

Characterization of Blended Sugar Palm and Areca Leaf Sheath Fiber as Alternative Textile Material

ENELYN F. PADROGADO

Capiz State University- Main Campus, Roxas City, Philippines

Abstract: Blending natural fibers combines their desirable qualities to create high performance textile materials while making good use of locally available agricultural waste. This approach reduces environmental strain and supports local economies by turning underutilized resources into valuable, eco-friendly products. This study evaluated the suitability of blended sugar palm and areca leaf sheath fibers as alternative textile materials. Sugar palm fibers offer great strength, while areca leaf sheath fibers provide good flexibility, combining them brings together the best qualities of both. The research used an experimental-developmental design and tested mechanical properties such as breaking elongation and tensile strength, chemical properties including rate of burning, water absorption and wash resistance, as well as user acceptance in terms of hand feel, irregularity of ribs, color shade and presence of plugs. Results showed that the blend has very elastic elongation and durable tensile strength, burns at a moderate rate, absorbs moisture well and keeps its quality after repeated washing. Evaluators rated the material as “Very Acceptable” overall, confirming that it meets practical and aesthetic standards. Using these natural fibers makes good use of agricultural by-products, supports environmental protection and offers economic opportunities for local communities. Future work may explore different mixing proportions, fiber treatments and production methods to further improve performance and expand possible uses. Based on the results, the study concluded that blended sugar palm and areca leaf sheath fibers meet the required quality standards and have good market potential. They serve as a sustainable material suitable for various textile applications.

Keywords: *Sugar Palm fiber, Areca leaf sheath fiber, blended textile, sustainable material, eco-friendly products.*

I. INTRODUCTION

Background of the Study

In recent years, the textile industry has moved toward sustainable and eco-friendly materials due to growing environmental concerns. Natural fibers from agricultural waste, such as sugar palm and areca leaf sheath, have emerged as viable alternatives because they are abundant, low-cost, and biodegradable. Sugar palm fiber is strong and durable but tends to be stiff and coarse, while areca leaf sheath fiber is lightweight, soft, and flexible but has lower tensile strength. Blending these two fibers offers a way to combine their strengths and overcome individual limitations, producing a material with balanced performance.

While fiber blending is a proven method to enhance textile properties, research specifically on sugar palm and areca leaf sheath combinations remains limited. Utilizing these locally available residues also helps reduce waste, supports environmental protection, and creates economic opportunities for communities.

The researcher intends to blend sugar palm and areca leaf sheath fibers to develop a functional textile material. This study aims to characterize the material’s mechanical and physical properties, and evaluate its acceptability based on sensory attributes producing a sustainable, affordable product while promoting the use of local resources.

This study aimed to characterize blended Sugar Palm (*Arenga pinnata*) and Areca leaf sheath (*Areca catechu*) fibers as alternative textile material. Specifically, it aimed to:

1. determine the mechanical properties of blended Sugar Palm and Areca leaf sheath fibers in terms of breaking elongation and tensile strength;
2. determine the chemical properties of blended Sugar Palm and Areca leaf sheath textile in terms of rate of burning, water absorption, and washability; and,
3. determine the level of acceptability of blended Sugar Palm and Areca leaf sheath textile in terms of hand feel, irregularity of ribs, color shade, and presence of plugs.

II. METHODOLOGY

Methods of Research

This study employed both experimental and developmental research methods to characterize blended Sugar Palm and Areca leaf sheath fibers as a sustainable textile material. Developmental research served as a systematic

approach for designing, creating, and assessing products to ensure they meet consistency and effectiveness standards (Laing et al., 2016). The focus was to formulate and refine the fiber blend, ensuring the resulting material possessed desirable qualities suitable to serve as a viable alternative to conventional fabrics. This method provided a structured framework to guide the entire process, from initial creation to final validation of the product.

Alongside this, experimental design was implemented to identify the key factors and variables that significantly influence the quality and characteristics of the blended fiber product. As emphasized by Moreh (2017), this approach is essential for analyzing how different elements affect material performance, particularly in textile-related studies. It involved systematic testing and assessment of the blend's mechanical, chemical, and physical attributes to verify its suitability and functional capacity. By combining both methods, the research achieved a thorough development and evaluation process, contributing valuable insights into sustainable material innovation.

Locale and Respondents of the Study

All observations for the characterization of the blended fibers were carried out through experimentation, conducted in three separate trials. Twenty-five (25) evaluators were selected based on their expertise in fashion and textiles, including dress shop owners, designers, and dressmakers with extensive experience working with various fabrics.

Research Instrument

The primary research instrument used in this study was a structured evaluation sheet designed to gather necessary data and feedback regarding the material. To interpret the results and determine the extent of acceptability of the blended Sugar Palm and Areca leaf sheath fibers as a textile material, the statistical measure of mean was applied and calculated. This method helped quantify the general assessment and overall quality rating given by the respondents.

