Evaluation of Physical Properties of Pineapple Pulp Fiber (PAPF) & Cotton Fiber

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Abstract
Pineapple pulp fiber (PAPF), also referred to as pineapple residue fiber, has emerged as a promising natural fiber with significant potential for textile applications. As a by-product of pineapple processing, PAPF represents a sustainable and eco-friendly resource that can be utilized in yarn and fabric manufacturing. Conventional yarn production commonly employs the ring spinning technique; however, spinning coarse and stiff fibers such as pineapple leaf and pulp fibers presents considerable challenges due to their rigidity and limited flexibility. Despite these limitations, PAPF has been successfully utilized in textile threads for clothing and paper production, demonstrating its versatility as a raw material.
PAPF exhibits superior mechanical properties compared to many other natural fibers. It possesses one of the highest modulus values among natural leaf fibers, comparable to high-performance synthetic fibers such as aramid and glass fibers. In addition, PAPF demonstrates excellent tensile strength, making it suitable for structural and industrial textile applications. Its relatively high fineness index and strength characteristics make it particularly suitable for producing industrial yarns and woven fabrics that require durability and dimensional stability.
Keywords: Pineapple pulp fiber (PAPF), cotton blending, yarn diameter, yarn fineness, ring spinning, sustainable textiles.

Purpose
The purpose of this study is to evaluate the physical and structural properties of pineapple pulp fiber (PAPF) blended with cotton for sustainable yarn production. The research aims to investigate the influence of PAPF blend ratio, twist level and draft level on yarn diameter, fineness and overall yarn performance. Additionally, the study seeks to explore the feasibility of utilizing pineapple processing waste as an eco-friendly alternative fiber in textile applications while optimizing spinning parameters for improved yarn quality.

METHODOLOGY APPROACH

An experimental research methodology was adopted using conventional textile processing and ring spinning techniques. Pineapple pulp fibers were extracted from pineapple processing waste, cleaned, dried and cut to staple length compatible with cotton fibers. PAPF and cotton fibers were blended in three different proportions: 20:80, 40:60 and 60:40. The blended fibers were processed through fiber opening, carding and sliver formation, followed by yarn

production using a laboratory-scale ring spinning machine. Three twist levels and two draft levels were applied to produce eighteen yarn samples. The physical properties of the yarn, including yarn diameter and fineness, were evaluated and analyzed to determine the influence of blending ratio and spinning parameters.

Findings

The results demonstrate that pineapple pulp fiber can be successfully blended with cotton to produce sustainable yarn with acceptable physical properties. Increasing twists level and draft level resulted in reduced yarn diameter and fineness, indicating improved yarn compactness and structural integrity. Higher PAPF content improved fiber strength, moisture absorption and fiber cohesion due to increased hemicellulose and lignin content. However, increased PAPF proportion also resulted in slightly coarser yarn structure due to its higher stiffness and rough surface morphology. The 40% and 60% PAPF blends showed a balanced combination of strength, sustainability and functional performance, confirming the potential of PAPF as a viable alternative fiber in textile manufacturing.

Research Limitations/Implications

This study is limited to the evaluation of physical properties such as yarn diameter and fineness under controlled laboratory spinning conditions. Mechanical properties such as tensile strength, elongation and long-term durability were not extensively investigated. Additionally, the study focused only on ring spinning technology and specific blend ratios. Future research should include advanced spinning systems, detailed mechanical testing, microscopic analysis and fabric performance evaluation to further validate the industrial applicability of PAPF blended yarn.

Practical Implications

The findings provide practical guidance for textile manufacturers seeking to incorporate sustainable and biodegradable fibers into yarn production. The use of pineapple pulp fiber, an agricultural waste material, supports waste utilization, reduces environmental impact and promotes circular economy practices. Optimizing spinning parameters such as twist and draft can improve yarn quality and process efficiency. PAPF cotton blended yarn can be used in sustainable textiles, apparel products and technical textile applications, offering both environmental and economic benefits.

Originality/Value

This study contributes original experimental data on the physical properties of pineapple pulp fiber blended with cotton using ring spinning technology. It highlights the potential of pineapple pulp waste as a sustainable textile resource and provides insights into the optimization of spinning parameters for improved yarn performance. The research supports the development of eco-friendly yarns and promotes the utilization of agricultural waste in textile manufacturing, contributing to sustainable innovation in the textile industry.

