BONGKOT - A POTENTIAL SOURCE OF NONWOOD FIBRE FOR PAPERMAKING

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ABSTRACT

Throughout Southeast Asia, the oil palm, Elaeis guineensis, is grown in large plantations for its fruit from which two valuable oils are obtained. The fruit consists of a fibrous casing commonly known as bongkot which contains the plant seeds. The orange-yellow pericarp yields palm oil which is used in soap making. The endosperm yields a white, pleasantly flavored oil known as palm-kernel oil, also used in making soaps. The fibrous casing, or bongkot, is either burned or spread among the palm trees. Alternative value-added uses for the bongkot are being considered, one of which is its suitability as a raw material for pulp and paper production.

This paper summarizes a literature survey of studies published on the subject of using bongkot as a source of nonwood plant fibre for papermaking. The studies explored raw material preparation and pulp quality using the Kraft, TMP, and NSSC processes. An analysis of the three processes shows that bongkot produces pulp that has high strength but low brightness with small black spots. The pulp, however, is suitable for producing a variety of products. The results indicate that using bongkot is both technologically and commercially feasible.

INTRODUCTION

Our planet is blessed with an unimaginable variety of plant life of which only a small portion has been studied for possible uses in industry. In cases where a specific plant species is found to be able to exist in large amounts and where it can be easily harvested, one possible consideration is its use as a fibre source for the pulp and paper industry. One such plant species is found in the Southeast Asian country of Indonesia: oil palm trees.

Indonesia has a tropical climate that permits the growing of various cash crops. One such crop is oil palm trees, which have an economic life of 25 to 30 years. Harvested from these trees is a fruit with seeds that can be pressed for their valuable oil. The fruit that contains these seeds has a fibrous casing (bongkot) which has been the subject of various studies aimed at determining its pulping properties. At present, bongkot is either burned for power, or shredded and spread among the palm trees. The total area used by the various palm tree plantations is about 1.6 million ha, which is spread over sixteen provinces of three islands.

BONGKOT COMPOSITION

As seen in table 1, bongkot fibres are short. Even so, the fibre length and L/D ratio of bongkot fibres makes them suitable for paper making [1] based on the fact that bongkot fibres are comparable to commercial temperate hardwoods.

Table 2 gives the chemical composition of bongkot which reveals that it has a high pentosan and low lignin content that is similar to straw and grasses.

Table 1. Mean Dimensions of Bongkot Fibres

Fibre Length (L)	mm	0.82
Fibre Diameter (D)	microns	27.0
L/D Ratio		30.3

Table 2. Chemical Composition of Bongkot Fibres

Holocellulose	70.0%
Alphacellulose	42.7%
Lignin	17.2%
Alcohol-Benzene Solubles	0.9%
Hot Water Solubles	2.8%
Alkali Solubles	17.2%
Pentosans	27.3%
Ash	0.7%

BONGKOT RAW MATERIAL

Palm oil mills use a pressurized cooking process to remove the oil containing seeds. Steamed bongkot is a by-product of the process. In this form, the bongkot is highly susceptible to pest infestation, mould and fungal attack because the steamed bongkot has a high moisture content and it is rich in sugars and starch. Another problem using steamed bongkot directly from the palm oil mill is that it demands a high chemical consumption, and produces a pulp which is dirty and has poor strength [1].

Researchers found that one process to solve this problem involved hammering and tearing apart the steamed bongkot after which the material was passed through a refiner (plates at maximum clearance) equipped with a continuous jet of water. This loosened the non-fibrous material which could then be washed away. Once it is broken up and cleaned, the remaining material can be dried quickly in the sun and then stored until needed for pulping. The easy disintegration of bongkot allows for less energy usage in its preparation than bagasse and other tropical hardwoods [3].

BONGKOT PULPING

Kraft Pulping

Three studies [1,2,4] were conducted using the kraft process to produce pulp from bongkot. Two studies [2,4] pretreated the raw material with NaOH which resulted in an increase in brownstock yield. One study [4] also included the addition of anthraquinone, which improved yield up to a certain point (42.9%), after which yield decreased. The third study [1] reported yields of up to 56%.

Table 3 provides the observed physical properties of the unbleached kraft pulp [4]. Beating the unbleached kraft pulps had a beneficial result on the properties of freeness, tear, breaking, burst, and folding endurance, all of which are within the upper range of hardwood kraft pulps.

The unbleached pulp brightness was reported as 40% ISO [4]. Using a simple CEH bleach sequence, a brightness of 90% ISO was achieved [1]. The effect of bleaching on the physical properties of the pulp is negligible as shown in table 4.