Data Gathering Procedure

The mean was utilized as the statistical tool to determine the level of acceptability of the textile material made from blended Sugar Palm and Areca leaf sheath fibers, with data measured using a 5-point Likert scale. The evaluation was conducted by twenty-five qualified experts, consisting of dress shop owners, fashion designers, and dressmakers, who assessed the material based on their professional knowledge and experience.

III. RESULTS AND DISCUSSION

Mechanical Properties of Blended Sugar Palm and Areca leaf sheath Fibers as Textile Material in terms of Breaking Elongation

The data presents the breaking elongation of the fibers, tested with a uniform initial length of 27.868 mm. Sugar palm fibers showed elongation lengths of 42.20 mm, 53.90 mm, and 37.10 mm, averaging 44.40%. Areca leaf sheath fibers recorded 29.80 mm, 26.20 mm, and 18.20 mm, with a mean of 24.73%. The blended fibers measured 52.70 mm, 23.90 mm, and 20.60 mm, averaging 32.40%, and all specimens were interpreted as "Very Elastic." These results confirm the blend's notable elasticity, matching the quality of other natural fibers used in textiles. Such properties ensure good texture and strength, making the material suitable for bags, mats, ropes, and accessories.

This combination merges the strength of sugar palm and the flexibility of areca fibers, effectively balancing performance as noted by Reddy et al. (2018). Nurazzi et al. (2022) stated that good stretching characteristics improve processability without compromising quality. Longanathan et al. (2024) added that areca's natural flexibility allows the material to withstand deformation and resist damage. The high elongation values further indicate enhanced durability and workability compared to using each fiber separately. Ultimately, this blend serves as a cost-effective, biodegradable, and sustainable alternative ideal for areas where these resources are abundant.

Mechanical Properties of Blended Sugar Palm and Areca leaf sheath Fibers as Textile Material in terms of Tensile Strength

The data presents the tensile strength results for each fiber type across three trials. Sugar palm fibers recorded 29.43 N, 24.53 N, and 29.43 N, averaging 27.80 N as "Moderately Durable". Areca leaf sheath fibers measured 19.62 N, 14.72 N, and 29.43 N, with a mean of 21.26 N also rated "Moderately Durable". The blend, using 5 strands from each fiber, yielded 24.53 N, 39.24 N, and 34.30 N, achieving an average of 32.69 N classified as "Durable". These values show that blending significantly improves strength compared to using each fiber individually.

The results confirm that combining sugar palm's long cellulose chains with areca's rigid structure effectively distributes stress and reduces damage under tension. This supports studies by Nguyen et al. (2022) and Choudhury et al. (2018), noting that blending different fiber types minimizes defects and enhances performance. According to Mishra et

al. (2023), the blend's strength above 30 N qualifies it for technical textiles and heavy-duty applications. Consequently, this material serves as a viable, eco-friendly alternative suitable for both everyday and industrial textile products.

Chemical Properties of Blended Sugar Palm and Areca leaf sheath Fibers as Textile Material in terms of Rate of Burning

The data presents the burning behavior of blended textiles measured at 1.09 in² and tested across three trials. Burning times recorded were 36, 33, and 32 seconds, corresponding to rates of 0.0303, 0.0330, and 0.0341, with a mean value of 0.0325. Falling within the 0.01 to 0.05 range, the material is classified as "Least Combustible." This property arises from sugar palm's dense structure and high lignin content combined with areca leaf sheath's naturally slow-burning components. Their combination results in a composite that ignites slowly and burns much less intensely compared to other natural fibers.

While the blend shows promising attributes, its inherent combustibility limits applications where fire safety is a major requirement. Ahmad et al. (2021) noted that treatment with bio-based additives like starch or gelatin effectively improves flame resistance. Such coatings raised the Limiting Oxygen Index to 25%, reduced heat release by about 40%, and restricted char length to just 4 cm. These enhancements significantly delay ignition and reduce the spread of fire across the material. Thus, with or without treatment, this blended fiber becomes viable for broader uses where fire safety is essential.

Chemical Properties of Blended Sugar Palm and Areca leaf sheath Fibers as Textile Material in terms of Water Absorption

The data presents the water absorption test results, where samples floated throughout the 30-minute duration. Dry weights were 0.1652 mg, 0.1638 mg, and 0.1635 mg, increasing to 0.9789 mg, 0.9754 mg, and 0.9720 mg after soaking. The absorption percentages recorded were 65.10%, 64.90%, and 64.80%, yielding a grand mean of 64.90% interpreted as "Absorbent." This high capacity results from combining sugar palm's moisture-retentive structure with areca leaf sheath's interactive surface properties. Such characteristics make the fabric ideal for items like cleaning wipes and packaging, though less suitable for uses requiring quick drying or submersion.

