



Faculty of Engineering

Department of Textile Engineering

Project (Thesis) Report on

**Sustainable Menstrual Hygiene: A Comprehensive Study on Banana Fiber
Based Sanitary Pads.**

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Declaration

We therefore announce that, this project has been done by us under the supervision of **Md. Kamrul Islam**, Lecturer of the Textile Department and co-supervision of Daffodil International University. The total report is written on the basis of our own experiment. We also pronounce that neither this project nor any part of this undertaking has been submitted near differently for entitlement of any degree & certification in Textile Engineering degree.

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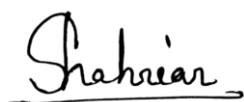


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Abstract

This thesis explores the feasibility and effectiveness of utilizing banana fiber as a sustainable alternative for the production of sanitary pads. With a growing global awareness of the environmental impact associated with traditional menstrual hygiene products, the need for eco-friendly alternatives has become imperative. The research delves into the mechanical and absorbent properties of banana fibers, investigating their potential as a biodegradable and cost-effective material for sanitary pad production. The study involves the extraction and processing of banana fibers, followed by the design and manufacturing of prototype sanitary pads. The performance of these pads is evaluated through comprehensive laboratory tests, including absorbency, comfort, and durability assessments. Comparative studies are conducted against conventional sanitary pads to assess the overall effectiveness and user satisfaction of the banana fiber-based alternative. Furthermore, the environmental impact of the banana fiber sanitary pads is analyzed, considering factors such as production energy, carbon footprint, and disposal. A life cycle assessment is conducted to provide a holistic understanding of the ecological footprint associated with both traditional and banana fiber-based sanitary pads.

We dedicated this project work to our beloved parents. Who nourishing our soul with their words & never giving up on us. Thank you for all the words of encouragement. For being the absolute rock that you are.

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Chapter 1:

Introduction

1.1 Introduction

Sanitary napkins are a member of disposable hygiene products that belong to technical textiles as they comprise practical fabric substances. Sanitary napkins have a big marketplace due to the fact nearly half of the world's populace includes girls and every woman has menstrual bleeding at some point in their fertile intervals.

Bangladesh is a developing country with a population of 169.4 million (2021) about 83.35 million women are living compared to 81.71 million men.

There are few estimates in scientific literature, but many sources suggest that women using disposable pads use 2-4 per day. If a woman bleeds 5days per 28 days or around one month, this means 130-260 pads or tampons per year, or 5,000-10,000 over her reproductive years. Disposable pads are a major contributor to plastic waste, with up to 90% of their composition being plastic. This is a significant concern for our planet, as it adds to the already troubling amount of plastic waste.

So, creating a sustainable sanitary napkin is crucial. Using natural resources such as banana fiber, bamboo fiber, or other less harmful natural fibers can ensure its effectiveness while reducing harm to the environment.

Though, this revolutionary and eco-friendly sanitary napkin made of 85% of carded banana fiber, 17% wastage viscose and 3% paper is used for make a sheet paper to prevent unwanted leakage.

Chapter 2:

Literature Review

2.1 Menstrual Hygiene and Health:

Before we dive into menstrual hygiene. It's important to have a basic understanding of a menstrual cycle. A menstrual cycle is a monthly process in which a female body prepares for pregnancy. It is controlled by hormones & typically lasts between 25-35 days. These hormones. Namely estrogen & progesterone. Cause a thickening of uterine lining to prepare for a potential pregnancy. If pregnancy does not occur. A lining is shed through vagina. Resulting in menstruation.

2.2 Environmental Impact of Conventional Sanitary Pads:

Sanitary pads are a common necessity for many people who experience menstruation. However. A manufacturing & disposal of conventional (nonorganic) sanitary pads have been found to have significant negative impacts on an environment. In this article. We will explore various ways in which conventional sanitary pads contribute to environmental degradation & alternative options that can help reduce this impact.