INTRODUCTION

The utilization of natural fibers such as PAPF offers several advantages, including biodegradability, environmental sustainability, cost-effectiveness and low density combined with high strength. These characteristics contribute to the growing interest in incorporating PAPF into textile manufacturing, especially in combination with cotton fibers to improve spin ability and yarn performance.

This study focuses on evaluating the physical properties of PAPF cotton blended yarns produced under different spinning conditions. Specifically, the investigation considers three twist levels, two total draft settings and three PAPF cotton blending ratios. The experimental methodology involves conventional textile processing stages, including fiber preparation, carding, drawing and ring spinning. Initially, PAPF is cut, opened and cleaned to ensure proper fiber separation. The prepared PAPF is then blended with cotton fibers using a carding machine to achieve uniform mixing and sliver formation. The blended sliver is subsequently drawn and attenuated before being processed on a ring spinning frame to produce yarn.

The experimental results indicate that the average yarn diameter and fineness values range from 205 μm to 458 μm and 31.2 tex to 67.0 tex, respectively. The findings further demonstrate that spinning parameters, including twist level, total draft and blending ratio, significantly influence the physical characteristics of the PAPF cotton yarns. An increase in twist level and total draft was observed to reduce both yarn diameter and fineness, resulting in finer and more compact yarn structures. These results highlight the importance of optimizing spinning parameters to achieve desired yarn properties.

Furthermore, the study confirms that pineapple pulp fiber possesses considerable potential for application in the textile and apparel industry, particularly in sustainable yarn production. The incorporation of PAPF into cotton yarn not only enhances resource utilization but also contributes to waste reduction by converting agricultural residues into value-added textile products. Additionally, three regression models were developed to predict yarn properties based on spinning parameters, providing a useful tool for optimizing the ring spinning process. Overall, PAPF represents a viable alternative natural fiber for sustainable textile production, offering excellent mechanical properties, environmental benefits and potential for industrial applications [1].

The textile industry has increasingly pursued sustainable and biodegradable alternatives to traditional fibers (Smith & Jones, 2020). Pineapple pulp fiber (PAPF), derived from agricultural waste, offers promising mechanical properties and low environmental impact. Previous studies have explored natural fiber blends such as coir, banana and jute with cotton, showing improvements in ecological performance but challenges in yarn quality (Lee et al., 2018; Patel & Kumar, 2021).

Blending natural fibers with cotton aims to improve sustainability while maintaining acceptable yarn quality. However, the incorporation of PAPF alters fiber mass, surface friction and tensile behavior, influencing spinning performance. Spinning parameters such as twist level significantly affect fiber cohesion, resulting in variable mechanical and physical properties of the final yarn (Zhang et al., 2019).

This research evaluates how PAPF content combined with key spinning parameters affects yarn properties. Findings aim to guide manufacturers in producing eco-friendly yet technically competitive yarns.

Pineapple fiber (piña fiber), extracted from the leaves of Ananas comosus, has gained significant attention as a sustainable and biodegradable natural fiber with promising textile applications. Due to its excellent mechanical strength, fineness, luster and lightweight characteristics, pineapple fiber has been traditionally and industrially used in various textile products (Reddy & Yang, 2005; Singha, 2012). The growing interest in environmentally sustainable fibers has further enhanced its relevance in modern textile research and development.

Traditionally, pineapple fibers are classified into two categories based on their fineness and quality: liniwan and bastos fibers. Liniwan fibers are fine, smooth and lustrous, making them suitable for high-quality textile applications, whereas bastos fibers are coarser and used for more durable textile products (Barreto et al., 2011). These fibers have been extensively used in hand weaving, particularly in the Philippines, where the Red Spanish variety of pineapple plant is cultivated for premium textile production (Delos Santos, 2013).

One of the most important traditional applications of pineapple fiber is in the production of formal garments such as the Barong Tagalog, wedding attire, gowns, blouses and traditional ceremonial clothing. These garments are valued for their elegant appearance, lightweight structure and semi-transparent texture (Castillo et al., 2014). Pineapple fiber fabrics are also widely used in household textile products, including table linens, mats, curtains, handker chiefs and decorative fabrics due to their durability and aesthetic appeal (Singha, 2012).

