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Handmade Paper from MUSA Accuminata (Banana) Stem

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Abstract: *Banana stem is readily collected from banana trees after collection of banana fruits. The stem is used as a waste product and used in domestic cooking purpose. It's removed after cutting of banana stem in small pieces and again stem is blowing inside the digester at a high pressure and consecutive use of sodium hydroxide, sodium sulphide and sodium hypochlorite.(1) The fiber is molten and making pulp. In recent history there's decline of Indian Handmade Paper in import request due to increase of cost of traditionally used good quality raw material. The present paper covers the potential for availability of banana fibre and its morphological & chemical nature as well as the pulping technologies with enzymatic refining.(2) Banana fibre is a natural fibre with high strength, which can be blended lightly with cotton fibre or synthetic fibre to produce compound material. In the fiber extraction process, a substantial measure of Lignocellulosic wastes are generated, disposal of which creates problem in the adjacent area. In this paper, extracted banana fiber(EBF) and waste banana fiber(WBF) were characterized in terms of chemical and morphological plots to assumed Banana is one of the most well- known and useful plants in the world. Almost all the parts of this manufactory, that are, fruit, leaves, flower bud, trunk, and pseudo-stem, can be used. This chapter deals with the fiber extracted from the pseudo-stem of the banana plant of the banana plant. This chapter deals with the fiber extracted from the pseudo-stem of the banana factory. It discusses the product of banana pseudo-stem fiber, which includes colony and harvesting; extraction of banana pseudo-stem fiber; retting; and degumming of the fiber. It also deals with the characteristics of the banana pseudo-stem fiber, similar as morphological, physical and mechanical, duration, degradability, thermal, chemical, and antibacterial properties(3). Several possible uses of this fiber are also mentioned, similar as the use of this fiber to fabricate rope, place mats, paper cardboard, string thread, tea bags, high- quality fabric materials, absorbent, polymer/ fiber composites,etc.(4).*

Keywords: Banana stem.

I. INTRODUCTION

Now banana stem is used as a source of raw material for medicinal of a paper pulp. This pulp is used to prepare different types of paper like as tissue, bloating, tracing and writing printing paper. Banana stems are easy available and cultivates in large scale at the North Eastern(NE) region of India. After harvesting, the cultivator cuts the banana trees and throws off enormous quantity of these stems into the fields because after harvesting the fruit, there's no significant use of banana trees. Constructing a tissue paper through the banana stem will be good for cultivators because after harvesting the fruit there's no use of this but using the banana stem for the product of tissue paper will help the farmers get some money and will increase their interest in climaxing banana crops. Several industries manufacture the tissue paper using bamboo, hardwood, softwood and juteetc. As the raw material, because it contains actually good probability of cellulose. On this base, banana stem acts as a actually suitable alternate raw material, containing very good probability of cellulose(5,6). The Indian handmade paper industries has been placed the class of village industry and had seen significant growth in last one decade. But there's tremendous decline in export figure in last couple of years because of enlarging price of traditionally used raw materials i.e. hosiery waste and rags so the paper makers couldn't suitable to supply the demand as per the transnational rate. The demand of handmade paper and paper products not only at National position but in the international arena has also been declined. As per estimates, there are nearly further than 500 handmade paper units scattered each over India producing nearly50,000 tonnes of handmade paper and board. The Indian handmade paper industry in the recent past wherein the produce of handmade paper industry has reached to a succession of Rs250,000 million which provides employment to about15,000 people and utmost of them

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are positioned in the rural area situated in the rural areas(7). Banana(Musa paradisiaca, family Musaceae) is a major fruit crop of the tropical and tropical regions of the world grown on about8.8 million hectares(8). Bangladesh produced 770203 tonnes of bananas in 2014.

On a global scale, non-wood fibers are a minor part of raw material stock to paper and paperboard manufacture. In multiple countries, still, they're still broadly used and are of significant significance in terms of overall volume and as a percentage of total pulp supply. Natural fibers present important advantages similar as low consistence, applicable stiffness and mechanical parcels, and high disposability and renewability. Further, they're recyclable and biodegradable. There has been a lot of research on use of natural fibers in mounts(9,10). Banana is the common name for herbaceous plants of the genus Musa family Musaceae and is also the name given to the fruit of this plant(10).

