

Banana Fiber: Scope and Value Added Product Development

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ABSTRACT

Banana fiber is a natural bast fiber which has wide range of uses in handicraft product developments such as mat, rope and twines, but only 10% of its pseudo stem is being used for making products and remaining is waste or used as fertilizer. As it has a property like weatherproof, UV protection (because of lignin content), moisture absorption, anti-oxidant and bio degradable etc., it can be used to make variety of products that help farmers economically and have wide scope to create new market. Recent studies have indicated banana fiber possesses a lot of advantageous physical and chemical properties which can be used a very good raw material for the textile and packaging industry.

Keywords: banana fiber, bio degradable, value addition, weather proof, packaging material

1. INTRODUCTION

Banana plant (scientific name: *Musa acuminata*) not only gives the delicious fruit but it also provides textile fiber, the banana fiber. It grows easily as it sets out young shoots and is most commonly found in hot tropical climates. All varieties of banana plants have fibers in abundance. These fibers are obtained after the fruit is harvested and fall in the group of bast fibers. After the fruit production, the trunk of the banana plant i.e.

the pseudostem is thrown as agricultural waste to a great extent. These pseudostems can be effectively utilized in production of the banana fibers as, annually; about 1.5 million tons of dry banana fibers can be produced from the outer sheath of pseudostem. Biomass (pseudostem) waste, a rich source of natural fibers the pseudostem can be profitably utilized for numerous applications and preparation of various products.

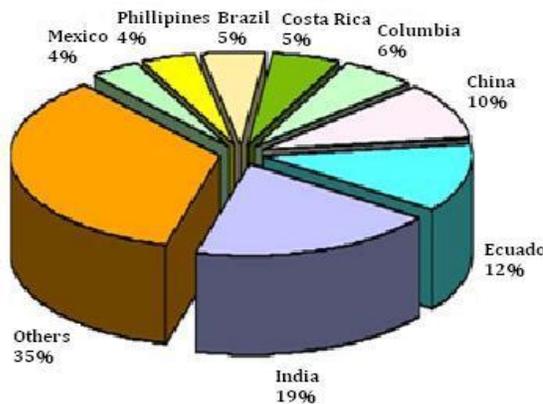


Figure 1. Growth % of Banana in the world

2. BIO FIBERS

Lignocellulosic are used for various applications, depending on their composition and physical properties. Recently, natural cellulose fibers suitable for textile and other industrial applications have been produced from corn husks and corn stalk. Use of lignocellulosic to produce ethanol and other sugars can possibly be achieved by fermentation. Biomasses can also be converted into carbon, hydrogen and oxygen to produce various chemicals, enzymes and proteins. It is reasonable to expect that agricultural byproducts will be a major source of industrial products and chemicals in the near future. However, there are a few limitations associated with agro-based fibers that should be considered when designing products using bio-fibers. The primary limitation is the relatively higher moisture absorption of natural fibers, making it difficult for the hydrophobic fibers and hydrophilic polymers to bond together.

All varieties of banana trees abound in fibers. In fact almost each and every part of the banana plant gives fibers of various strength, color and beauty and staple length which can be used for various purposes. Out of the 14-18 sheaths available in a stem, the outermost 4-6 sheaths yield coarse fiber, the outer 6-8 sheath soft lustrous fiber and the rest middle sheath excluding the innermost 4-6 sheaths yield very soft fibers. In each sheath, there are 3 distinct layers, the outer

layer including the epidermis, contain the bundles of fiber dispersed in a soft tissue matrix. The middle layer consists of water transporting fiber vascular tissue and the inner layer consists of soft, cellular tissue. The quantity of fiber in each sheath depends upon its width and its location in the stem, as does its quality. In addition to fruit production, huge quantity of biomass (pseudostem, leaves, suckers etc.) is generated [1,2].

