DEVELOPMENT OF BAMBOO LEAF FIBER

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ABSTRACT: *Environmentally friendly materials that are rich in lignocellulose can be promising raw materials for the production of paper and textiles in industries. This study assesses the suitability of bamboo leaves for producing eco-friendly and biodegradable paper. Three varieties, mature and young leaves, were used, Bambusa blumeana, Gigantochloa atter, and Schizostachyum lumampao. The study aims to develop bamboo leaf fiber and identify the three varieties of bamboo leaves that can be used as bamboo fiber in making paper. Further, determine the physical and mechanical properties of the three varieties of bamboo leaves. materials for the production of paper and textiles in industries. Results showed that in mature and young leaves, in terms of grammage, Schizostachyum lumampao is the highest, followed by Bambusa blumeana and the least is Gigantochloa atter. In terms of absorbance rate, Gigantochloa atter absorbed water faster, and the least is Schizostachyum lumampao. In terms of tensile index, Schizostachyum lumampao has stronger strength. The results obtained indicated that each variety of bamboo leaves has different physical and mechanical properties*

Keywords: Bamboo leaves, pulp, paper, environmentally friendly

I. INTRODUCTION

It has been known that the paper industry that utilizes wood as raw material has a significant contribution to deforestation leading to climate change, species loss, perturbation in the water cycle, and soil erosion Okoro [1]. Wayman [2] Chen [3], confer that plant fibers were classified as environmentally friendly materials and are a promising raw material rich in lignocellulose that can be employed in the paper and textile industries. Plant fibers originate from a vast variety of sources and the most common plant fiber is bamboo. Bamboo is popular as a raw material for pulp and paper making in many countries of the world including Malaysia, China, and India. Various studies have been reported on the fiber dimensions, chemical composition of different bamboo species from different countries, and their suitability for commercial pulping. Bamboo which is fast growing and high-yielding naturally accurate perennial, giant woody grass is a self-propagatory plant that takes 2 to 6 years to mature depending on the species can also produce large biomass remains yet to be used for viable industrial raw materials for the production of pulp and paper even at small scale from some non-woods, woody grass and agricultural products, Odeyemi [4]. Issues that the project wishes to address: The project wishes to find or search for a specific variety of bamboo that can be used for handmade paper like a hand towel, corkboard, wrapper, etc..

2. METHODOLOGY

The study focused on the development of fiber from localized different bamboo varieties. Experimental research was used to determine the physical and mechanical properties of the three varieties of bamboo leaves. The raw materials of different bamboo varieties were collected from different areas available in Cantilan, Surigao del Sur. The leaves were washed and subjected to drying. The dried samples were stored in an air-tight plastic bag for further cooking and pulping processes. The analytical chemicals were purchased at Josh's Pharmacy Butuan City; Sodium hydroxide (NaOH), dye, and deckler molder. Other apparatus/equipment were prepared and used in the experiment.

Chemical Process to Produce Bamboo Fiber:

The dried bamboo leaves of different varieties were cut into small pieces and each sample was prepared and each weighed 400g. Each of the weighed samples was placed in an earthen pot and mixed with water and 100 grams of caustic soda boiled for 2-3 hours for complete leaf digestion to take place. The content of the cooking earthen pot was agitated at intervals of thirty minutes until the end of the cook was reached. The resultant fibrous mass was poured out at the end of cooking and spent liquor drained. The digested pulp was washed after aging several times with distilled water to remove all traces of black liquor and residual sodium hydroxide. At the end of washing the pulp was blended until it became fine, and the weight of the wet pulp was measured based on wet weight. The resulting pulp was oven-dried at 60OC for a period of 24 h to obtain pulp having a dry mass ready for paper-making.

Paper manufacturing from different varieties of bamboo:

The oven-dried pulp was then blended with water and introduced into the molder or deckle.The mixture was allowed to stand for approximately 12 minutes until all the pulp had settled down on the molder. Once settled, the water was drained leaving the pulp on the molder. The sheets were dewatered using sponges followed by a roller through gentle movements without applying too much pressure and the wet paper sheets were eventually allowed to dry at ambient conditions for a period of approximately 48 h or more and the dry ironed sheets were conditioned for physical and mechanical tests.

Physical Analysis

i. Grammage determination (TAPPI T410 OM-08)

The samples were cut in dimensions 100 x 100 cm from different sheets of paper followed by weighing on an electronic weighing balance. The grammage was determined using the formula g= m/A x n. Where g is the sheet grammage in g m-2, m is the mass of the paper sample in g, A is the paper area in m-2, and n is the number of samples.

Mechanical analysis

i. Absorbancy Rate (TAPPI T831 Om-93)

The water absorbency experiment was carried out to determine the time taken in seconds for the drop of water to get entirely absorbed into a paper specimen and damp the bottom side of the sample when placed on the surface of the paper with the aid of 10µL micropipette inclined at an angle of 30O to the horizontal. The absorbancy rate is a measure of the suitability and quality of wrapping, packaging, tissue, and towel paper for sorbing processes.SP [5].

