

The Role of Sisal and Pine Wood Pulp in Eco-Friendly Hygiene Products

J. Archana¹; V. Gowin²; R. Harinistwetha³ (B. Tech Scholars); S. Chandrakumar⁴

Assistant Professor (Sr.G), Department of Fashion Technology,
Kumaraguru College of Technology, Coimbatore 641049.

Publication Date: 2025/03/08

Abstract: Greater consciousness of environmental sustainability and the need for biodegradable substitutes of conventional hygiene items have driven research into natural fibres for sanitary products. This research describes the design and production of panty liners composed of sisal fibres and pine wood pulp to present a non-polluting, high absorbent, and skin-safe substitute for man-made products. Sisal fibres, which possess high tensile strength and antimicrobial action, are combined in a blend with soft and absorbent pine wood pulp for enhanced comfort and performance. While retention of moisture, breathability, and structural integrity strength were tested on prototype panty liners, findings show that an aimed mixture of sisal and pine wood pulp provides the silky texture that offers maximum absorbency of ultimate comfort. Furthermore, biodegradable studies verify that these materials dissolve much more quickly compared to traditional materials based on plastic, lowering their environmental impact.

Keywords: Biodegradable Panty Liners, Sisal fibres, Pine Wood Pulp, Sustainable Hygiene Products, Menstrual Care, Eco-Friendly Alternatives.

How to Cite: J. Archana; V. Gowin; R. Harinistwetha; S. Chandrakumar. (2025). The Role of Sisal and Pine Wood Pulp in Eco-Friendly Hygiene Products. *International Journal of Innovative Science and Research Technology*, 10(2), 1742-1749.
<https://doi.org/10.5281/zenodo.14979420>

I. INTRODUCTION

Growing environmental concerns related to disposable hygiene products have created greater demand for sustainable and biodegradable alternatives. Traditional panty liners are largely composed of synthetic fibers, superabsorbent polymers, and plastic-based materials, which form the major portion of non-biodegradable waste and environmental contamination. They take centuries to break down, making them a serious ecological hazard. In addition, some chemical additives in synthetic hygiene products tend to irritate the skin and trigger allergic reactions, further making natural alternatives inevitable. Sisal fibres possess high tensile strength, natural absorbency, and antimicrobial activity, which make them a potential ingredient for hygiene products. Pine wood pulp, conversely, is a soft, breathable, and biodegradable material that is used to add comfort and enhance absorption efficiency. Through the incorporation of these natural fibers, the goal is to create a high-performance panty liner that has less environmental impact but still provides user comfort and safety.

The study emphasizes material selection, product design, absorbency testing, biodegradability analysis, and dermatological safety tests. This research will, through laboratory experiments and testing on prototypes, prove the viability of sisal and pine wood pulp in eco-friendly feminine hygiene products.

This paper sheds light on the design, production, and performance testing of such biodegradable panty liners, overcoming limitations like cost-effectiveness, scalability, and acceptability. The results help pave the way for a greener and more sustainable future in the field of personal care products.

II. KEY DIFFERENCES BETWEEN NATURAL AND SYNTHETIC PANTY LINERS

Natural panty liners offer sustainability, comfort, and skin safety, making them an eco-friendly alternative to synthetic liners. While synthetic liners are widely available and often cheaper, their plastic content, chemical additives, and environmental impact raise concerns.

Table 1 Natural Vs Synthetic Panty Liners

Feature	Natural Panty Liners	Synthetic Panty Liners
Material	Made from biodegradable fibres like sisal, pine wood pulp, organic cotton and bamboo	Made from synthetic fibres like plastic films and superabsorbent polymers and the chemicals.
Biodegradability	Eco-Friendly and decompose within the months	Non-bio-degradable and decomposes takes hundreds of years to breakdown
Absorbency	High absorbency due to its structure	Uses chemical based superabsorbent in high liquid retention
Anti-microbial properties	Natural fibres like sisal have antimicrobial properties, reducing bacterial growth	May promote bacterial growth due to non-breathable layers
Environmental impact	Sustainable, compostable and low carbon footprint	High environmental impact due to plastic and chemical waste

A. Overview of Sisal Fiber

Agave family. It is among the most extensively grown natural fibres because of its strength, toughness versatility.