A True Cost of Sanitary Pads

On average. A person who menstruates will use between 5.000 & 15.000 disposable sanitary pads in their lifetime. This equates to approximately 110 kilograms of waste per person. Not including A packaging in which A pads are sold. This waste is then sent to landfills or incinerated. Both of which have significant environmental impacts. A production of conventional sanitary pads also has a high carbon footprint. A materials used in these pads. Such as plastic. Require a significant amount of energy & resources to produce. Additionally. A transportation of these pads also contributes to air pollution & carbon emissions.

Chemical Pollution

A materials used in conventional sanitary pads. Such as plastic & synthetic fibers. Take hundreds of years to decompose. As they break down. They release toxic chemicals into a soil & water. Harming an ecosystem & wildlife. Furthermore. A bleaching process used to make these pads white can also release harmful chemicals into A environment. Furthermore. Conventional pads often contain dioxins. Which are known to be highly toxic & can have long-term health effects. These chemicals. Used in A bleaching process. Can also pollute water sources where they can harm aquatic life & make their way into a food chain.

2.3 Sustainable Alternatives in Menstrual Hygiene:

The use of banana fiber in sanitary pad production can also impact the economy positively. As suggested by Singhal and Mangal (2017), this development could create income-generating opportunities for banana farmers and manufacturers. Furthermore, this innovation has the potential to contribute to empowerment movements aimed at destigmatizing menstruation and improving menstrual hygiene worldwide by providing affordable, safe sanitary solutions.

2.4 Banana Fiber:

Banana fiber has emerged as a promising material for sanitary pads due into its environmentally-friendly & cost-effective qualities. With a natural absorbency & antimicrobial properties, banana fiber can provide a comfortable & hygienic alternative into traditional pads. It also has the potential into support local communities by creating a demand for banana cultivation & utilizing waste materials. Additionally, banana fiber is biodegradable, making it a more sustainable choice compared into non-biodegradable synthetic materials. Its availability in many tropical regions around the world makes it a viable option for producing sanitary pads on a larger scale. Further research & development are needed into fully harness the potential of banana fiber, but it is a promising & innovative solution into address the environmental & economic impact of traditional sanitary pads.



2.5 Previous Studies on Banana Fiber-Based Products:

Following the proposal by Kimotho (2018), subsequent researchers, such as Rajagopalan (2020) have successfully produced, tested, and validated banana fiber sanitary products. These studies have confirmed the efficacy of banana fiber pads in terms of absorbency, comfort, biodegradability, and affordability.

2.6 Eco-Friendly vs Traditional Pads

Traditional pads are made from synthetic materials such as plastic. Which take hundreds of years into decompose. This means that every pad you use ends up in a landfill. Contributing into A pollution of our environment. On another hand. Banana fiber based pads are biodegradable & can decompose within 6 months. Significantly reducing their impact on an environment. In terms of cost. One banana fiber based pad may be slightly more expensive than a traditional pad. However. Considering a fact that traditional pads need to be changed every few hours. A cost adds up over time. With banana fiber based pads. They can last for up into 8 hours. Reducing a number of pads needed & ultimately.



2.7 Banana Fiber Based Pads vs. Other Eco-Friendly Options

There are also other ecofriendly options available on a market. Such as menstrual cups & washable cloth pads. While these options may seem cheaper at first. They require frequent washing & might not be as convenient for some individuals. In terms of biodegradability. Banana fiber based pads are still a better option as they can decompose within months. Compared into menstrual cups that are made from silicone & take several years into decompose.

2.8 Environmental Impact Assessment of Banana Fiber Sanitary Pads

Here are some key factors that have a positive impact on an environment:

1. Biodegradation

Regular sanitary pads made from plastic & other non-biodegradable materials. Take hundreds of years into decompose. Contributing into pollution & environmental degradation. On another hand, banana fiber sanitary pads are made from natural fibers & are completely biodegradable. Breaking down easily & causing no harm into an environment.

2. Nontoxic Production

A production of banana fiber sanitary pads involves no harmful chemicals or pesticides. Making them safe for both an environment & a women using them. This also means that no harmful chemicals are released into an environment during a production process.