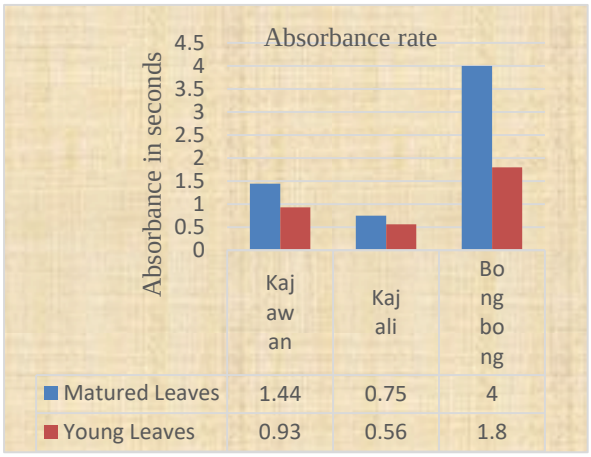

Table 2: Absorbancy rate of different varieties of Bamboo leaves

ii. Tensile index (T 494 om-01N)

The tensile strength is the maximum stress to break a strip of paper sheet. It is one of the most important basic physical properties of paper and paperboard. The tensile index was determined using the following equation:

I = F/wg,where F is the mean tensile force at break in kN, w is the width of the sample in meters and g is the grammage of the sample in g m-2

3. RESULTS AND DISCUSSION

Physical Analysis

Grammage determination

One of the fundamental properties of paper and paperboard is grammage or basis weight. The grammage of paper depends on the mass and the size of the sheet. According to Gulsoy and Simsir [6] different grammages of paper have different functions in the market such that paper having a small mass per unit area can be used as wrapping paper in the food industry or as toilet paper while those having a larger mass per unit area can be used as posters or cardboards.

Table 1. Mean grammage for the different test

Type of Bamboo Properties	*Bambusa blumeana* (Kajawan)	*Gigantochloa atter* (Kajali)	*Schizostachyum lumampao* (Bongbong)
Matured	1.8 g/m^2	0.67 g/m^2	3.5 g/m^2
Young	1.3 g/m^2	0.35 g/m^2	2.4 g/m^2

It can be gleaned in Table 1 that among the three varieties of bamboo, matured bongbong leaves have the highest grammage (3.5 g/m2) same with the young leaves (2.4 g/m2). It is stated that the larger the mass per unit area can be used as posters or cardboard. On the other hand, kajali having a smaller grammage, matured 0.67 g/m2 and young 0.35 g/m2 has a potential source in making paper. The kajawan with a grammage of 1.8 g/m2 (matured) and 1.3 g/m2 (young) can be a source in making wrappers. Figures 1 and 2 were products from different varieties of Bamboo Leaves**.**

Mechanical Analysis

Absorbancy Rate (TAPPI T831 Om-93)

Water absorbency is a measure of the amount of water absorbed by the wetted surface of paper and board materials. The water absorbency rate is used as a measure of the acceptability of tissue, towelling and blotter papers in sorptive tasks. The absorbency is affected by several factors such as the material characteristics, contact time, sheet size, liquid type, liquid temperature, surrounding temperature and humidity, and many others**.**

In table 2 Result showed that the matured bamboo leaves of Kajali has a higher absorbancy rate compared to Bong bong (4.0 sec) and Kajawan (1.44 sec) since it indicates a shorter time in absorbing water (0.75 sec). Results also show in Young bamboo leaves that bongbong takes a longer time to absorb water (1.8 sec) compared to Kajali (0.56 sec) and Kajawan (0.93 sec). Maybe it is because the cell walls of bamboo are made up of cellulose layers, which have many tiny spaces between them. The amount of expansion depends on the type of bamboo and its age. According to Gulsoy and Simsir when the paper has a smaller grammage and has a high absorbance rate, this would indicate that the paper can be used as toilet paper or wrapping paper. In the present study, Kajali has these characteristics. Moreover, Bongbong leaves having higher grammage value and longer absorbance of water can be used as cardboard. The water absorption of paper is a measure of its ability to absorb water. The higher the water absorption, the more absorbent the paper. The standard water absorption for paper is typically between 5 and 10%.

Tensile index (T 494 om-01N)

Tensile strength is indicative of the strength derived from factors such as fiber strength, fiber length, and bonding. It may be used to deduce information about these factors, especially when used as a tensile strength index. For quality control purposes, tensile strength has been used as an indication of the serviceability of many papers which are subjected to a simple and direct tensile stress. Tensile strength can also be used as an indication of the potential resistance to web breaking of papers such as printing papers during printing on a web fed press or other web fed converting operations. When evaluating the tensile strength, the stretch and the tensile energy absorption for these parameters can be of equal or greater importance in predicting the performance of paper, especially when that paper is subjected to an uneven stress such as gummed tape, or a dynamic stress such as when a sack full of granular material is dropped.

The tensile index of paper made from bamboo leaves can vary depending on various factors such as processing methods, fiber composition, and additives used. Generally, bamboo fibers are known for their strength and flexibility, so paper made from bamboo leaves could potentially have a higher tensile index. In the present study, results showed that matured leaves has higher tensile index than young leaves. In terms of their variety Bong bong has a higher Tensile index followed by kajawan and kalaji leaves is the least.

Table 3. Tensile strength of different varieties of Bamboo Leaves.

	Kajawan (Nm/g)	Kajali (Nm/g)	Bongbong (Nm/g)
Matured	18.05	6.78	35.13
Young	13.10	3.45	24.83

According to Tejado [7] paper is a network made from randomly deposited cellulose fibers which are about 1-3 mm long and 20-30 μm in diameter. The fibers are hollow tube-like structures, with wall thicknesses typically in the range of 3-5 μm. The fiber wall, as it exists in nature, consists of cellulose, hemicelluloses and lignin, although often most of the lignin is removed before using the pulp for papermaking. One should also take into account water as a fiber wall component since fibers are completely soaked when the sheet of paper is formed. After drying, nearly all the fibers in the paper are collapsed. Wet paper is much weaker and no fibers break when it ruptures.

4. CONCLUSION

It was observed that nonwood lignocellulose plants from different varieties of bamboo leaves are feasible as raw materials for making paper. Gigantochloa atter (kajali) is suitable for towel paper making; Bambusa blumeana (kajawan) can be a source for making wrappers; and Schizostachyum lumampao (Bongbong) can be used in making corkboard.

5. REFERENCES

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