➤ Sisal Fiber

Sisal (*Agave sisalana*) is a stiff, natural fibre obtained from the leaves of the sisal plant, which is a member of the



Fig 1 Sisal Plant

B. Applications of Sisal Fibre

➤ Application in Sanitary Napkins and Panty Liners

Sisal fibers, when blended with pine wood pulp, organic cotton, or bamboo, can be utilized in the absorbent core of panty liners and sanitary pads. The advantages are:

- Superior Moisture Retention – Equivalent to synthetic absorbents.
- Eco-Friendliness – Completely biodegradable, as opposed to plastic-based pads.
- Odor Control & Comfort – Antimicrobial properties inhibit bacterial growth, avoiding infections.
- Sisal fibres are applicable in disposable wet wipes, baby wipes, and facial tissues because of their
- Softness & Durability – Ideal for cosmetic and personal use.
- Chemical-Free Cleaning – Suitable for sensitive skin and baby use.
- Sustainability – Offers a plastic-free option to traditional wipes.

C. Advantages of Sisal Fibre in Hygiene Products

➤ Biodegradability

- Eco-Friendly: Sisal is a biodegradable, natural fibre that disintegrates quickly, as opposed to man-made fibres such as plastic or petrochemical-based fibres, which may take centuries to degrade.
- Effective moisture retention: Sisal fibres possess good moisture-absorbing properties, which is vital for ensuring dryness and avoiding leakage in products such as sanitary pads and panty liners.

III. OVERVIEW OF PINE WOOD PULP

➤ Pine Wood Pulp

Pine wood pulp is a cellulose fibre obtained from pine wood, mainly from softwood pine species like *Pinus radiata* and *Pinus sylvestris*. Pine wood pulp is one of the most common pulping raw materials used in paper and pulp manufacturing, characterized by high-quality cellulose

content and versatility. In addition to paper production, pine wood pulp has been used in other biodegradable products

such as hygiene products like sanitary napkins, panty liners, and diapers.



Fig 2 Pinewood

➤ *Applications of Pine Wood Pulp in Hygiene Product*

Pine wood pulp, which is rich in cellulose, absorbent, and biodegradable, is a very good material for the manufacture of different hygiene products. Its natural characteristics help in the development of more sustainable, environmentally friendly products compared to synthetic materials employed in sanitary products, diapers, and other personal care products. Some of the major applications of pine wood pulp in hygiene products are discussed below.

A. Adult Incontinence Products

➤ *Absorbent Materials for Incontinence Pads*

- Pine wood pulp is utilized in adult incontinence items, including pads and briefs, to supply absorbent cores for urinary incontinence management.
- The Odor-locking functionality of pine wood pulp assists in retaining dryness and Odor prevention, such as used in baby diapers and sanitary pads.

B. Medical and Surgical Products

➤ *Wound Dressings & Absorbent Pads*

- Pine wood pulp may be used in the production of absorbent medical dressings or pads, where softness and high absorbency are paramount.
- Hydrophilic Properties: Pine wood pulp may be treated to make it more water-attracting, thus making it suitable for application in absorbent medical uses.

C. Advantages of Pine Wood Pulp

➤ *Biodegradability and Sustainability*

- Environmentally friendly: Pine wood pulp is derived from renewable resources, making it a biodegradable alternative to synthetic fibres. Unlike synthetic materials, which can take decades to decompose, pine wood pulp breaks down naturally in a relatively short time, reducing the environmental impact of disposable hygiene product.
- Effective moisture retention: Pine wood pulp is very effective in absorbing, which makes it a good candidate for sanitary pads, panty liners, diapers, and incontinence products. It provides comfort and dryness by absorbing and holding water in its form.