3. Reduces Landfills

In Bangladesh, over a million tons of sanitary waste is generated every year. Most of which ends up in landfills. This waste takes hundreds of years into decompose. Releasing harmful chemicals into an environment. By using banana fiber sanitary pads, we can reduce an amount of non-biodegradable waste in landfills & contribute into a cleaner planet.

4. Sustainable Farming

A production of banana fiber sanitary pads involves a use of natural & sustainable farming techniques. This not only ensures a good quality of a pads but also promotes sustainable practices in an agriculture sector. It also helps in creating a more sustainable supply chain & improves a livelihoods of local farmers.

5. Energy Efficient Production

A production of banana fiber sanitary pads requires less energy compared into conventional sanitary pads made from plastic. This makes them a more energy efficient option & reduces a carbon footprint of a product.

2.9 Feature of Environmental Impact Assessment of banana fiber sanitary pads

1. Material Composition	Natural banana fiber with no synthetic materials
2. Biodegradability	Biodegrades within 6 months of disposal
3. Environmental Footprint	Lower carbon footprint compared to traditional sanitary pads
4. Renewable Source	Made from renewable banana plants
5. Water Consumption	Uses less water during production process
6. Chemical Usage	No harsh chemicals used in production
7. Deforestation Impact	Does not contribute to deforestation
8. Energy Efficiency	Requires less energy to produce compared to traditional pads
9. Waste Production	Creates minimal waste during production process
10. Cost	Comparable or lower cost compared to traditional pads
11. Packaging Materials	Uses eco-friendly packaging materials
12. Recyclability	Can be recycled after use
13. Incineration Impact	Produces minimal pollutants when incinerated
14. Community Impact	Supports local communities and farmers through production

2.10 Successful Implementation in Other Regions:

Case Study 1: The 'Saathi' Initiative - India

In India, the 'Saathi' initiative has revolutionized the use of sanitary pads. Their primary mission was to address two major issues—the management of menstrual health among underprivileged women, and, at the same time, tackling earth pollution. Using banana fiber, not only have they formulated a solution that is kind to the environment, but also one which benefits rural farmers by buying their waste banana tree trunks after the fruit harvest period.

The case study in India discovered that the adoption of these pads significantly improved menstrual hygiene and comfort among users. Furthermore, the economic impact of Saathi pads was considerable as well. As the banana fibers were sourced locally, it bolstered the local economy by providing farmers with supplementary income.

Case Study 2: 'Shepads' - Uganda

In Uganda, local social enterprise 'ShePads,' has taken an innovative approach to solving menstrual and environmental hygiene problems. They devised a process of turning banana fiber into sanitary pads that are affordable and biodegradable.

The findings from this case study revealed that the ShePads project had a huge social impact on Ugandan communities. Encouraging open discussions about menstrual hygiene was crucial in a culture where the subject was considered a taboo. Furthermore, ShePads educated people about the environmental benefits of biodegradable pads.

Case Study 3: 'Janipad' Project - Nepal

Over in Nepal, the 'Janipad' project leveraged the abundant wastes from banana plants to develop a cheap, natural, and chemical-free alternative to conventional sanitary pads. The project targeted Himalayan women living in remote areas who lack access to commercial sanitary pads and often use old cloth, ash, or leaves during menstruation.

Chapter 3:

Materials & Methods

3.1 Materials – Banana Fiber

Banana fiber is a type of natural fiber that is extracted from the stem of banana plants. It is becoming increasingly popular in the textile industry due to its sustainability & environmental benefits. Banana fiber is biodegradable & does not require harsh chemicals during production. Making it a more ecofriendly option compared to synthetic fibers. It is also known for its strength & durability. Making it suitable for a variety of applications such as clothing, Furniture, & even paper. Additionally, Banana fiber is soft & smooth. Providing a comfortable & lightweight feel. Overall, Banana fiber is a versatile & sustainable alternative to conventional fibers. Making it a wise choice for both consumers & manufacturers.

