal-Free Alternatives: By introducing plant-based leather bags, the project provides a cruelty-free alternative to animal products, which aligns with growing vegan and sustainable fashion trends.

5.5 Contribution to Sustainable Development Goals (SDGs)

This thesis contributes to multiple SDGs:

- SDG 12 (Responsible Consumption and Production): Promotes upcycling and reduction of waste materials.
- SDG 13 (Climate Action): Reduces reliance on synthetic materials and lowers carbon footprint.

- SDG 8 (Decent Work and Economic Growth): Encourages small-scale, labor-intensive industries.
- SDG 11 (Sustainable Cities and Communities): Supports the growth of green urban and rural enterprises.
- SDG 15 (Life on Land and Water): Helps control invasive species that harm aquatic ecosystems.amination techniques, the potential to scale this idea for broader impact is significant.

Chapter 6: Conclusion

This research set out to explore a new life for an old problem the overgrowth of water hyacinth in Bangladesh’s freshwater bodies. While traditionally viewed as an environmental nuisance, this invasive plant was reimagined as a raw material for sustainable product development.

By extracting and treating its stalk fibers, we successfully developed three categories of products: table mats, vegan leather bag and fruit bowl. These prototypes proved not only functionally viable but also aligned with eco-conscious design principles. The study confirmed that with basic tools, safe treatments, and thoughtful design, this low-cost, biodegradable resource can be shaped into aesthetically pleasing, durable, and marketable goods.

Limitations:

- Manual processing is time-consuming.
- Uniform sheet thickness and professional-grade finishing for vegan leather remain difficult without industrial support.
- Seasonal availability and moisture control must be managed carefully during production.

In conclusion, this project proves that an invasive plant can become a creative solution turning a burden into an opportunity for sustainability and design innovation. By bridging traditional craftsmanship with eco-conscious engineering, this work contributes meaningfully to the fields of textile product development, environmental stewardship, and sustainable fashion

Chapter 7: References

Alam, M. S., & Hossain, M. D. (2019). Exploring income-generating possibilities from invasive plant species: A case study on water hyacinth-based ventures in rural Bangladesh. *International Journal of Sustainable Development and Planning, 14(2),* 153–160.

Chattopadhyay, R., & Kothari, V. K. (2014). *Natural fibres and their composite materials*. Cambridge, UK: Woodhead Publishing.

Ellen MacArthur Foundation. (2021). *Understanding the circular economy*. https://ellenmacarthurfoundation.org/

Nair, S., & Thomas, A. (2020). Empowering rural women through sustainable handicrafts: *A case study on water hyacinth crafts in India.* Journal of Rural Development, 39(3), 412–427.

Sharma, A., Ghosh, A., & Basak, R. (2021). *Evaluation of natural binder-based composites from water hyacinth for eco-friendly applications.* Materials Today: Proceedings, 46, 8976–8982.

Singh, K., & Bhattacharya, M. (2020). *Eco-friendly retting techniques for extraction of fiber from aquatic weeds.* Environmental Science and Pollution Research, 27(15), 18024–18032.

Yadav, A., Kumar, R., & Singh, S. (2017). *Effect of alkali treatment on the mechanical properties of water hyacinth fiber reinforced composites.* International Journal of Engineering Research and Technology, 6(2), 88–92.

Food and Agriculture Organization of the United Nations. (2020). *Promoting sustainability through the use of natural fibres*. http://www.fao.org

Jahan, M. S., & Rahman, M. M. (2010). Assessment of pulping and paper-making qualities of water hyacinth. *Cellulose Chemistry and Technology, 44*(10), 439–444.

Ndimele, P. E., Kumolu-Johnson, C. A., & Anetekhai, M. A. (2011). *Eichhornia crassipes (Mart.) Solms: Ecological concerns and economic opportunities. Research Journal of Environmental Sciences,* 5(6), 509–520.

Parvin, M., & Begum, A. (2021). The role of water hyacinth crafts in supporting sustainable livelihoods in Bangladesh. *Bangladesh Journal of Environmental Research, 19*, 87–95.