IV. PHYSICAL PROPERTIES OF SISAL AND WOOD PINE

A. Sisal Fibre

➤ *Fiber Structure*

- Length: sisal fibres have lengths ranging from 0.6 to 1.2 meters (2 to 4 feet).
- Diameter: the fibre is 50 to 300 microns thick, depending on processing conditions.
- Cellular structure: sisal consists of empty, tube-shaped cellulose cells, which make it light in weight and highly absorbent.

➤ *Tensile Strength*

- High Strength: Sisal fibres contain a tensile strength of 500–700 MPa, one of the highest natural fibre strengths.
- Durability: This strength makes sisal very durable against wear and tear, perfect for applications needing toughness.

➤ *Moisture Absorption (Hygroscopicity)*

- High Absorbency: Sisal absorbs between 10-22% of its weight in water.
- Breathability: The fibre provides airflow, hence comfortable for products such as panty liners and sanitary pads.

➤ *Density*

- Specific density: Approximately 1.3–1.5 g/cm³, thus a fairly light fibre as opposed to man-made fibres.

B. Pine Wood Pulp➤ *Fiber Structure*

- Fiber length: Pine wood pulp is made up of long fibres (2–5 mm), thus stronger than hardwood pulp.
- Fiber diameter: Between 30–50 microns.
- Cellulose content: High cellulose content (approximately 40–50%), adding to durability and strength.
- Porosity: Very porous structure, enabling effective absorption of liquids.

➤ *Absorbency and Moisture Retention*

- High absorbency: Pine wood pulp has the ability to absorb multiple times its own weight in liquid, making it suitable for hygienic applications such as diapers, sanitary pads, and incontinence items.

➤ *Density*

- Bulk density: Varies from 0.3 to 0.5 g/cm³, making it a relatively light material.
- Compatibility: Is compressible for high-density uses, such as absorbent cores in sanitary products.

