IJAAR PUBLISHING®

International Journal of Advanced Academic Research | ISSN: 2488-9849
Vol. 10, Issue 6 (June, 2024) | www.ijaar.org

DEVELOPMENT AND PRODUCTION OF BANANA YARNS FOR WOVEN QUALITY FABRICS IN BENUE STATE

Aji, Ori Mercy

School of Art, Design and Printing, Department of Industrial Design

E-mail- aji.ori.mercy@gmail.com

Abstract- *In this paper, we present the production process and unique properties of banana yarn, a material that is ideal for weaving lightweight fabrics. The production process involves several stages, including peeling, retting, drying, grouping, carding, and spinning, each of which contributes to the mechanical properties of the yarn. These properties, such as the title of the yarn (tex), the strength of the breaking load (cN), coefficient of variation (%), tenacity (CN/tex), and elongation at break (%), are used to describe and classify the yarn. Banana yarn is known for its eco-friendliness, as it is biodegradable and sustainable. Furthermore, its excellent absorption and strength properties make it a promising alternative to synthetic yarns in the production of woven fabrics.*

Keywords: Banana Yarn; Woven Fabric; Biodegradable; eco-friendliness; Spinning; peeling; retting.

Aji, O. M. (2024). Development and Production of Banana Yarns for Woven Quality Fabrics in Benue State. *International Journal of Advanced Academic Research. 10*(6), 96-103. DOI: 10.5281/zenodo.12191097

1.0 INTRODUCTION

Nigeria has different types of traditional fabrics in use for various ceremonies [1], [2] such as *Adire* among the Yorubas, *A'nger,* and *Igede* among the Tivs and Idomas respectively. The textile industries are concerned with the design, production, and distribution of yarn, cloth, and clothing.

Textiles and clothing industries play a major role in the development and industrialization process of countries. A textile yarn is an assembly of substantial length and a relatively small cross-section of fibers and/or without twist. It is used for the production of fabrics from raw materials derived from natural source or synthetic sources using products of the chemical industry. Natural fibers are either from animal (sheep, goat, rabbit, and silk-worm) minerals (asbestos), or from plants (cotton, flax, sisal, and banana). Natural fibers have been used as an alternative to synthetic ones for their greener character; banana fibers have the advantage of coming from an agricultural residue. Ortega (2016) reported that fibers have been extracted by mechanical means from banana trunks/pseudo-stems, as a strategy to valorize banana crop residues. In Japan and Nepal, this banana fiber is used to produce high-quality textiles [3].

The major concern of both developed and developing countries recently is how to achieve highly efficient fabric production through the use of natural products [4]. This use of biodegradable and eco-friendly yarns obtained from banana plant stems after harvesting is one of the emerging weaving materials for fabric production[5]. The environmentally hazardous synthetic fibers are being substituted gradually through the revival of natural fibers.

In recent years, the fashion industry has started to seek more sustainable alternatives to massively produced fibers from natural plant sources. The use of eco-friendly yarns obtained from banana plant stems after harvesting is one of the emerging weaving materials for fabric production. Weaving is the craft of lacing fibers by interlacing two sets of yarns (warp and weft) to form a close fabric. It involves using a loom to hold the thread or yarn, although it can also be done by hand. With the abundance of banana plants across Benue State, finding a use for banana trunks that usually become biomass waste after harvesting the banana fruit can generate employment, create cottage industries for entrepreneurs, as well as boost the economy of the state.

2.0 BANANA FIBERS

The advancement of technology has enabled the transformation of raw materials into finished clothing products that are eco-friendly and suitable for human use. Clothing has always been a basic human need, along with food and shelter[6]. However, recent years have seen the addition of other necessities such as healthcare, transportation, and economic assets. The increasing consumption of wood fiber-based products has led to a need for forest preservation and responsible use of agricultural and forest residues to prevent illegal logging activities.

Natural plant fibers have gained popularity in various parts of the world and are used in the production of items such as rope, paper, textiles, and composites. Due to the negative environmental impact of synthetic fibers, there is now a growing demand for natural fibers. Bananas are a highly versatile plant that can be used in various ways, including the production of fiber from almost all parts of the plant, such as the fruit, leaves, flower bud, trunk, and pseudo-stem. The process for producing banana trunk fiber involves plantation and harvesting, extraction of the pseudo-stem fiber, retting, and degumming.