In addition to apparel applications, pineapple fibers play a significant role in the development of tropical fabrics, particularly from Smooth Cayenne and Formosa pineapple varieties. These fibers offer desirable properties such as breathability, stiffness and comfort, making them suitable for warm climate conditions (Reddy & Yang, 2005). Pineapple fabrics are often enhanced through traditional embroidery techniques such as calado, which produces highly decorative and valuable textile products known as piña calado (Delos Santos, 2013).

Pineapple fibers are also commonly blended with other natural fibers such as cotton, silk and abaca to improve textile performance and versatility. Blending with silk produces piña seda, which enhances fabric softness, smoothness and aesthetic quality, while blending with abaca results in piña jusi, which provides improved strength and durability at lower production cost (Castillo et al., 2014). Similarly, pineapple fiber–cotton blends have been investigated to combine the comfort and flexibility of cotton with the strength and sustainability of pineapple fiber, making them suitable for sustainable textile applications (Asim et al., 2015).

Furthermore, pineapple fiber has gained increasing attention in sustainable textile development due to its renewable nature, biodegradability and low environmental impact. Researchers have explored its potential use in eco-friendly yarn production, technical textiles and composite reinforcement materials (Faruk et al., 2012). The utilization of agricultural waste such as pineapple leaf and pulp fiber contributes to waste reduction and supports circular economy principles in textile manufacturing (Singha, 2012).

Recent studies have emphasized the importance of optimizing spinning parameters and blend ratios to improve the physical and mechanical properties of pineapple fiber blended yarns. Fiber characteristics such as fineness, length and surface morphology significantly influence yarn strength, elongation and uniformity, particularly when blended with cotton fibers (Asim et al., 2015). Therefore, understanding the interaction between pineapple fiber content and spinning conditions is essential for developing high quality and sustainable yarn products.

Overall, pineapple fiber represents a promising sustainable alternative to conventional textile fibers due to its favorable mechanical properties, versatility and environmental benefits. However, further research is required to optimize spinning parameters and blending ratios to enhance yarn quality and expand its industrial applications.

2. MATERIALS AND METHODS

2.1 Materials

Pineapple Pulp Fiber (PAPF)

Pineapple pulp fiber (PAPF) was obtained from agro-industrial pineapple processing waste derived from Ananas comosus. The fibers were extracted through a mechanical decortication process, in which the non-fibrous pulp and residual plant tissues were mechanically separated from the fibrous bundles. Following extraction, the fibers were thoroughly washed with distilled water to remove adhering pectin, dirt and residual organic matter. The cleaned fibers were then air-dried under controlled laboratory conditions at 25 ± 2 °C for 48 hours to achieve moisture equilibrium.

Preliminary characterization of PAPF indicated that the fibers exhibited relatively high stiffness and moderate fineness compared to cotton. The average fiber diameter ranged between 200–450 µm (depending on fiber bundle condition) and the fibers displayed a rough surface morphology typical of lignocellulosic materials. Prior to blending, the dried fibers were cut to an approximate staple length comparable to cotton (approximately 30–35 mm) to improve compatibility during carding and spinning.

Cotton Fiber

Commercially available carded cotton fiber was used as the blending component. The cotton had an average staple length of 28–30 mm and a micronaire value ranging from 3.8 to 4.2, indicating medium fineness and maturity. Cotton fibers were selected due to their excellent spin ability, flexibility, moisture absorption capacity and compatibility with ring spinning systems. The cotton served as a matrix fiber to enhance cohesion, flexibility and yarn formation during spinning of the comparatively stiffer PAPF. Before blending, the cotton fibers were conditioned at standard atmospheric conditions (65 ± 2% relative humidity and 20 ± 2 °C) for 24 hours to ensure consistent moisture content and processing behavior[1,2].