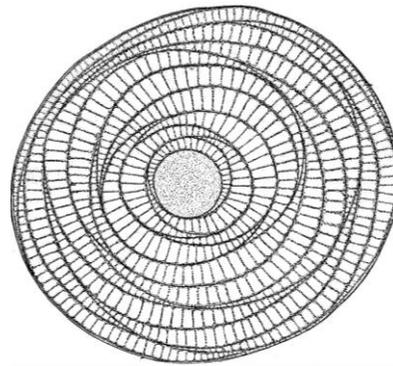


Figure 2. Pseudostem cross sectional view

Presently, this biomass is discarded as waste. In past, some researchers have successfully demonstrated use of banana pseudostem and leaves for extraction of fibers on a small scale. In India, the fibers are being used for preparing handicrafts, ropes etc., which otherwise can be used for making fabrics, home furnishings and good quality papers. The major problem of non-adoption of fiber extraction technology is low recovery of fibers leading to high transport cost. This plant has long been a good source for high quality textiles in many parts of the world, especially in Japan and Nepal. [3-5]

3. BANANA PRODUCTS

The stem of the banana plant is usually thrown away once the plantain is harvested. The stem forms a major waste material in the large scale and this disposal has become a huge problem. So from this they started to extract fiber mechanically and used to make various products. Most of the Banana fibers produced today is used for ropes and cordage. The resistance of the fiber to the sea-water and its natural buoyancy has created a ready

market for it in the manufacture of shipping cables. It is also widely used for making power transmission ropes and cordage, wall drilling cables, fishing nets, lines and other types of cordage. Although banana plants and fibers are available in tropical regions in abundance, their application potential has not been exploited fully. At present, other companies make the limited application of banana fiber, for example, in making ropes, mats, and some other fields such as the composite materials. In recent years, more and more plant fibers were considered to be "environmentally friendly" fiber sources, and many countries are emphasizing the utilizing of these fibers. The best thing about these fabrics is that they are biodegradable, finally broken down into water and carbon dioxide by microorganisms in the soil. Innovation sees no limit and consumers can expect something big coming up in the textile industry like fabrics and textiles woven from fine quality banana fiber. Several studies carried out on blending revealed that the studies were carried out on cotton with various natural and synthetic fibers with a view to impart value addition. In the present investigation banana fibers were blended with cotton and jute fibers to make banana blended fabrics and further evaluation of the fabric properties are also carried out. With the increasing environmental awareness and growing importance of eco-friendly fabrics, banana fiber has also been recognized for all its good qualities and now its application is increasing in other fields too such as apparel garments and home furnishings.

However, in Japan, it is being used for making traditional dresses like kimono, and kamishimo since the Edo period (1600-1868). Due to its being lightweight and comfortable to wear, it is still preferred by people there as summer wear. Banana fiber is also used to make fine cushion covers, Neckties, bags, table cloths, curtains etc. Rugs made from banana silk yarn fibers are also very popular world over.



Figure 3. Banana Fiber package

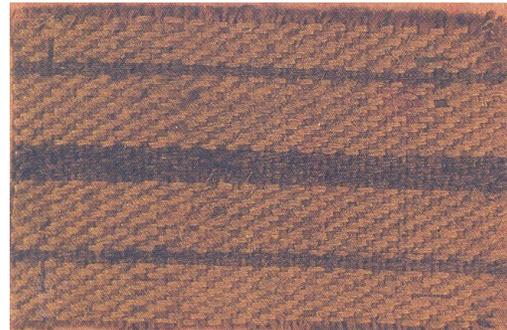


Figure 4. Banana Fiber mat



Figure 5. Banana Sheet

The fiber portion of the pseudostem left over after extraction of starch was utilized for the preparation of paper pulp. Banana fibers are reported to have been spun on the jute spinning machinery and used in making ropes and sacks. Hand extracted fibers have been used to produce handbags and other fancy articles was done first in Bombay. However, to do any material we have to first know about fiber yield, structure and properties of banana fibers. Subsequently, Bhama evaluated yield, structure and properties of banana fibers