In the North Eastern region of India, several kinds of banana trees are set up, one of which is genus Musa. North Eastern region of India has actually suitable weather for banana crops. Genus Musa is cultivated in large scale as well as it contains very good probability of cellulose(11,12).

In Manufacturing of the tissue paper, lignin creates the problem because it can not be readily separated due to the intermolecular linkage of cellulose. Lignin is a combination of phenolic groups and it interconnects with the cellulose and the attendant bond is really strong. But delignification is truly important to obtain a high- quality pulp because about 85- 90 percent lignin separations ought to be done for making a white tissue paper(6,12,13). Removal of 85- 90 percent lignin implies that white pulp is produced because the brightness of the pulp depends upon the removal of the lignin percentage. The extent of lignin removal is characterized by the use of kappa number. Kappa number is directly commensurable to the percentage of lignin removal, hence with the decrease in lignin removal chance there's a decrease in the kappa number. In making a pulp, we generally know the three processes i.e. sulphate process(also known as kraft process), sulfite, and soda pop process are suitable. In addition, various semi chemical, mechanical and semi mechanical can be used(14,15). Keeping view in all the failure of good quality lignocellulosic raw material & also with the growing trend of environmental benevolence, demand of handmade papers made out of natural fibers is rising. Also, the rising cost of traditionally used cellulosic raw materials like cotton rags and hosiery waste, being used in handmade papermaking is also forcing the industry to search for further cellulosic raw materials for product of handmade paper and board which are available as waste biomass in different parts of the world. This should help in furnishing further opportunities for cost effective, locally available lignocellulosic raw materials agro residues like banana there by addressing the problem of environment and the issue of global warming in a right prospective(16).

Banana(Musa paradisiaca) grows nearly far and wide in Bangladesh round the year. Banana crop produces large amounts of post-harvest biomass wastes. Presently tons of waste are dumped annually as waste from which banana fibre can be extracted. Some of them are a implicit resource of raw materials similar as natural fibers, which can be used as reinforcement for compound materials. A good number of styles have so far been studied for the extraction of banana fiber. Anaerobic digestion of soft tissue fiber of banana wastes separated fibers(17,18) extracted fibres from fruit and bunch stems of banana plant by water retting and showed that bunch stem fibres were superior in terms of fineness, initial modulus and breaking strength(19) extracted banana fibre from stem and bunch of banana waste by alkalization and silanization followed by mechanical treatment. The extracted banana fibre has been studied for reinforcing material for lignocellulosic compound materials(20,21,22) and pulp(23,24,25). Banana pseudo-stem has been known as a implicit cellulose source, though generally discarded as agricultural waste in numerous countries. Over the Years, an adding pre occupation regarding forest preservation and rational use of forest and agricultural residues has occurred. This fact was mainly motivated by the adding consumption of wood fiber- based products, similar as panel, paper, and boards. This demand is presently answered by using increasing quantities of recycled fibers. Therefore, in some paper grades, further than 50 of raw materials are secondary fibers. Annual plants could also be a new source of lignocellulosic fibers for paper making and/ or compound materials(26,27)

II. PROCESS OF MAKING PULP

Remove External strip layer from each layer of banana stem. Dry in sunlight over a day. Chopping of the banana stem waste, After harvesting of the fruits carried as raw material and is also that banana stem cuts into small pieces(approximately 4- 5 cm) that's called chopping of the banana stem. After that small pieces of banana stem drying in the sun up to 90 %drying of the banana stem. The chemical composition of a representative sample is sodium hydroxide

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process is used for making of pulp as a feed of paper machine. This process removes the lignin and hemicelluloses after cutting of banana stem as a small pieces which digesting the banana stem chips with high pressure steam and consecutive use of sodium hydroxide, sodium sulphide and sodium hypochlorite. This process of chemical pulping is used to separate the lignin probabilities of lignocelluloses from the cellulose and improve the brightness of the pulp. The lignin chance in the pulp is determined with the help of kappa number. The effective density, rheology and attention of the pulp also determines with the help of rotational viscometer, Rheometer and Consistency tester. The pulp behaves like time independent non-Newtonianpseudo-plastic inflow behavior. The pulp is used to prepare the several types of paper. But here we used for preparation of tissue, bloating and tracing paper, in card sheet. Calcium carbonate is used as a sizing material We've to observe several properties of the paper pulp and paper similar as strength, smoothness, formation, brightness and air permeability of the paper.

