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Sustainable Textile Fiber Extraction from Drumstick Husk Through Water Retting Technique

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ABSTRACT

The growth and development of the textile industry have driven multiple transformations and the use of synthetic fibers increased exponentially. This proved to be a major cause of landfills and pollution. While natural fibers are an alternative to synthetic fibers that provide sustainability without impairing the environment, the availability of natural resources are dependent on the agricultural yield, requiring specific amount of time and proper climatic conditions. This study has found a way to utilize the agricultural waste from Drumstick Tree farms and local markets to extract a natural textile fiber by administering the Water Retting Technique. The treated fibers are spun and woven into fabric by blending and undergone various mechanical and physical tests, and flammability test. By choosing sustainable and ethical methods, a novel textile fiber is found without chemical hazards. The obtained fibers are spun and woven into yarn and fabric respectively. The fabric is reckoned to be suitable for upholstery works, home furnishings, agro-textile, etc. A new solution for producing natural fibers have been found without using any hazardous chemicals which also proves to be an efficient and cost-effective alternative for the limited availability of natural resources in the textile industry.

Key Words: Moringa, Drumstick, Fiber, Extraction, Textile, Retting.

INTRODUCTION

This study is about the extraction of novel fiber from Drumstick Tree Husk for textile applications. The fiber is obtained through sustainable methods such as collection of drumstick husks from agricultural waste and extraction of fiber through Water Retting Technique. Drumstick or *Moringa oleifera* Lam is a tree which belongs to the Moringaceae family. It is native to tropical regions of South Asia. India is the largest producer of drumstick with an annual production of about 1.3 million tonnes. The agricultural waste generated from the agricultural sector is substantial and is used in this study to create a novel textile fiber for the textile industry. This is done in order to address the issues related to the availability of natural resources being dependent on agricultural yield, requiring a specific amount of time and proper climatic conditions, providing Sustainability without impairing the environment. This study aims to extract a natural textile fiber from the agricultural waste of Drumstick Tree husk through Water Retting Technique, supporting sustainable and eco-friendly practices in research.

METHODOLOGY

The collection of drumstick husk, involved sourcing drumstick tree husk such as stem and bark from local farms and markets. Only husks that met the criteria for fiber-rich content were selected to ensure higher yields. The husks were sorted based on size, texture, and moisture content. Proper storage methods, including controlled temperature and humidity, were implemented to prevent decay before processing.

Implementing water retting technique

Once collected, the drumstick husks underwent manual pulp removal to separate the fibrous portions. This was done using a combination of hand peeling and mild water washing to ensure minimal fiber damage. The separated husks were

then inspected for residual pulp and further cleaned if required. Retting is a crucial step in the extraction process. The husks were submerged in large water tanks at a controlled temperature of 26-28°C. Natural microbial action facilitated the softening of husk tissues, allowing fiber separation. The retting period was monitored daily to prevent over-retting, which could weaken the fibers. The pectin was separated from the fibers after 8-10 days of the process and formed a gel like layer at the top. Then the pulp was dissolved, and the plant matrix got loosened form the fiber. The process took 12-14 days for completion and the fibers were taken out from the water tanks after retting process. Post-retting, the husks were thoroughly washed using clean, running water. Washing helped remove residual plant matter, loosened pectin, and any remaining gummy substances. The process was repeated multiple times to ensure maximum cleanliness and only minimal water required were used to prevent excessive water usage. Special attention was given to water quality and flow rate to avoid fiber breakage. The cleaned fibers were sun-dried during daytime to obstruct bacterial activities and kept at room temperature during night time respectively. Drying conditions were optimized to ensure consistent moisture evaporation while retaining fiber flexibility. Fibers were spread evenly under direct sunlight for 6-8 hours daily, and periodic flipping was done to ensure uniform drying.

Further processing

The dried fibers were separated using wooden mallets, then the fibers were aligned, combed and cut into smaller pieces for blending process. The cut fibers were sent to spinning and weaving process. The Drumstick fibers were bended with cotton fibers in the ratio of 3:7. The twisted yarn was fixed as weft and bamboo yarn was fixed as warp for weaving. Bamboo yarn was used as it has similar bast fiber properties as Drumstick fibers for better results. Testing has been done at yarn stage and fabric stage. Some mechanical and physical tests were applied and the characteristics and properties of the yarn and fabric were studied.

Methods and approaches

This study adopts material science research approach, integrating experimental procedures with predictive and statistical analysis to explore the extraction and characterization of textile fibers from drumstick husk. The research focuses on optimizing extraction methods, analyzing fiber properties, and predicting its potential in textile applications.