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gathered from a few commercially cultivated varieties and observed that variations exist in both structure and properties of fibers from different regions along the length and across the thickness of the pseudostem. They also reported differences in tensile and structural properties among fibers belonging to different varieties and showed that the matrix in which the cells are embedded in the fiber had a role in deciding the tensile strength of the fiber. Visvesvaraya Industrial Research and Development Centre Mumbai have carried out a techno economic research study on extraction and utilization of banana stem fiber. According to them, handmade paper industry can effectively and competitively use banana fiber as its raw material. It has been stated that banana fibers possess lot of advantageous physical and chemical properties which promotes its use in textile applications. Enzyme application increases tensile energy, extensibility and improves the surface characteristics of the cotton-banana union fabric. Detailed study was undertaken to explore the sewability of cotton-banana blended fabrics and it is concluded that they give higher/better seam pucker but higher bending rigidity than 100% cotton. A wide range of products including bags, basket, wall hangings, floor mats, home furnishings, etc. can be made in banana fiber. The fiber extracted by mechanical process is of superior quality and is extensively used for making high quality special pare and decorative papers. Banana fiber is being used in making socks in European countries. [6-9].

Tenacity of 33 cultivars of banana grown in Philippines was reported to range from 22.4-44.8 g/tex. Saba cultivar showed maximum strength of 22.4g/tex. These values were lower in comparison with those of abaca, which were 55.3 g/tex. The percentage elongation of single fiber in tensile testing is found to be more than that of the hybrid composite.

Therefore, the single composite withstands more strain before failure in tensile testing than the hybrid fiber composite. The fiber was extracted by hand stripping by using a stripping device applying low pressure to prevent the fibers from

breaking [10, 11]. Several products have been made from banana fibers in the Philippines. Paper board, tissue paper etc., can be prepared out of banana pseudostem. Banana fibers can be used as natural absorbent, bio – remediation agent for bacteria in natural water purifier, for mushroom production, they are also used in making of handicrafts, quality paper cards, tea bags, string thread, high quality fabric material, paper for currency notes and good rope for tying purpose. The banana fibers were reported to be elegant and highly versatile. As they did not easily crumple, these fibers have been used in the manufacture of dress materials. The fineness of texture was found to depend on the quality of fibers used. The material had beautiful sheen and so has been used to prepare wedding gowns and barongs. When used in layers and flourlike, the fiber made beautiful dresses. Banana fiber dyed from its natural beige to bright colors was used to make chic blouses and outfits with plenty of ruffles and laces. Napkins and placemats have also been made. The fiber of Cavendish variety has been used as a potential source for specialty pulp manufacture. Pulped through sulphate process, it has been used as a raw material for the manufacture of good quality wrapping papers. Banana fibers spun with other fibers make excellent ropes suitable for agricultural purposes. Banana fiber being a natural sorbent has high potential in absorbing spilled oils in refineries. With fairly low amount of ash and lignin and high amount of holocellulose, pseudostem and petioles are suitable for pulping in paper industry. Banana and banana pseudostem contains pathogenesis – proteins possessing antimicrobial properties.

In Costa Rica, Industrial production of paper from banana pseudostem is going on and a whole range of products labeled Earth which includes paper, cardboard, notepads, letter paper, envelopes, post card, packaging material and notebooks have been launched. The banana fiber paper is reported to be of high strength and it is used to make tea bags and currency notes. In Germany, work is in

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progress to develop banana fiber lining for car interiors [12-14].

Many applications of banana pseudostem have been enlisted as follows:

- As an eco-friendly substitute in textile industry in place of the environmentally hazardous synthetic fibers.
- To provide livelihood to the rural poor through generation of employment in the fiber producing and processing industry.
- Being completely biodegradable and naturally occurring, the banana fiber products are expected to be in great demand in the international markets as they pose no toxic effects to man and environment.
- To make value added products, which would enhance the profitability of banana farming.
- To minimize deforestation due to various wood/cellulose processing industries, thus protecting our ecology and environment.
- Boxes made from these boards can be used for transport of fruits and other materials.
- Thicker varieties of banana paper can be used for making files, covers and packing materials [15,16]