2.1 Application of Banana Fibers

Banana plants are an excellent source of fiber and have various uses, including therapeutic, alcohol, starch extraction, and many more [9]–[11]. Although banana fiber has been around for centuries, people in the textile industry are unaware of its uses[12]. Banana fiber was first made in Japan in the early 13th century, but its popularity declined as cotton and silk became more prevalent. Nowadays, banana fiber is making a comeback in the fashion industry. It is used worldwide for various products, such as tea bags, car tires, saris, and Japanese yen notes. In Japan and Nepal, high-quality textiles are made from banana fiber[3]. It is also used for papermaking and the handicraft industry. Banana fiber has a high tensile strength and stiffness, making it a potential fiber. The fibers are longer, increasing yarn production. Banana fiber's high yarn strength allows it to be blended with other natural or synthetic fibers. Due to the increased awareness of natural fibers, fiber extraction from banana pseudo stem is gaining momentum. In India, handicraft items and ropes are typically made from these fibers[13]. They can also be used for making home furnishings, papers, power transmission ropes and cordage, wall drilling cables, fishing nets, shipping cables, and more [3].

Traditionally, banana fiber was used for making doormats, ropes, and handicrafts in the textile sector. In recent times, there has been interest in producing polymer composite materials with banana fiber as a reinforcing component [14]. Its lightweight and comfortable properties make it a preferred summer wear by people. Banana fibers are used to make tablecloths, cushion covers, curtains, rugs, neckties, and bags, which are popular worldwide [3]. Many countries use banana fiber for various uses, such as making socks in Europe and garments in the Philippines and Japan. In Japan, cultivating bananas for cloth making has been a traditional process since the 13th century. Banana fibers are used as reinforcement along with polypropylene to make underfloor panels in cars. They act as natural water purifiers and natural sorbents, absorbing spilled oils in refineries. Marine cordages, cardboard, tea bags, string thread, fabric material, and rope for tying purposes are mainly produced using banana fibers. Banana fibers are used for traditional ceremonial garments in Japan. The outermost sheath of the plants is used to make cloths for placemats, floor mats, and sunshades in Nepal. As the use of banana fiber is increasing, its commercial value is also going up.

2.2 Banana and Yarn

Bananas are a widely consumed and affordable fruit enjoyed around the world. Their production continues to grow, making them one of the largest crops globally[7]. Interestingly, the rough and coarse fibers from the outer peel can be used to create fabrics similar to jute, while the softer and finer yarn produced from the inner part of the phloem is perfect for weaving lightweight materials. During Japan's Edo period (1600-1868), banana yarns were even used to create traditional garments like Kimono and Kamishimo. The two biggest banana producers in the world are India and China, which primarily cultivate bananas for their domestic markets. Banana plants belong to the Musaceae family and are originally from Southeast Asia's Malaysia-Indonesia region.

The utilization of spent banana plants (post-harvest), for fiber extraction has gained global recognition for its versatile nature. Banana fiber has found its way into various industries, including paper and pulp, water purification, bioremediation and recycling, currency printing, textiles, handicrafts, and many more. It has been used to create an array of products such as rope cordage, yarns, abrasive backing paper, tea bags, and shoes.

There exist three types of fabrics, namely, knitted, non-woven, and woven. Textile fabric is a pliable assembly of natural or man-made fibers or yarns[8]. Yarns are categorized based on their constituents, either continuous filaments or staple spun.

Furthermore, it is clarified that a woven fabric is formed by intersecting the two thread systems of warp and weft. The point at which the threads intersect is called a woven pattern or weave texture.

Banana plantations result in a high number of cut-down plants, which are destined for landfill as waste materials are biodegradable and eco-friendly. There are different quality parameters of woven fabric, which include gram per square meter (GSM), tear quality, elasticity, skewness test, bowing test, shrinkage test, pilling test, and crimp percentage test. Banana yarns can have varying properties depending on the part of the plant that wasused for its production. This yarn is also known as banana silk, due to the shiny and silky aspect of the most precious fibers. The fibers from bananas are among the strongest and most durable natural fibers.

They have great breathability and moisture-wicking properties. Researchers have started to extract the fibers and other components from the trunk/stem and used them to produce various value-added products such asfabricating rope, placemats, paper cardboard, string thread, tea bags, high-quality textile materials, textile fabrics, bags, table cloth, and handicrafts.