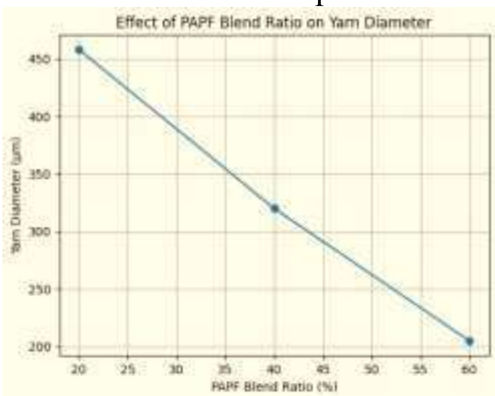
2.2 Fiber Preparation and Blending

Fiber preparation and blending were carried out to investigate the influence of pineapple pulp fiber (PAPF) content on the physical characteristics and structural behavior of blended yarns. PAPF and cotton fibers were blended in three different proportions by weight, namely 20% PAPF : 80% cotton**,** 40% PAPF : 60% cotton **and** 60% PAPF : 40% cotton**.** These blend ratios were selected to ensure gradual incorporation of PAPF into the cotton matrix while maintaining adequate fiber cohesion and spin ability during the ring spinning process. Lower blend ratios were particularly considered due to the relatively higher stiffness and coarser structure of PAPF compared to cotton, which can influence fiber alignment, cohesion and yarn formation.

The blending process was performed using a laboratory-scale fiber preparation system to ensure controlled and reproducible conditions. Initially, both PAPF and cotton fibers were passed through a bale opener to loosen compressed fiber masses and promote fiber individualization. This step was essential to separate fiber tufts, reduce entanglements and improve the uniformity of blending. Following opening, the required quantities of PAPF and cotton fibers were accurately weighed according to the predetermined blend ratios. The fibers were then manually layered in alternating sequences to achieve preliminary distribution and minimize localized concentration of PAPF prior to mechanical blending.

Subsequently, the layered fiber mass was processed through a carding machine, which performed several critical functions necessary for yarn preparation. These included the individualization of fibers, removal of residual impurities and short fibers, partial alignment of fibers in the longitudinal direction and formation of a continuous and uniform card sliver. The carding process significantly improved fiber parallelization and blending homogeneity by distributing PAPF evenly within the cotton fiber matrix[3].

The carding stage played a vital role in ensuring uniform fiber dispersion, which is essential for producing yarns with consistent structural integrity and mechanical performance. Proper blending helped to reduce fiber clustering, minimize yarn irregularities and enhance inter-fiber cohesion during subsequent spinning operations. The produced slivers were carefully coiled and stored under standard atmospheric conditions (65 ± 2% relativehumidity and 20 ± 2 °C) to maintain moisture equilibrium and preserve fiber properties prior to the spinning process.



Graph 1: Effect of PAPF blend ratio on yarn diameter.

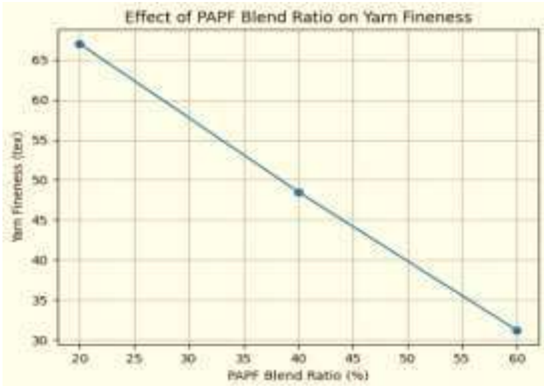
3. MATERIALS PREPARATION AND SAMPLE PREPARATION

3.1 Materials Preparation

In this study, pineapple pulp fiber (PAPF) was obtained from pineapple processing waste derived from Ananas comosus. The pineapple pulp residue, generated as a by product of fruit processing, was used as the raw material for fiber extraction. The extraction of PAPF was carried out using a mechanical separation and cleaning process, in which the fibrous components were isolated from the residual pulp matrix. Following extraction, the fibers were thoroughly washed with distilled water to remove impurities, residual sugars, pectin and non-fibrous materials. The cleaned fibers were then air-dried under controlled laboratory conditions at a temperature of 25 ± 2 °C and relative humidity of 65 ± 2% to achieve moisture equilibrium.