The present study reports development of softening processes for the inherently coarse banana fibers making it more suitable for spinning operations, spinning of the softened fibers into yarns, after blending them with suitable natural fibers and testing the physical and mechanical properties of the yarns. The Yarns were further converted to fabrics and again assessed for their physical and mechanical properties. The fabrics were further passed through various finishing processes and then tested for all the mechanical and physical properties. The fabrics were further taken for dyeing with two classes of dyes and then assessed for the various fastness properties [17]

4. BANANA PACKAGING

The research examined the green packaging development from banana fiber for instant food products. The purposes were to construct, approve and develop the sketch design, to develop banana fiber package prototypes that protect food products inside, to eliminate packaging environment problems, prevent natural resource and save energy in package processing, and to design packaging for instant banana food products such as packages such as stand-up pouch, paper box, paper cup, and zip lock paper bag. The research was found that Satisfaction of every factor was good level and every packaging patterns conformed to the identity design in structural and graphical packaging. As a result of studying structural packaging factors, it indicated factors that had excellent satisfaction level in every packaging pattern, were packaging with aesthetic and elegant ones, identity packaging, and souvenir packaging.

The development of green packaging from banana fiber for instant food products. Variables studied in this issue, packaging design of green packaging from banana fiber for instant food products of the envelope (Stand-up pouch), box (Paper Box), paper cups (Paper Cup), paper bags (Zip Lock Paper Bag). In this research, banana fiber used to produce packaging to select the quality of the physical, chemical and consumer product safety. Packaging is recycling-based that is eco-friendly disposal. [18]

After completion of product development, to find out the results a questioner was prepared and the results are found, it was found for each style. Data were analyzed opinions by the statistical package for the social science program and using mean, percentage and standard deviation

- 4.50 to 5.00 - very good
- 3.50 to 4.49 - good
- 2.50 to 3.49 - medium
- 1.50 to 2.49 - less
- 1 to 1.49 – least

Packaging from banana fiber for instant food products as envelope style, the result obtained was 4.10 (mean), 0.48 (S.D) good

Packaging from banana fiber for instant food products as box style, the result obtained was 4.14(mean), 0.48 (S.D) good

Packaging from banana fiber for instant food products as paper cup style, the result obtained was 4.17 (mean), 0.39 (S.D) good

Packaging from banana fiber for instant food products as zip lock style, the result obtained was 4.27 (mean), 0.40 (S.D) good.

Enzymes are specific in action. Contrary to inorganic catalysts such as acids, bases, metals, and metal oxides, enzymes are very specific. In other words, each enzyme can breakdown or synthesized one particular compound. In some cases, they limited their actions to specific both in the compound with which they react. Most proteases, for instance, can breakdown several types of protein, but in each protein molecule only certain bonds will be cleaned depending on the which enzyme is used. Enzymatic reaction are non-toxic and readily broken down bio-finishing, also called bio-polishing, is a finishing process applied to cellulose textiles that produces permanent effects by the use of enzymes. Bio finishing removes protruding fiber and slubs from fabrics, significantly reduces pilling, softens fabric hand and provides a smooth fabric appearance, especially for knitwear and as a pretreatment for printing. In denim processing, Bio – finishing can reduce or eliminate abrasive stone and the aggressive chlorine chemistry. Bio-finishing is not only useful for cotton but also for regenerated cellulose fabrics, especially for lyocel and microfiber articles. By incorporating enzymes into detergents to remove protruding surface fibers, improved color retention is achieved after multiple launderings [19, 20].

CONCLUSION

Banana is cultivated in about 2, 30,000 hectares of land and the fiber yield is around 8.7 lakh toned. Though banana fiber extraction is not done on any large scale at present, banana fibers are reported to have been spun on the jute spinning machinery and used hand bags and other fancy articles. Agro-based bio-fibers have the composition, properties and structure that make them suitable for uses such as composite, textile, pulp and paper manufacture. In addition, bio-fibers can also be used to produce fuel, chemicals, enzymes and food. Byproducts produced from the cultivation of corn, wheat, rice, sorghum, barley, sugarcane, pineapple, banana and coconut are the major sources of agro-based bio-fibers. Likewise banana fiber based production processes, structure, properties and suitability of these bio-fibers are to be identified for various industrial applications.

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