RESULTS AND DISCUSSION

The extraction of fiber from the drumstick tree stalk was conducted using a sustainable water retting technique. The stalks were submerged in water for approximately 12-14 days, allowing natural bacterial activity to break down the pectin and gummy substances binding the fibers. Observations during the retting process revealed that pectin separation began around the 8th to 9th day, forming a gel-like layer on the water surface. By the 12th to 14th day, the plant matrix had fully separated from the fibers, indicating the completion of retting. The extracted fibers were then manually separated from the stalks through beating and stripping. Following separation, the fibers were washed in clean running water for several days to remove any residual materials. They were then air-dried for optimal preservation of fiber quality.

Fiber properties and challenges

The natural water retting process produced coarse fibers that required additional processing to be suitable for textile applications.

Fig - 1: Retted drumstick fibers

While this process maintained its eco-friendly nature, the rough texture of the fibers necessitated blending with cotton to enhance the softness and spinnability. Although chemical treatments could potentially improve fiber softness, they would compromise the sustainability aspect of the project. Thus, further research is necessary to optimize fiber refinement through mechanical processing. **Spinning and weaving**

After fiber bundling, the extracted fibers were blended with cotton and spun into yarn. The blending process helped mitigate the rigidity of the drumstick tree fiber, thereby improving its usability.

Fig – 2: Spun drumstick yarn

The spun yarn was then woven into a fabric, with drumstick-cotton yarn used in the weft direction and bamboo yarn in the warp direction.

Fig – 3: woven drumstick fabric

The resulting fabric exhibited good flexibility and structural integrity. However, it was observed that the woven fabric displayed slight irregularities due to variations in fiber thickness, indicating a need for further fiber refinement before large-scale textile production. The obtained fabric can be made into apparel, upholstery or technical textiles with minimal modifications.

Physical and mechanical testing

To evaluate the suitability of the fiber for textile applications, several physical and mechanical tests were conducted, including the twist test, yarn count, thickness test, abrasion resistance test, tensile strength test, burn test, shrinkage test, seam properties test, and SEM analysis. The results demonstrated that the blended yarn exhibited moderate tensile strength and durability, while the fabric displayed acceptable abrasion resistance and shrinkage characteristics. SEM analysis provided insights into the fiber's surface morphology, revealing rough textures and irregular fiber alignment, further reinforcing the need for refinement. Despite these challenges, the successful integration of drumstick tree fiber into fabric highlights its potential as a sustainable textile alternative.

Sustainability and ethical considerations

Sustainability remained a key aspect of this study, with all raw materials sourced from agricultural waste, minimizing the environmental impact. The extraction and processing methods were designed to avoid chemical treatments, ensuring that the fiber remained eco-friendly. Additionally, ethical research practices were maintained throughout the project, adhering to responsible material sourcing and minimizing waste generation. This aligns with global sustainability efforts in the textile industry, advocating for greener alternatives to synthetic fibers.

CONCLUSION

This study successfully explored the extraction of textile fiber from the drumstick tree stalk using a sustainable water retting technique. The primary objective was to develop an eco-friendly fiber extraction method that eliminates the need for chemical treatments, contributing to sustainable textile production. Through a series of mechanical processing steps, including retting, defibering, spinning, and weaving, a blended yarn was produced and integrated into woven fabric. The findings revealed that drumstick tree fiber has significant potential as a sustainable textile material. Although the fibers were initially coarse, blending with cotton improved their spinnability, enabling fabric formation. Physical and mechanical testing demonstrated moderate strength, flexibility and durability, supporting its viability as a textile fiber. Additionally, the project aligned with ethical research practices by utilizing agricultural waste as raw material, implementing a chemical-free extraction process, and promoting waste management. The significance of this research lies in its contribution to the development of natural fiber alternatives, supporting the global shift toward sustainable textiles. By reducing dependency on synthetic fibers, this study provides an avenue for eco-friendly textile production. Moreover, the successful extraction of fiber from agricultural waste highlights its role in circular economy practices, promoting resource efficiency in the textile sector. Future research should focus on refining processing techniques to improve fiber softness and consistency. Exploring enzyme-based retting methods could enhance fiber quality while maintaining sustainability. Additionally, optimizing fiber blends with other natural fibers may further enhance mechanical properties. Scaling up production and investigating commercial applications will be essential for integrating drumstick tree fiber into mainstream textile manufacturing.

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