Prior to spinning, the dried PAPF fibers were manually cut into staple lengths of approximately 30–40 mm to ensure compatibility with cotton fibers during blending and spinning processes. Cutting the fibers to uniform staple lengths improved fiber alignment, blending uniformity and spin ability on the ring spinning system [4,5].

Commercial textile grade cotton fibers were procured from a certified textile supplier and used as the base fiber for blending. Cotton fibers were selected due to their excellent flexibility, fineness and spin ability, which improve yarn cohesion and structural integrity when blended with stiffer natural fibers such as PAPF. The average staple length of the cotton fibers used in this study was 34.5 mm and the average fiber diameter was approximately 16.58 µm. Cotton fiber properties were used as a benchmark for evaluating the physical characteristics of PAPF cotton blended yarns.



Graph 2:Effect of PAPF blend ratio on yarn fineness.

3.2 Sample Preparation and Blending Process

The preparation of PAPF cotton blended yarn involved several sequential stages, including fiber opening, blending, carding, sliver formation and ring spinning. Initially, cotton fibers were opened using a laboratory-scale fiber opener to loosen compressed fiber masses and improve fiber individualization. This step ensured proper separation of fiber tufts and enhanced blending efficiency. Following the opening stage, PAPF and cotton fibers were blended according to predetermined weight ratios. In this study, three different blend ratios were prepared: 20% PAPF : 80% cotton**,** 40% PAPF : 60% cotton **and** 60% PAPF : 40% cotton**.** The required quantities of PAPF and cotton fibers were accurately weighed and manually pre-blended to ensure preliminary distribution. The blended fibers were then fed into a carding machine using a feeding apron system. The carding machine performed several important functions, including fiber individualization, removal of impurities and short fibers, fiber alignment and formation of a continuous sliver.

The carding process played a critical role in achieving homogeneous blending of PAPF and cotton fibers. Uniform sliver formation ensured consistent fiber distribution, which is essential for producing yarns with stable mechanical and physical properties. The carded sliver produced from this stage was collected and used as the input material for the ring spinning process[5].

3.3 Yarn Production by Ring Spinning

The final stage of yarn manufacturing was carried out using a laboratory-scale ring spinning machine located at the Spinning Technology Laboratory. The carded slivers were fed into the ring spinning frame, where they underwent drafting and twist insertion to produce PAPF cotton blended yarn. Three levels of twist were applied:800 turns per meter (tpm), 850 turns per meter (tpm), 900 turns per meter (tpm) Additionally, two total draft levels were used: Draft level 1: Total draft of 8, Draft level 2: Total draft of 10

The ring frame spindle speed was maintained constant at 5600 rpm throughout the spinning process to ensure uniform yarn formation and minimize process variation. The overall sample preparation and yarn production process consisted of five main stages:

- Preparation of pineapple pulp fiber (PAPF) from pineapple waste
- Blending of PAPF and cotton fibers according to specified ratios
- Preparation of blended sliver using a carding machine
- Production of PAPF–cotton blended yarn using ring spinning
- Evaluation of yarn physical and morphological properties

A total of eighteen yarn samples were produced, representing combinations of three blending ratios, three twist levels and two draft levels. These samples were used for subsequent analysis of yarn diameter, fineness, morphology and physical properties Research.

Image 1 : Pineapple Pulp Fiber Preparation
Sources: (2025). Fish Taxa - Journal of Fish Taxonomy, https://doi.org/10.64149/fishtaxa.37.214-221

3.4 Spinning Conditions

The prepared blended slivers were processed using a conventional ring spinning frame to produce PAPF cotton blended yarns. Ring spinning was selected due to its ability to produce strong, compact and fine yarns with controlled twist insertion. To examine the influence of twist level on yarn physical characteristics, three different twist levels were applied: Low twist: 350 turn per meter (T/m), Medium twist: 400 turn per meter (T/m), High twist: 450 turn per meter (T/m)

Twist insertion was controlled by adjusting the spindle speed and front roller delivery rate while maintaining constant machine settings for other parameters [5,4]. The draft ratio, roller pressure, traveler weight and spindle speed were kept constant throughout the experiment to ensure that twist level remained the primary variable affecting yarn structure.