Sr. No.	Constituents	Percentage
1	Cellulose	32.5 ± 0.5
2	Hemi cellulose	14.72 ± 2.15
3	Lignin	15.12 ± 0.76
4	Moisture	9.5 ± 1.5
5	Ash	8.25 ± 0.14

Table 1: Composition of Banana Fiber

Properties	Tissue	Blotting	Tracing
Burst Strength (KPa)	80-100	120-150	205-265
PH	7.5	7.5	6-7
Tensile Strength (Nm)	22-60	150-180	220-440
Roughness (ml/min)	350-400	300-350	100-300
Brightness (%)	80-90	75-80	70-75

Table 2: Paper Properties

Sr. No.	Properties	Name of the Equipment
1	GSM	GSM Test
2	Tear factor	Tear Factor Tester (Presto)
3	Burst Factor	Mullen tester
4	PH	PH meter
5	Tensile Strength	Alwetron TH-1
6	Roughness	Air-leak Tester
7	Effective viscosity	Rotational viscometer
8	Pseudoplastic flow behavior	Rheometer
9	Pulp Consistency	ConsistencyPRO

Table 3: Name of the equipment uses in pulp and paper testing quality

III. EXPERIMENTAL

3.1 Raw Material

The raw material used for this study was whole length banana stem. Banana stem was collected from a common species(Musa acuminata) in Thailand. This type of banana plant is generally grown each over the country. The stem was cut from factory and chopped in small pieces(2 – 3 inch) and allowed to sun dry for about ¾ days in the open air. After sun drying, oven dry(OD) measurement was done and the stem was also prepared for cooking.

3.2 Pulping

Cook fibre in 13NaOH for11/2 hours untill material is soft. During this treatment, the hydroxide anions react with the lignin, causing the polymer to portion into smaller water alkali-soluble fractions. There are several variations in cooking process. Under high temperature and pressure lignin and Cellulose degrade to give fractions that are soluble in the strongly basic liquid.

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3.3 Bleaching of Chemical Pulp

Bleaching was done after oxygen delignification. Pulps were taken in plastic bags in a water bath. Bleaching chemicals and water were added together into pulp and the mixture was heated near to reaction temperature in microwave oven. Pulp was mixed well during bleaching time after every 15 min. After every stage, pH of filtrate was measured and after D stages residual chlorine was determined. Pulp was then washed by a diluting and dewatering procedure; first, it was diluted to consistency 5% and then dewatered. This was repeated two times.

3.4 Fiber Morphology and Chemical Composition of Banana Stem Fiber

Hollocellulose was determined according to general procedure, whereas in case of lignin estimation T222 om-98 was followed. The detailed procedures for extractives, ash, water solubility, and pentosans were TAPPI general. Banana fiber chemical pulp was used for fiber length and fiber coarseness measurements. L & W fiber analyzer instrument was used for this purpose.

3.5 Sheet Making

The bleached banana stem fiber pulp was beaten and handsheets were made for testing the physical and optical properties