It was concluded that, with a small addition of long fibre pulp, the kraft pulp may be suitable for the manufacture of medium strength paper.

Table 3. Physical Properties of Unbleached Kraft Pulp

Cook No.	Beating Time (min)	Freeness (ml CSF)	Burst Index (kPa• m^2/g)	Tensile Index (Nm/g)	Tear Index (mN•m^2/g)	Double Folds	Stretch (%)	Air Resistance (sec.)
1	0	580	1.6	20	7.3	13	4.6	1.0
	60	430	4.6	50	9.2	119	8.1	4.2
	120	360	5.2	57	9.4	190	8.6	7.0
2	0	440	1.8	23	7.5	14	4.1	0.9
	60	340	4.2	44	9.3	59	7.5	6.7
	120	310	5.2	58	9.2	143	7.9	10.7
3	0	490	1.5	22	7.6	13	4.1	4.1
	15	420	3.9	45	8.9	65	6.5	6.4
	60	350	4.5	53	9.6	124	8.0	7.9
	90	296	5.2	60	9.8	221	8.0	17.0
4	0	565	1.7	23	7.8	15	4.1	0.7
	30	455	4.5	50	9.2	104	8.1	2.1
	60	420	4.9	54	9.2	117	7.9	2.8
	90	405	5.0	55	9.3	134	7.9	3.8

Table 4. Physical Properties of Bleached Kraft Pulp

Cook No.	Beating Time (min)	Freeness (ml CSF)	Burst Index (kPa• m^2/g)	Tensile Index (Nm/g)	Tear Index (mN•m^2/g)	Double Folds	Stretch (%)	Air Resistance (sec.)
3	0	575	1.7	21	7.0	11	4.5	1.1
	15	505	3.9	44	9.2	50	6.6	2.5
	60	400	3.9	47	7.9	46	6.9	2.9
	90	315	4.2	50	8.3	62	6.6	5.7

Thermomechanical Pulping

Thermomechanical pulping of bongkot [1,3], which had been pretreated with NaOH, resulted in a yield of 76%. As shown in table 5, it has better tear resistance and slightly lower tensile strength than commercial softwood TMP, but is superior to bagasse TMP. Black and small foreign materials were observed [3] in the pulp (although it is unclear if they employed the same refining method as given in the earlier description), but it was felt that further investigation was required for its removal. The brightness of the pulp was less than 30% ISO unbleached, but was improved to 50% ISO using a single stage H_2O_2 bleaching process.

Neutral Sulphite Semi-Chemical Pulping

The neutral sulphite semi-chemical (NSSC) pulping process, as shown by the results in table 6, gives poor quality pulp. The strength properties were poor, and improved only slightly on beating [2].

Table 5. Physical Properties of TMP

Freeness (ml CSF)	Burst Index (kPa•m^2/g)	Tensile Index (Nm/g)	Tear Index (mN•m^2/g)	Double Folds	Opacity (%)	Stretch (%)
187	-	28	11.9	71	98.3	-
163	-	29	9.9	45	99.2	-
150	-	28	10.4	68	99.0	-
131	-	31	10.7	75	98.7	-

Table 6. Physical Properties of NSSC Pulp

Freeness (ml CSF)	Burst Index (kPa•m^2/g)	Tensile Index (Nm/g)	Tear Index (mN•m^2/g)	Double Folds	Opacity (%)	Stretch (%)
400	1.2	18	5.4	6	-	3.6
390	1.8	24	6.0	8	-	4.1
350	2.4	30	5.6	14	-	5.1

CONCLUSIONS

Research into the utilization of oil palm empty fruit bunches (bongkot) has been active since 1954. Pulp suitable for certain paper products can be successfully produced. Bongkot, to a large extent, resembles straw and produces paper products very similar to straw.

Utilization of bongkot appears to be commercially and technologically feasible. It may also be highly desirable environmentally because it relieves the environmental impact of bongkot, which is viewed as waste from the current oil production industry.

Paper produced from bongkot will have relatively high physical strength, particularly tear.

It appears that the most significant technical issue which must be addressed for the commercial use of bongkot by the pulp and paper industry is the presence of black spots in the pulp. These black spots may be the result of fungal attack on the steamed bongkot as it exits the palm oil mill. Development of a suitable raw material preparation system including hammermilling and wet cleaning before storage (similar to a bagasse preparation system) to remove the sugars and starch may reduce or eliminate the black spots in the pulp. This could form an area for further research in the development of bongkot as a fibre resource.

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