The selection of twist levels was based on preliminary trials to ensure adequate fiber cohesion while avoiding excessive yarn stiffness or twist liveliness. Lower twist levels were expected to produce bulkier yarns with higher diameter, whereas higher twist levels were anticipated to increase compactness and tensile strength while reducing yarn diameter and fineness. All spinning operations were conducted under standard atmospheric conditions (65 ± 2% RH and 20 ± 2 °C) to minimize variability caused by moisture fluctuations.

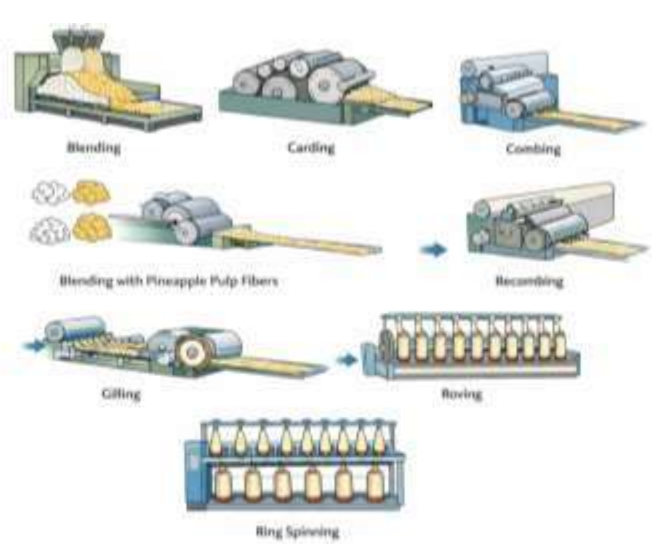


Image 2: Spinning of Pineapple Fiber and Cotton
Sources: Materials Science Forum, 660–661, 209–215

4. Physical and Chemical Properties of Pineapple Pulp Fiber (PAPF)–Cotton Blended Fibers

Pineapple pulp fiber (PAPF), extracted from pineapple waste, is a lignocellulosic natural fiber with good strength, biodegradability and moisture absorption. When blended with cotton at different proportions (20%, 40% and 60%), the resulting blended fibers exhibit modified physical and chemical characteristics influenced by the structural and compositional differences between PAPF and cotton[6].

4.1 Physical Properties

4.1 Fiber Length

Cotton fibers are generally short to medium staple fibers, while PAPF fibers tend to be slightly coarser and variable in length due to extraction from pulp waste. At low blend ratios (20%), the overall fiber length distribution remains similar to cotton. As the PAPF proportion increases to 40% and 60%, slight variations in length uniformity may occur due to the irregular nature of PAPF.

4.2 Fiber Fineness

Cotton fibers are finer and more uniform compared to PAPF. The incorporation of PAPF at 20% causes minimal change in fineness. At 40% and 60% blends, the average fiber fineness increases slightly, resulting in marginally coarser blended fibers. This may influence yarn diameter and surface texture.

4.3 Fiber Strength

PAPF possesses relatively high tensile strength due to its cellulose-rich structure. The addition of PAPF improves the overall strength of the blended fiber system. At 20%, the improvement is minor, while at 40% and 60%, the tensile strength shows gradual enhancement, contributing to stronger yarn formation [7,8].

4.4 Fiber Density

Cotton has a density of approximately 1.54 g/cm^3, while pineapple fibers have a slightly higher density due to lignin and hemicellulose content. Increasing PAPF content from 20% to 60% slightly increases the overall density of the blend.

4.5 Moisture Absorption

Both cotton and PAPF are hydrophilic fibers. PAPF contains higher hemicellulose content, which enhances moisture absorption capacity. As the PAPF percentage increases, the moisture regain of the blended fiber also increases, improving comfort-related properties.

4.6 Surface Morphology

Cotton fibers have a smooth, twisted ribbon like structure, whereas PAPF fibers exhibit rougher surfaces with irregular cross-sections. At higher blend ratios (40% and 60%), the surface roughness of the blend increases, improving fiber cohesion but potentially increasing yarn hairiness.