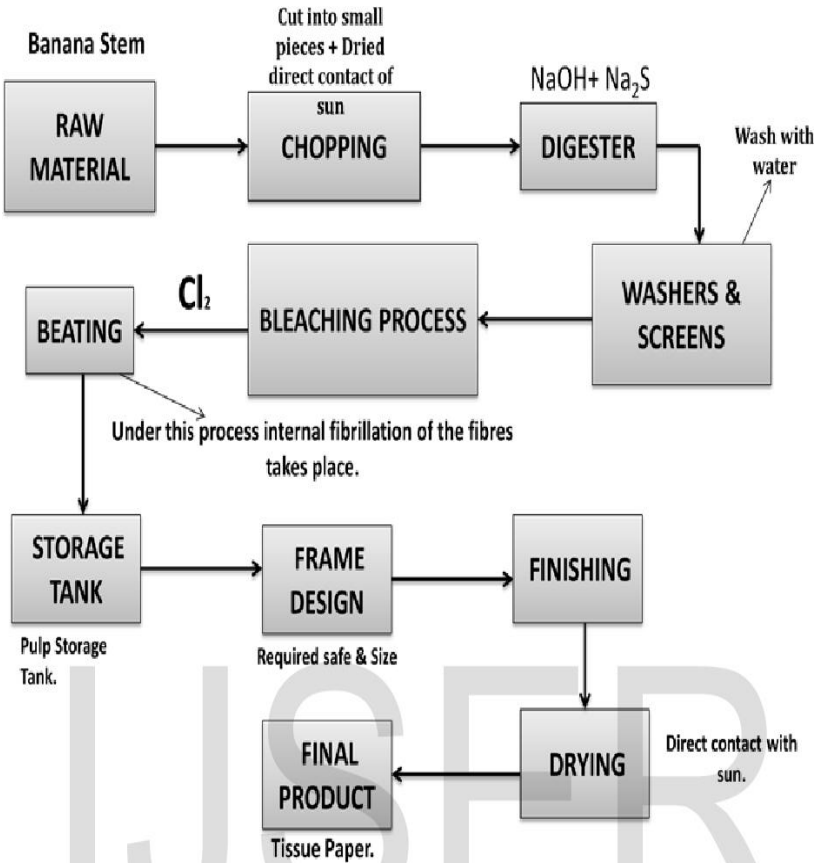
3.6 Pressing and Drying

After handsheet making, sheets were pressed and dried and they were kept in the conditioned room overnight before testing..

3.7 Paper Testing

The conditioned paper was tested for mechanical and optical properties according to the following standards.

IV. FLOW SHEET DIAGRAM



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V. PROCESS

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VI. RESULT AND DISCUSSION

The physical strength properties of the fibres of banana at 100 degree temperature showed a good strength properties .Also the effluent generated is under control. The tensile and folding strengths are remarkable, also the other strength properties like tear and burst strengths are good. So the banana fibre can be used for making handmade papers by using NaOH in digester. The pulp thus produced can be used for making variety of handmade papers / paper boards, particularly specialty papers like archival tissue and water mark papers (Chhapri Papers). This method can be useful for the industry people who have the cooking utensils like digesters or even they do not have digesters simply go for open digestion.

VII. BANANA STEM FIBER PAPER PROPERTIES

The fiber morphology and chemical composition study of banana pseudo-stem used for this investigation are shown in Table 1. The first remark concerns the high amount of ash (approximately 16%), which is common for annual plants.

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The ash content is high for industry processing. The second remark is the low amount of lignin, i.e., approximately 15%, to compare with other annual plants. In spite of the high content of ash, this raw material is worth pulping, mainly because of its relatively low lignin content. The quantity of extractives in methanol/benzene (1:2) was 3.52% that is medium when compared with other wood and some other annual plants. Hollocellulose is a collective term referring to the entire polysaccharide portion of wood [28].

	[spanname="2 to 5"] Fiber morphology				[spanname="6 to 11"] Chemical composition					
Banana stem	Fiber length	Fiber width	Coarseness	Fines (%)	Hollocellulose (%)	Lignin (%)	Pentosans (%)	Ash (%)	Extractives (%)	Solubility (%)
	1.73 mm	31.4 µm	0.15 mg/m	21	61.5	14.9	12.8	15.7	3.52	14.91

Table 1: Fiber morphology and chemical composition of banana stem fiber

Parameter	D_0	E_P	D_1
Residual ClO_2 (g/L)	0.064	–	0.125
Residual H_2O_2 (g/L)	–	0.012	–
Kappa number	14.90	11.21	6.4
Brightness % ISO	19.36	32.34	44.81
Viscosity	790	620	585
End pH	–	–	5.91

Table 2: Bleaching result alter every Mage

Banana stem was cooked by the kraft process with different chemical charges and a wide range of time and temperature, and the optimal pulping conditions were established as in our previous work [29]. The highest yield 48.61% can be obtained with a relatively small alkali charge (14%) within 120 min at 170 ◦C.