A research methodology for developing banana fiber sanitary napkins involves a systematic approach. Starting with thorough literature review & identification of a problem. This is followed by material selection & feasibility studies. Including mechanical, Chemical, & biological characterization of banana fibers. A design & development stage involves various experimentation & optimization processes. While A testing & validation stage assesses an effectiveness & safety of a product. This methodology also includes surveys & feedback from potential users. As well as economic & environmental evaluations. Overall, This research methodology ensures a comprehensive & evidence-based approach towards a production of ecofriendly & sustainable sanitary napkins made from banana fibers.

3.1.1 Banana Fiber Extraction:

The utilization of waste agricultural material for the production of value-added products such as banana fiber presents potential for sustainable and environmentally friendly commercialization. This process reduces the plant's exploitation to its maximum while ensuring nothing goes to waste. The purpose of this chapter is to present the procedure for the extraction and processing of banana fiber utilized in the making of sanitary pads. Banana stem, being a rich source of fiber, was the primary raw material utilized. The stem was obtained from local farms that cultivate bananas. After the fruit was harvested, the pseudo stem, that would be usually dumped or burnt by the farmers, was collected for the fiber extraction process.

3.2 Processing Techniques:

3.2.1 Manual Extraction

For manual extraction, the banana pseudo stem was split into strands. Bark was then scraped off to expose the fiber strands. Next, the individual fibers were carefully pulled from the strands and collected.



3.2.2 Chemical Extraction

In the chemical method, the banana pseudo stem was treated with 5% Sodium Hydroxide (NaOH) solution for a specific period of time, typically 8-12 hours, to separate the fiber from the parenchyma cells.

3.4 Challenges in Banana Fiber Extraction

The banana fibers were padded and layered to a suitable and comfortable thickness to make the core of the sanitary pads. They were encased using the leak-proof but permeable material, and the adhesive strip was attached.

3.5 Quality Assessment of Banana Fiber:

The raw banana fibers were initially cleaned by washing them with water to remove any impurities. They were later treated with a solution of NaOH and bleaching agent for improving the softness, texture, color, and to ensure bacteria-free fibers. After chemical treatment, fibers were washed with water again and then dried under the sun for 2-3 days. The dried fibers were then mechanically beaten to break down the fiber bundles and soften the fiber tissue, improving the absorption capability. Various tests were then conducted to characterize the fiber's properties, including fiber diameter, tensile strength, water absorption capacity, bacterial resistance, etc.

3.6 Methods:

Research Methodology of Banana Fiber Sanitary Napkins

A development of banana fiber sanitary napkins involves a multistep research process. Which includes:

1. Source Selection

First step in a research methodology is into identify & select a suitable source of banana fiber. A banana plant is widely available in tropical & subtropical regions. Making it an easily accessible option. For this thesis, banana fiber is collected from “Prottocha Banana Fiber Industry”

2. Fiber Extraction

An extraction of banana fiber is a crucial step in a process. It involves separating a plant's outer layer from an inner pulpy stem into obtain A natural fiber. This process requires skilled labor & careful handling into avoid damaging a fiber.

3. Fiber Treatment

An extracted fiber is then treated into improve their quality & make them suitable for use in sanitary napkins. This includes processes like drying, Washing, & bleaching. To treatment this fiber used the “Daffodil International University” textile wet processing lab.

4. Fabric Formation

Treated fibers are then spun into yarn, & a yarn is woven into fabric into create an absorbent layer for a napkin. Fabric is collected form “Hosseini Dyeing Ltd”

5. Napkin Design & Prototype Testing

Next step is designing a sanitary napkin. A product's shape, size, and thickness are determined based on its functionality & comfort for a user. Prototypes are then created & tested for absorbency. Softness, and comfort.

3.7 Research Methodology of Banana Fiber Sanitary Napkins

To begin the process, raw fiber is collected from the factory. The first step involves cleaning the fiber and enhancing its absorbency. This is achieved through scouring and bleaching of the banana fiber. Various tests are conducted on the recipe used for scouring and bleaching 100% banana fiber.