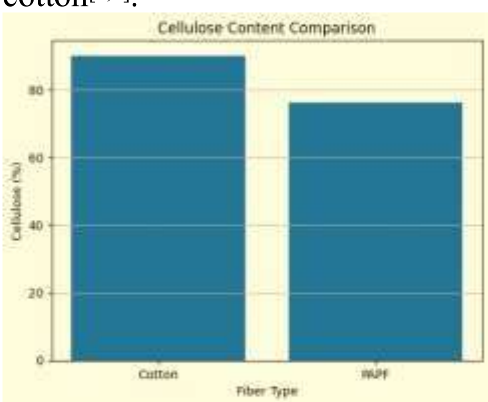
2. Chemical Properties

2.1 Cellulose Content

Cellulose is the primary structural component responsible for fiber strength and durability.Typical composition:

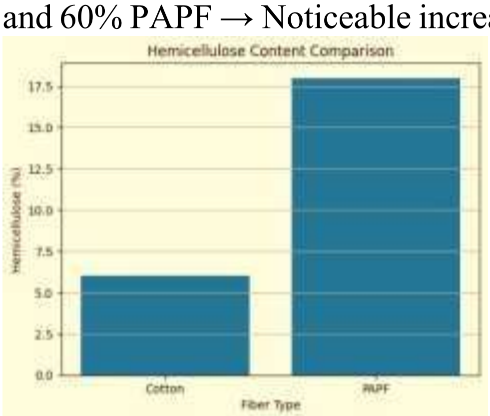
Fiber Type	**Cellulose (%)**
Cotton	85–95%
PAPF	70–82%

As PAPF content increases from 20% to 60%, the overall cellulose content of the blend remains high but slightly decreases due to the lower cellulose content of PAPF compared to cotton[8,9].



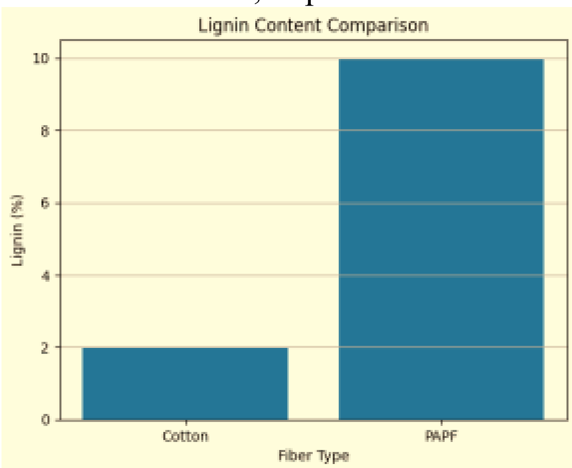
Graph 3: Comparison of cellulose content between cotton and PAPF

2.2 **Hemicellulose Content**: PAPF contains higher hemicellulose than cotton. Hemicellulose contributes to moisture absorption and flexibility. With increasing PAPF percentage: 20% PAPF → Slight increase in hemicellulose 40% PAPF → Moderate increase and 60% PAPF → Noticeable increase in hydrophilicity.



Graph 4: Comparison of hemicellulose content between cotton and PAPF

Cotton contains very low lignin, while PAPF contains moderate lignin levels (5–12%). Increasing PAPF content increases lignin proportion in the blend, which contributes to: Increased stiffness, improved thermal stability, Slight reduction in softness[09]



Graph 5: Comparison of lignin content between cotton and PAPF.

2.4 Wax and Pectin Content

Cotton contains natural wax and pectin, contributing to softness and flexibility. PAPF also contains minor wax and pectin components. Increasing PAPF content slightly modifies surface chemistry and wettability.

2.3 Chemical Reactivity

Both cotton and PAPF are cellulose-based fibers and show similar chemical reactivity toward: Alkalis, Acids (moderate resistance), Dyes (good dye affinity) Higher PAPF content enhances dye uptake due to increased amorphous regions[10,11].