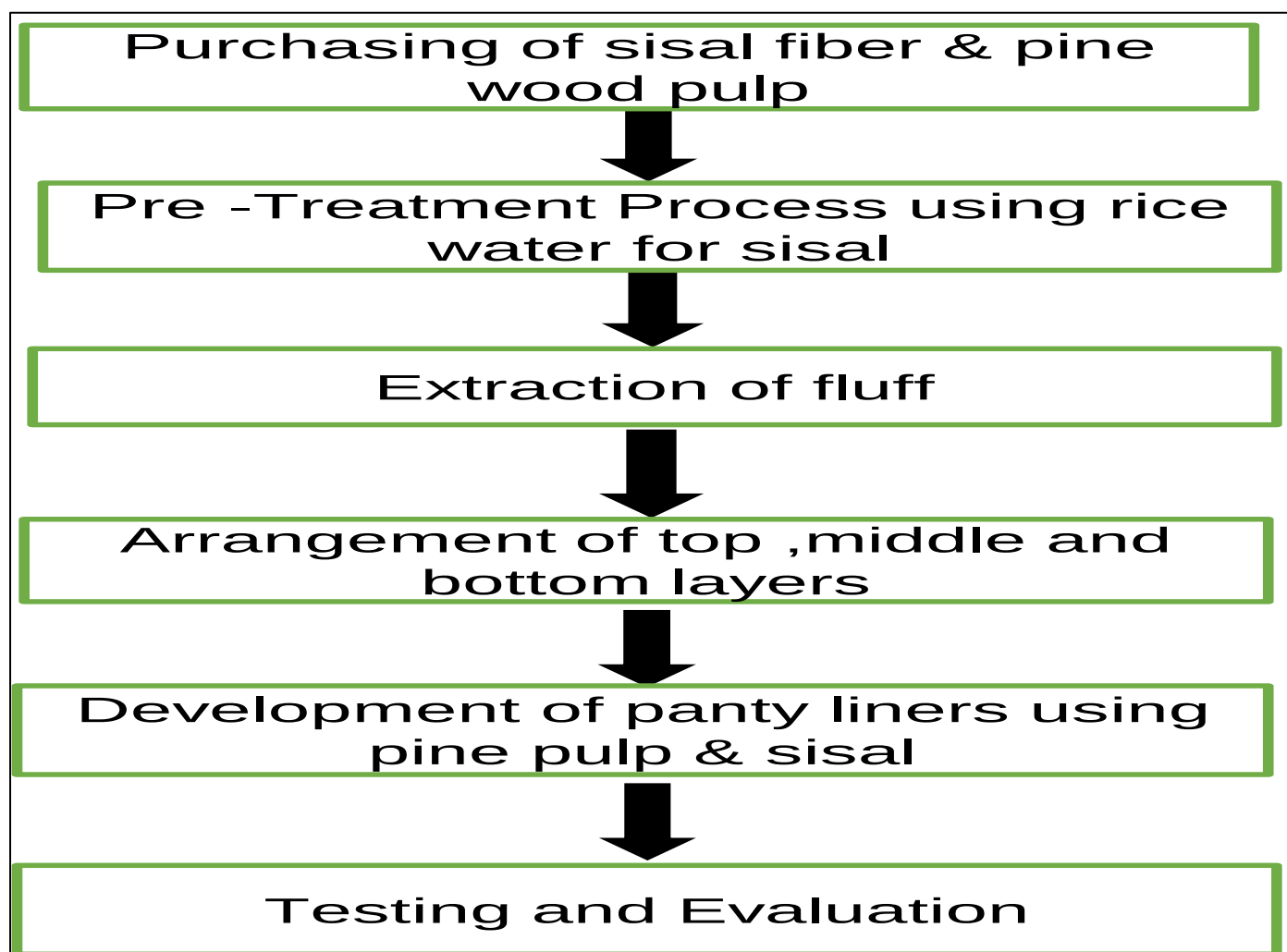
V. METHODOLOGY

Fig 3 Methodology

➤ *Sisal Treatment Process*

- Extraction of Sisal

- ✓ The process of decortication strips away the outer cover of the leaves, leaving only raw fibers behind.
- ✓ The raw fibers are cleansed with clear water to erase dirt and residual unwanted material.

➤ *Rice Water Treatment*

- Preparation: Rice water which is collected is left to ferment for 12–24 hours in order to maximize its softening ability inherent in it.
- *Soaking Process*

- Clean sisal fibres are immersed into fermented rice water for 6–12 hours.
- The nutrients and starch enter the fibre structure, enhancing softness and tensile strength.

➤ *Drying and Grinding*

- we remove the treated sisal fibres from rice water and dry them in sunlight in a regulated environment and beaten up to separate the lignin content.
- subsequently, grind the fibre so that it transforms into fluff pulp and employ for layers.



Fig 4 Before Treatment



Fig 5 After Treatment

➤ *Treatment Process of Pine Wood Pulp Wood Preparation*

- Pulp Wood Preparation
- ✓ Collection: Pine wood is cut and taken to the processing plant.
- ✓ Debarking: The outside bark is peeled off to maintain clean wood fibres.
- ✓ Chipping: The wood is chopped into tiny chips (about 1–5 cm) for easy pulping.

➤ *Mechanical Pulping (For Soft, Unbleached Pulp)*

- The wood chips are reduced in size by using revolving stones or refiners.
- The process maintains most of the fibre structure, which is highly absorbent.

➤ *Drying & Sheet Formation*

- The processed pulp is fluffed and dried into absorbent sheets of thin nature. Subsequently, the sheet is ground and crushed to produce fluff.



Fig 6 Processed Sheets



Fig 7 Pinewood Pulp

➤ *Manufacturing of Panty Liner*

The panty liner is made up of various layers, each with its own purpose:

- Top Layer (Skin Contact Layer) – Soft, breathable material (cotton, bamboo, or non-woven biodegradable material).
- Absorbent Core – Sisal fiber and pine wood pulp blend, offering moisture retention and Odor control.
- Bottom Layer (Leak-Proof Film) – Biodegradable water-proof barrier to avoid leakage.
- Adhesive Layer – Utilizes biodegradable glue for firm attachment to underwear.