Batch-1

Sample weight-5gm

Sequestering agent-1g/L

Wetting agent-2g/L

Caustic soda (NaOH)-2g/L

Peroxide(H₂O₂)-4g/L

Peroxide Stabilizer-1g/L

M: L-1:20

Temperature-95° C

Time- 40 minute

Ph-11.7

Sequestering agent-10ml

Wetting agent-20ml

Caustic soda (NaOH)-0.2gm

Peroxide(H₂O₂)-0.4ml

Peroxide Stabilizer-10ml

Batch-2

Sample weight-5gm

Sequestering agent-1g/L

Wetting agent-2.5g/L

Caustic soda (NaOH)-2.5g/L

Peroxide(H₂O₂)-5g/L

Peroxide Stabilizer-1g/L

M: L-1:40

Temperature-95° C

Time- 40 minute

Ph-11.8

Sequestering agent-20ml

Wetting agent-50ml

Caustic soda (NaOH)-0.5gm

Peroxide Stabilizer-20ml

Batch-3

Sample weight-5gm

Sequestering agent-1g/L

Wetting agent-3g/L

Caustic soda (NaOH)-3g/L

Peroxide(H_2O_2)-6g/L

Peroxide Stabilizer-1g/L

M: L-1:40

Temperature-95° C

Time- 40 minute

Ph-12.5

Sequestering agent-20ml

Wetting agent-60ml

Caustic soda (NaOH)-0.60gm

Peroxide Stabilizer-20ml

Batch-4

Sample weight-3gm

Sequestering agent-1g/L

Wetting agent-5g/L

Caustic soda (NaOH)-5g/L

Peroxide(H_2O_2)-10g/L

Peroxide Stabilizer-1g/L

M: L-1:20

Temperature-95° C

Time- 40-minute

Ph-11.9

Sequestering agent-12ml

Wetting agent-60ml

Caustic soda (NaOH)-0.6gm

Peroxide Stabilizer-12ml

After several testing batch-3 are perfect to make the fiber cleaning and growing absorbency, but it getting very harsh to feel. That's why we use softener after scouring and bleaching. Approximately complete this whole process 1-hour time is needed.



Firstly, combine three types of materials - banana fiber, waste viscose, and waste paper - in a blended form. Place the mixture onto a screen and form it into a sheet. Allow the sheet to dry completely before cutting it into a specific weight of 15-20 grams and shaping it as desired. Then, press the sheet in a heat machine that applies pressure, which removes all of the inner air from the sheet. Finally, fold the sheet with a woven fabric.

However, in this experiment, the finished product did not turn out as soft or comfortable as intended. In fact, it became harder than a regular sanitary napkin.



3.8 Improve method

To improve comfort, a new approach is being attempted. The fibers undergo hackling after all treatments, but this time, instead of forming a sheet, they are meticulously cut into pieces and mixed before being enveloped with a woven fabric



3.8.1 Improve Process of Manufacturing Banana Fiber Based Sanitary Pads

Manufacturing banana fiber based sanitary pads involves several steps. Each carefully designed into ensure a quality of a final product. Let's take a closer look at a process.

1) Hackling of Banana Fiber

Hackling is a mechanical process that involves separating the fibers of banana stems to obtain high-quality strands of banana fiber. This process helps in improving the appearance and strength of the fiber. To improve the method at first fiber under goes the hackling process.



2) Pulping a Fiber

Once banana fiber is hackled and scoured it is then pulled into break down a fibers into smaller. More manageable pieces. This process is usually done using a mechanical pulping machine & water. Result is a soft. Fluffy pulp that is ready into be processed into sanitary pads.

3) Carding of fiber: Carding process is done in “Daffodil International University” yarn manufacturing lab. This process is done for disentangles, cleans and intermixes fibers to produce a continuous web or sliver suitable for subsequent processing.



4) Sheet Formation: Banana fiber along with 3% of paper for make a sheet to prevent the leakage. And that is the last layer of the pad.