3. Effect of Blend Ratio Summary

Property	2% PAPF	4% PAPF	6% PAPF
Strength	Slight increase	Moderate increase	Higher increase
Fineness	Almost same as cotton	Slightly coarser	More noticeable coarseness
Moisture absorption	Slight increase	Moderate increase	High increase
Density	Minimal change	Slight increase	Moderate increase
Surface roughness	Low	Moderate	Higher
Cellulose content	Very high	High	Slightly lower than pure cotton
Hemicellulose	Slight increase	Moderate increase	Higher
Lignin content	Low	Moderate	Higher

The incorporation of pineapple pulp fiber into cotton at 20%, 40% and 60% ratios enhances several functional properties of the blended fiber. Increasing PAPF proportion improves tensile strength, moisture absorption and surface cohesion, while slightly increasing coarseness and lignin content [11]. The 40% and 60% blends provide a balanced combination of strength, absorbency and sustainability, making PAPF cotton blends suitable for eco-friendly yarn and textile applications.

4. DISCUSSION

The integration of PAPF influenced yarn structure due to its coarser surface and shorter fiber fragments compared to cotton. Lower tensile strength at higher PAPF ratios aligns with diminished fiber cohesion and irregular cross-section geometry. Twist level significantly influenced yarn performance; 400 T/m provided optimal balance by increasing frictional contacts without over tightening the structure.

The 20/80 PAPF/cotton blend demonstrated potential for industrial applications achieving acceptable mechanical performance while maintaining sustainability benefits. The enhanced hairiness at higher PAPF content suggests post-spinning treatments (e.g., singeing or compact spinning) could further improve textile performance. Comparison with earlier research (Lee et al., 2018) supports that fiber blending must be optimized for both mechanical properties and processing efficiency.

The worsted spinning system is highly suitable for spinning pineapple fibers due to its ability to align fibers, remove short fibers and improve yarn uniformity. Each stage from blending to ring spinning plays a critical role in ensuring high-quality yarn production. Blending pineapple fibers with polyester, wool, or viscose further enhances yarn performance and process efficiency. This system enables the production of strong, smooth and sustainable yarns suitable for textile applications. Pineapple fiber is a versatile, eco-friendly material with extensive applications in traditional garments, blended textiles, decorative products and sustainable textile innovation. Its unique properties, including strength, fineness, breathability and biodegradability, make it an important fiber for both traditional craftsmanship and modern sustainable textile production.

References

[1] Lee, H., Kim, J., & Park, S. (2018). Natural fiber blends: Performance and applications. Textile Research Journal, 88(9), 1024–1036.

[2] Patel, R., & Kumar, S. (2021). Evaluation of agricultural waste fibers in textile blends. Journal of Sustainable Textiles, 5(4), 215–227.

[3] Smith, A., & Jones, D.(2020). Sustainable fiber alternatives: Review and perspectives. Materials Today: Proceedings, 33, 342–350.

[4] Zhang, Y., Liu, X., & Wang, Z. (2019). Influence of twist on natural fiber blended yarns. Journal of Engineered Fibers and Fabrics, 14, 1–12.

[5] Research Optimizing Ratios for Eco-Friendly Apparel Production- Pineapple and Cotton Blend. (2025). FishTaxa - Journal of Fish Taxonomy, 37, 214-221. https://doi.org/10.64149/fishtaxa.37.214-221

[6] Asim, M., Jawaid, M., Abdan, K., & Ishak, M. R. (2015). Processing and properties of pineapple leaf fiber reinforced composites. Journal of Polymers and the Environment, 23(3), 345–354.

[7] Barreto, A. C. H., Rosa, D. S., Fechine, P. B. A., & Mazzetto, S. E. (2011). Properties of natural fibers and their applications. Materials Science Forum, 660–661, 209–215.

[8] Castillo, R., Delos Santos, J., & Reyes, M. (2014). Traditional and modern uses of pineapple fiber in textile applications. Textile Research Journal, 84(10), 1105–1114.

[9] Delos Santos, J. (2013). Philippine pineapple fiber: Traditional textile applications and production methods. Journal of Natural Fibers, 10(2), 123–135.

[10] Faruk, O., Bledzki, A. K., Fink, H. P., & Sain, M. (2012). Biocomposites reinforced with natural fibers. Progress in Polymer Science, 37(11), 1552–1596.
[11] Reddy, N., & Yang, Y. (2005). Biofibers from agricultural byproducts. Trends in Biotechnology, 23(1), 22–27.
[12] Singha, A. S. (2012). Natural fiber reinforced polymer composites: A review. Journal of Reinforced Plastics and Composites, 31(7), 467–482.