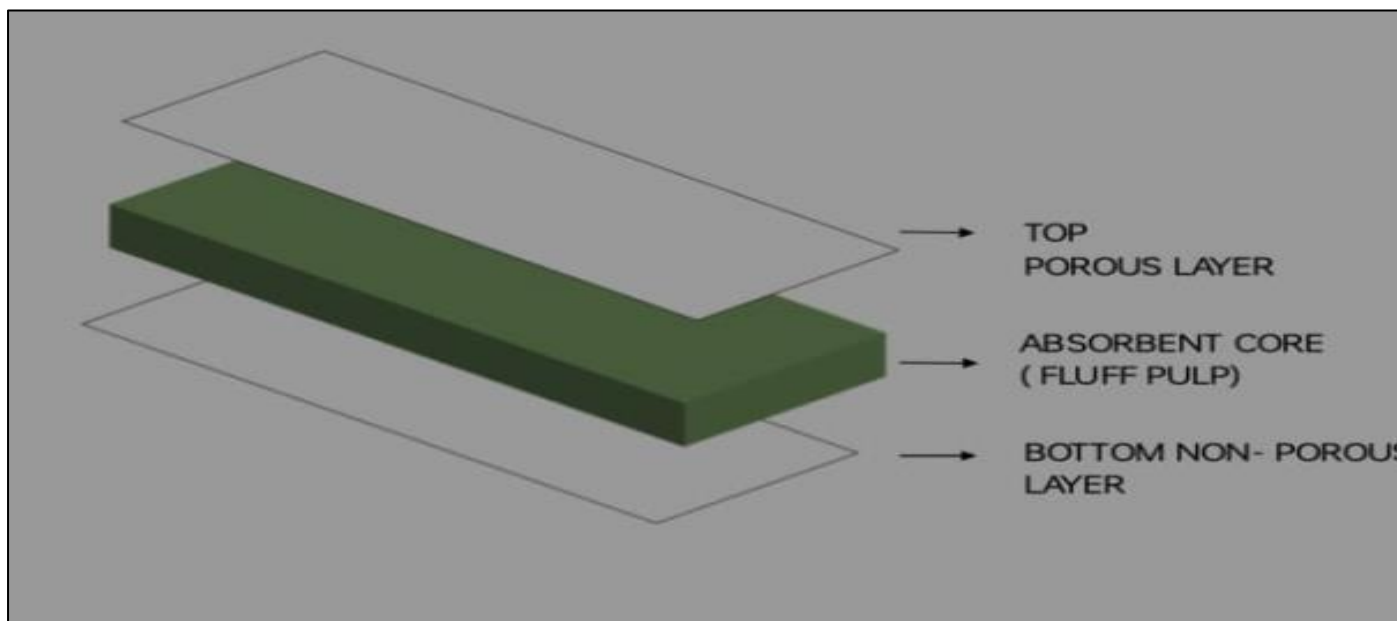


Fig 8 Fabrication

➤ Testing Process

The testing process for the sample includes assessing two major properties: pressure resistance and total absorbent capacity.

➤ Ability to Withstand Pressure

- The sample is tested with 30 mL of bromocresol solution.
- During the first minute, the pulp sucks up 6 mL of the solution.
- During a total time of 5 minutes, the whole 30 mL of the liquid is sucked up, thus reflecting its ability to withstand pressure over time.

➤ Total Absorbent Capacity

- The test is done with bromocresol purple solution to find out the maximum liquid holding capacity before leakage.
- The pulp keeps on absorbing the solution up to 41 mL, after which the liquid starts leaking.
- so it indicates that, it can absorb 40 ml.

Suitability for hygiene products- The sample shows good absorbency, which makes it suitable for napkin application. Its liquid absorbency under pressure guarantees effective moisture retention, avoiding surface wetness.