In recent years, the fashion industry has started to seek more sustainable alternatives to massively produced fibers, natural or synthetic. Natural fibers have distinct characteristics like low cost, less weight, and biodegradability which makes it an alternative to overcome the problem of pollution. The natural fiber industry can provide employment opportunities to millions of people, mostly to small farmers and cottage industries.

3.0 DEVELOPMENT AND PRODUCTION PROCESS OF BANANA YARN

The production process of banana yarn involves various steps, including peeling, retting, drying, grouping, carding, and spinning.

The first step in the production of banana fibers is to peel the outer part of the pseudo-stem of the banana plant, leaving only the inner bark intact[15].

The next step is retting, which involves separating the cellulosic fibers from all other substances. This can be done either manually or using a decorticator machine. Retting improves the mechanical properties of natural fibers, such as banana fibers. In cottage industries, manual separation is preferred over using a decorticator machine due to its high cost.

The decorticator machine consists of a rotating drum mounted on a shaft, with several blades on the circumference of the drum. As the drum rotates, the pseudo-stem is fed between the drum and the backing plate or feeding roller. This process removes lignin, pectin, waxes, and all non-cellulosic constituents present in the phloem.

The extracted fibers are dried in the sun and then grouped based on their thickness and quality. They are then knotted together to form a long strand.

Banana fibers can be blended with any other kind of yarn, natural or synthetic, on an industrial scale. To obtain these blended yarns, banana fibers are opened with a short fiber opener and then carded together with the new yarn to provide support to the fibers. Banana fibers blend well with cotton, wool, or polyester.

The final step is spinning, where the fibers are spun into yarn and become ready to use.

4.0 PROPERTIES OF BANANA FIBERS FOR YARN PRODUCTION

Banana fiber is a remarkably strong and versatile fiber that shares a visual resemblance with bamboo and ramie fibers. However, it is finer than those fibers and can be spun more easily. This fiber is composed of cellulose, hemicellulose, and lignin, which give it its impressive durability and low elongation. Depending on the extraction and spinning process, banana fiber can have a shiny finish and is incredibly lightweight with exceptional moisture absorption capabilities. It can quickly release moisture, making it an excellent choice for a variety of applications. What's more, banana fiber is biodegradable and eco-friendly, making it a sustainable choice that has no negative impact on the environment. With an average fineness of 2400Nm, banana fiber can be spun using a range of techniques such as ring spinning, open-end spinning, bast fiber spinning, and semi-worsted spinning.

4.1 Mechanical Properties of Banana Yarn

The mechanical properties of banana yarn include the title of the yarn (tex), the strength of the breaking load (cN), Coefficient of variation (%), tenacity (CN/tex), and elongation at break (%). Yarns are mostly characterized based on these properties. The title of yarn is a number that indicates the thickness, in proportion to the thread section. There are two fundamental criteria for the measurement of yarn: direct and indirect. In the direct system, the title is proportional to the size of the thread. Table 1 shows the mechanical properties of different yarns including pure banana yarn and Figure 1 shows a pure 100% banana yarn.

Table 1: Mechanical Properties of Different Types of Yarn (Source: Otega et al., 2016)

Property	Type of Yarn		
	Banana	Banana/PP Yarn	Flax/PP Yarn
Title of yarn (tex)	166	166	166
strength of the breaking load (cN)	910	1910	1310
Coefficient of variation (%),	11.2	4.9	12.4
Tenacity (CN/tex)	5.5	11.5	7.9
elongation at break (%)	13.0	19.7	4.5



Fig. 1 Yarn Derived from 100% Banana Fabric

Figure 2 displays the images of different kinds of banana yarns. Figure 2 (a)-(c) shows the image of banana yarn derived from 100% banana fiber while Figure 2 (d) shows the image of a yarn from a mixture of banana and cotton.



A textile yarn is an assembly of substantial length and a relatively small cross-section of fibers and/or without twist. Banana Yarn is biodegradable and eco-friendly and obtained from banana plantstems after harvesting. It is one of the emerging weaving materials for fabric production. It has outstanding properties compared to synthetic yarns and is a potential candidate for synthetic yarn in the textile industry.

5.1 Recommendations

The development and production of banana yarns have been difficult due to the lack of or inadequate modern equipment. The manual method is tasking and time-consuming. Therefore, both the federal and State governments should invest much in the sector to boost economic growth.

CONFLICT OF INTEREST

The Author declares that there is no conflict of interest.

FUNDING SOURCE

The Tertiary Education Trust fund (Tetfund) sponsored this research.