Before bleaching, the pulp was oxygen delignified (high-yield pulp was selected). After oxygen delignification, the kappa was 19.9. After cooking, brightness was 6.56% ISO, after oxygen delignification brightness was 8.42% ISO. The bleaching employed was three-stage bleaching (Table 2). The sequence was D0-EP-D1, where pulp was bleached with high bleaching chemical charge, the pH was controlled within the specified range, and the pulp was washed several times with distilled water. Bleached pulps were selected for refining in PFI mill at different revolutions and the important paper properties were tested.

Banana fibre can be an alternative raw material of paper industries like writing paper, anti grease paper, cheque paper as well as hard board industries[30,31,32]At first, raw paper materials are collected from banana plants and fibres are

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collected after wards. The collected fibres are soaked in water prior to make pulp. After the microbial treatment, banana fibre has to be washed to clean unwanted materials including microbes and convert to pulp in a process called Beating [40]. All of the additives in required amount and actual proportions must add during the beating process. Usually starch, polysaccharide Resins, and natural gums (glue) are used to modify or enhance the bonding between the Fibers in paper pulp. In the sizing step it is tried to retard the ability of wetting and penetration. Sizing reduces porosity and hence reduces absorption ability. After several steps to be carried out finished paper is made from pulp. This paper is used to prepare shopping bags, files, visiting card, greeting card, invitation cover, scribing pad, envelops, art paper, printing paper, etc.[33].Besides, writing paper is also prepared from banana fibre following as usual industrial process just by replacing banana fibre pulp against bamboo or wooden pulp.(34,35)

VIII. CONCLUSION

Banana stem is a cheapest and easily available raw material as a source of making paper pulp for the production of various types of paper. The process of making pulp is economically violable. The lignin separated from cellulose with the help of chemical treatment.

The making of paper is handmade. Sun ray is used for drying operation of paper mat. So energy is consumed from nature and according to economic standpoint it is profitable.

Strength and quality (brightness, formation, softness, smoothness) of the Paper produced in this process is marketable. Process cost is very low.

The handmade paper industry with minimum effluent discharge and small size units allows a large canvas for use of bio-technological application over the big paper mills. Taking advantage of several options such as proximity to consumer or exporter centers, easy accessibility for transportation of supplies and products to various consumer centers, as well as a large employment potential, the very use of banana fibre can be a sustainable objective .(36,37,38)

As the Indian economy based on the rural economy, this production system will not only stop the wealth drain from rural to urban areas but also establish a strong industrial base for rural development with the perfect use of biomass.The high biomass output of the fibre plants could provide large amounts of pulp, which could substitute the conventional raw materials used in India.

The another very good use of the banana pulps are as to blend it with bagasse (A short fibre Pulp). As evident from the results depicted in table 8 that the strength properties increased remarkably in many parameters. Here, it may also be recommended that this banana fibre by enzymatic route of refining, can replace imported long fibre wood pulp sheets which are being imported by big paper mills.

The main objective of this study was to establish the suitability of banana stem fiber as a potential source of lignocellulosic fibers for paper making. Paper-making properties were characterized by low strength. The handsheet density value was very high with high roughness. The air permeability was very poor. Compare with other raw materials, the optical properties were found to be extremely poor. Because of the lowest quality of its pulp, it is not suitable for fine paper making. However, there is scope for further research to completely characterize the banana fibers and facilitate proper applications in paper/board industries.(39)

WBF contains very low amount of α–cellulose and high amount of ash. WBF is constituted by fibers, broken fibers and nonfibrous cells. At 120 min of cooking with 8% alkali charge, WBF is defibrated with pulp yield of 35.9%. Initial SR value of EBF pulp is very high (65) and consequently increases to a very high tensile strength. Tear index of EBF is also very high due to the longer fiber length. The papermaking properties of WBF are quite acceptable for handmade paper. But these properties are much lower as compared to EBF pulp. The waste generated in banana fibre extraction plant can be used in handmade paper which will mitigate the pollution problem along with creating employment opportunity in rural area.

A proper experimental design would help find a compromise solution to increase the drainability of pasta at the expense of the decrease of properties of the mechanical strength of the paper to corrugate retrieved with these cellulosic. A proper experimental design would help find a compromise solution to increase the drainability of past at the expense of the decrease of properties of the mechanical strength of the paper to corrugate retrieved with these cellulosic.

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