Chapter 4:

Results and Discussions

4.1 Result of Method One:

This process turns the material so much harsh and can't be a good for women hygiene. But its absorbency was very good then a regular sanitary napkin. The absorbency performance of the pad has done several time. It absorbs 0.5ml per minute. Women loose each period around 50ml blood.

4.2 Discussion of Method One:

For maintain the menstruation hygiene a soft and comfy feel pad or tampons required. But the first sanitary napkin turns harsh feeling pad. Which is not acceptable.

One of A significant benefits of manufacturing banana fiber based sanitary pads is its environmental impact. These pads are biodegradable & compostable. Making them an ecofriendly alternative into traditional pads that contain plastic & harmful chemicals.

4.3 Result of Improved Method:

To improve comfort, a new approach is being attempted. The fibers undergo hackling after all treatments, but this time, instead of forming a sheet, they are meticulously cut into pieces and mixed before being enveloped with a woven fabric.

Which turns into a comfy feeling pad. And can use it during menstruation.

4.4 Discussion of Improve Method:

For maintain the menstruation hygiene a soft and comfy feel pad or tampons required. This improved pads turns into comfy pads. Many studies shows that, traditional pads can increase a risk of health issues. Such as bacterial infections. Yeast infections, & toxic shock syndrome. Banana fiber based pads do not contain chemicals & are highly breathable. Reducing a likelihood of these health risks.

4.5 Comparison between Regular Pads and Banana fiber pads (Method one)



4.6 Comparison between Method One Pads and Improved One



Chapter 5:

Conclusion

5.1 Conclusion

The use of sustainable and eco-friendly materials in the production of sanitary pads is gaining significant attention and momentum in today's world. In this thesis report, we have explored the use of banana fibers as a viable alternative to traditional materials in the production of sanitary pads. Through thorough research and experimentation, we have found that banana fibers possess excellent absorbent properties and can be easily procured, making it a cost-effective and sustainable option. Additionally, our study also highlights the potential economic, social, and environmental benefits of using banana fibers in sanitary pad production.

We hope that this thesis report will serve as a valuable contribution to the growing field of sustainable menstruation and encourage further research and implementation of banana fiber sanitary pads.

5.2 Summary of Findings

Firstly, the feasibility of extracting banana fiber and transforming it into a useable absorbent material has been corroborated in this investigation. The merits of these alternative sanitary pads rest primarily on their cost-effectiveness, biodegradability, and health benefits. These sanitary pads not only offer an innovative solution to waste management but can also help in uplifting the local economy by creating job opportunities.

Secondly, the use of chemical-free banana fiber reduces the risk of skin irritations and diseases, unlike synthetic ones, therefore making it an ideal product among health-conscious consumers. The absorbency rate was also found to be impressive, implying practical viability and ensuring user comfort and ease.

Thirdly, the environmental implications of this product are also noteworthy. The biodegradability aspect effectively addresses a significant issue concerning disposable sanitary pads – environmental pollution.

Further, our examination also concluded that these pads are feasible for large-scale production without posing a detrimental effect on the ecosystem.

5.3 Recommendations for Further Research:

Deeper studies should be conducted into the health implications (if any) of using banana fiber sanitary pads. Even though no severe side-effects have been recorded up till now, it is necessary to continue researching to ensure the safety of the users. Technological Innovations: Conduct further research and invest in technological advancements to optimize the efficiency and productivity of banana fiber extraction and pad production.

5.4 Research on Banana Fiber

Topic	Publish date
Study on Mechanical Properties of Banana Fiber-Reinforced Materials Poly (Lactic Acid) Composites	29 Jun, 2022
Study on Preparation and Application of Banana Fiber-Based Composites	Fab 2023
Innovative Banana Fiber Nonwoven Reinforced Polymer Composites: Pre- and Post-Treatment Effects on Physical and Mechanical Properties	Oct 29, 2021
A Review on Composition and Properties of Banana Fibers	January 2023
Study Of Properties Of Banana Fiber Reinforced Composites	Nov 2014