These findings align with Gonzales et al. (2020) and Garcia et al. (2020), who stated that blending fibers balances absorption, permeability, and durability effectively. Variations in results were attributed to differences in fiber alignment, density, and testing conditions. Reyes et al. (2022) suggested that natural coatings could be applied to adjust absorption levels for specific requirements. However, Santos et al. (2023) noted that high water retention may cause discomfort or heaviness when used next to the skin. Overall, the material's properties make it functional and customizable for various practical textile applications.

Chemical Properties of Blended Sugar Palm and Areca leaf sheath Fibers as Textile Material in terms of Washability

The data presents the washability test results using 2 grams of detergent powder, where three samples were soaked for 10 minutes. The fabric showed only a slight darkening in color but retained its original structure without any damage or deterioration. This indicates that the material maintains good physical stability when exposed to standard cleaning conditions.

Washability is a key factor determining the practical use and market value of any textile product. Garcia et al. (2021) emphasized that materials with similar appearance can perform very differently after repeated washing cycles. Like other natural fibers, its long-term durability depends on proper processing and careful maintenance during use.

Acceptability of Textile from a Blended Sugar Palm and Areca leaf sheath Fibers in terms of Hand Feel, Irregularity of Ribs, Color Shades, and Presence of Plugs

The data presents the evaluation results from industry experts, yielding a grand mean of 4.22 interpreted as "Very Acceptable." Hand feel scored 4.26, while color shade ranked highest at 4.30, both rated "Very Acceptable." The presence of plugs obtained a mean of 4.21, showing minimal defects that did not affect overall quality. Rib irregularity scored 4.10, described only as "Acceptable" due to slight structural variations. Nonetheless, these ratings confirm that the material meets professional standards for physical attributes and general appearance.

These findings align with Islam et al. (2019) and Shuvo et al. (2020), who noted that proper processing and blending significantly improve texture and color uniformity in natural fibers. Ahmed et al. (2017) and Garcia et al. (2018) added that careful preparation and spinning are essential for achieving a clean, consistent finish. Loganathan et al. (2020) further emphasized that treating areca fibers enhances their workability and blending compatibility. Sugar palm fibers

contributed structural strength, while areca improved surface quality and visual appeal. Together, they produced a blend that successfully combines desirable qualities from both materials.

The high acceptability ratings confirm that the blended textile is suitable for practical and commercial use. It is recommended for products such as bags, home décor, and eco-friendly packaging where sustainability is valued. The lower score for rib irregularity indicates that weaving consistency can still be improved through better treatment or processing. Loganathan et al. (2020) suggested that surface treatments can further refine texture without losing environmental benefits. Overall, the material proves to be a viable, high-quality alternative to synthetic fabrics for various applications.

IV. CONCLUSIONS

Based on the results of the study, several key conclusions were drawn:

The blended Sugar Palm and Areca Leaf Sheath fibers achieved acceptable breaking elongation and tensile strength suitable for commercial use. Combining the toughness of sugar palm with the rigidity of areca created a material that balances sturdiness and flexibility effectively. It offers sufficient resistance to stretching and tearing, serving as a reliable and eco-friendly alternative to synthetic fabrics.

In terms of burning rate, water absorption, and washability, the material showed satisfactory and consistent performance. It exhibited decent fire resistance due to dense fiber structure and good moisture retention from natural absorbent properties. The fabric remained stable and in good condition even after washing, proving it safe and practical compared to conventional textiles.

Evaluation results confirmed high acceptability regarding hand feel, color shade, and overall finish that meet industry standards. Proper processing softened the rough raw fibers, resulting in a smooth texture while retaining a natural, organic appearance. Minor irregularities were accepted as part of its character, verifying that the blend is visually pleasing, comfortable, and meets user expectations.

V. RECOMMENDATION

Future research should explore different blending ratios and fiber lengths to better understand their effects on the tensile strength and elongation properties of the blended fibers. Applying eco-friendly or natural treatments like mercerization and bio-enzyme methods can further enhance strength and flexibility, allowing use in heavier or specialized textile applications. Optimizing fiber preparation techniques and composition will also help improve water absorption and wash performance during regular use. Additionally, testing under real-world conditions and various water types will provide practical data to refine these functional characteristics effectively.

Standardized evaluation methods and feedback from diverse assessors are recommended to gather more accurate and representative opinions on fabric quality and consumer preference. Improvements in fiber sorting, weaving processes, and natural dye application can reduce irregularities and defects while enhancing the fabric's smoothness and visual consistency. Comparing the final product against established industry standards will help ensure it meets required quality benchmarks for commercial use. These adjustments will help address issues related to hand feel, color uniformity, and overall appearance for better market acceptance.

A full assessment of the entire production chain, from raw material gathering to manufacturing, is needed to strengthen the material's environmental benefits. Researchers should also study how different harvesting and processing techniques impact the surrounding ecosystem to minimize potential harm. Investigating options for reusing or recycling the material at the end of its life cycle will further support its sustainable value. Finally, comparing its ecological footprint with that of traditional textiles will confirm its position as a responsible and eco-friendly alternative.

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