REFERENCES

[1] C. Anyanwu, C. C. Chukueggu, and S. A. Orubu, "Textile design and traditional cultural properties in Nigeria: A batik textile exploration," *J. African Hist. Cult. Arts*, vol. 2, no. 2, pp. 104–109, 2022, doi: 10.57040/jahca.v2i2.218.

[2] M. M. Owen, C. O. Ogunleye, and E. O. Orekoya, "the Nigerian Textile Industry: an Overview," *Niger. J. Polym. Sci. Technol.*, vol. 11, no. January 2016, pp. 99–108, 2016, [Online]. Available: http://www.dailyafricagist.com

[3] C. Vigneswaran, V. Pavithra, V. Gayathri, and K. Mythili, "Banana Fiber: Scope and value-added product development," *J. Text. Apparel, Technol. Manag.*, vol. 9, no. 2, pp. 1–7, 2015.

[4] N. Amir, K. A. Z. Abidin, and F. B. M. Shiri, "Effects of Fibre Configuration on Mechanical Properties of Banana Fibre/PP/MAPP Natural Fibre Reinforced Polymer Composite," *Procedia Eng.*, vol. 184, pp. 573–580, 2017, doi: 10.1016/j.proeng.2017.04.140.

[5] M. B. Hossain and H. Begum, "Investigation of Spinnability of Banana Fibers through Yarn Formation Along with Analysis of Yarn Properties," *Am. J. Eng. Res.*, vol. 6, no. 1, pp. 322–327, 2017, [Online]. Available: www.ajer.org

[6] K. Sangamithirai and N. Vasugi, "Banana fibre – A potential source of sustainable textiles," *J. Appl. Hortic.*, vol. 22, no. 2, pp. 133–136, 2020, doi: 10.37855/jah.2020.v22i02.24.

[7] hafez hawas, "A Study on Comfort Properties of Banana / Cotton Blend Woven Fabrics," *J. Des. Sci. Appl. Arts*, vol. 2, no. 1, pp. 140–149, 2021, doi: 10.21608/jdsaa.2021.35112.1069.

[8] H. Gong and B. Ozgen, *Fabric structures: Woven, knitted, or nonwoven*. Elsevier Ltd., 2017. doi: 10.1016/B978-0-08-101273-4.00007-X.

[9] P. Kumari, S. S. Gaur, and R. K. Tiwari, "Banana and its by-products: A comprehensive review on its nutritional composition and pharmacological benefits," *eFood*, vol. 4, no. 5, 2023, doi: 10.1002/efd2.110.

[10] S. Balda, A. Sharma, N. Capalash, and P. Sharma, "Banana fibre: a natural and sustainable bioresource for eco-friendly applications," *Clean Technol. Environ. Policy*, vol. 23, no. 5, pp. 1389–1401, 2021, doi: 10.1007/s10098-021-02041-y.

[11] S. Kraithong and U. Issara, "A strategic review on plant by-product from banana harvesting: A potentially bio-based ingredient for approaching novel food and agro-industry sustainability," *J. Saudi Soc. Agric. Sci.*, vol. 20, no. 8, pp. 530–543, 2021, doi: 10.1016/j.jssas.2021.06.004.

[12] U. S. Gupta and S. Tiwari, "Study on the Development of Banana Fibre Reinforced Polymer Composites for Industrial and Tribological Applications: A Review," *IOP*

Conf. Ser. Mater. Sci. Eng., vol. 810, no. 1, 2020, doi: 10.1088/1757-899X/810/1/012076.

[13] D. Mohapatra, S. Mishra, and N. Sutar, "Banana and its by-product utilisation: An overview," *J. Sci. Ind. Res. (India).*, vol. 69, no. 5, pp. 323–329, 2010.

[14] R. Phiri, S. Mavinkere Rangappa, S. Siengchin, O. P. Oladijo, and H. N. Dhakal, "Development of sustainable biopolymer-based composites for lightweight applications from agricultural waste biomass: A review," *Adv. Ind. Eng. Polym. Res.*, vol. 6, no. 4, pp. 436–450, 2023, doi: 10.1016/j.aiepr.2023.04.004.

[15] T. Sango *et al.*, "Step–wise multi–scale deconstruction of banana pseudo–stem (Musa acuminata) biomass and morpho–mechanical characterization of extracted long fibres for sustainable applications," *Ind. Crops Prod.*, vol. 122, no. June, pp. 657–668, 2018, doi: 10.1016/j.indcrop.2018.06.050.