VI. CONCLUSION

The production of sustainable, biodegradable, and skin-friendly eco-friendly panty liners made from sisal fibre and pine wood pulp is a viable alternative to traditional synthetic liners. Sisal's natural absorbency and durability couple with the softness and moisture retention of pine wood pulp to provide maximum comfort and hygiene.

This process not only aids in protecting the environment by minimizing plastic use but also healthier menstrual hygiene using chemical-free, hypoallergenic materials. By

precise selection of materials, processing, and quality control testing, these panty liners achieve high performance, comfort, and sustainability.

Adopting these innovative, biodegradable sanitary products is part of a green future, embracing the use of natural fibres in personal hygiene while reducing its impact on the environment.

REFERENCES

- [1]. Desh Maruthi Jeyakanthan, Jens Schuster and Yousuf Pasha Shaik Department of Applied Logistics and Polymer Sciences, University of Applied Sciences Kaiserslautern, Institute for Plastics Engineering West Pfalz (IKW), Pirmasens, Germany(2023) "Development of Ecological Absorbent Core Sanitary Pads in Combination of Kenaf and Chitosan Fibers" DOI:10.4236/msa.2023.147023
- [2]. Anna Maria van Eijk ,Naduni Jayasinghe,Garazi Zulaika,Linda Mason,Muthusamy Sivakami,Holger W. Unger,Penelope A. Phillips-Howard" Exploring menstrual products: A systematic review and meta-analysis of reusable menstrual pads for public health internationally" September 24, 2021 DOI: 10.1371/journal.pone.0257610
- [3]. Mounika K. , Dr. K. B. Ilango, Baranitharan A. K. , Dhivyatharshini S. , Gowtham K. , Swetha V. , Vijaykumar S" Biodegradable Sanitary Napkins-An Innovative Approach Towards Menstrual Hygiene Using Bamboo Fiber And Lemon Grass" Int. J. in Pharm. Sci., 2023, Vol 1, Issue 11, 135-139 Vol 1, Issue 11, 135-139 DOI: 10.5281/zenodo.10078084.
- [4]. Vaishnavi RM, Amit VK and Shaikh MRN "Exploring Eco-Friendly Alternative: A Review of Natural Fibre Applications in Sanitary Napkins" Volume 6 Issue 2 2024 Pharmaceutical Sciences & Analytical Research Journal ISSN: 2640-6659

- [5]. Mazharul Islam Kiron ” Properties, Functions, Structure, Raw Materials and Manufacturing of Sanitary Pads” 2012
- [6]. Mazharul Islam Kiron “Properties, Functions, Structure, Raw Materials and Manufacturing of Sanitary Pads”2012
- [7]. Neha Barari Poonam Thakur and Komal Sharma “Bio-Degradable and Reusable Sanitary Napkins: A Green Remedy for Period Care” Volume 8, Issue 8, August DOI:10.5281/zenodo.8296503
- [8]. M. Mahalakshmia V. Maheshwari “Improvements to Eco-Friendly Sanitary Napkins made from Natural Fibres: Development and Characterization” Volume: 21, No: S1 (2024), pp. 1053-1059
- [9]. B. Keethana Priya ,Dr.V.Kavitha “Developement Of Herbal Sanitary Napkin With Herbal Finish” Vol-9 Issue-2 2023 Ijariie-Issn(O)-2395-4396
- [10]. Sabrina Sareen “Sustainable menstrual alternatives: The journey so far” International Journal of Home Science 2021; 7(3): 216-219
- [11]. Jamie Hand Christina Hwang Wren Vogel Christina Lopez Sangchul Hwang”An exploration of market organic sanitary products for improving menstrual health and environmental impact” journal of water sanitation and hygiene department volume 13, Issue 2
- [12]. Desh Maruthi Jeyakanthan, Jens Schuster, Yousuf Pasha Shaik “Development of Ecological Absorbent Core Sanitary Pads in Combination of Kenaf and Chitosan Fibers”doi: 10.4236/msa.2023.147023