CHEMI-MECHANICAL PULP AND PAPER FROM RAPHIA PALM (*Raphia hookeri*)

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ABSTRACT

Chemi-mechanical pulp was made from the piassava of *Raphia hookeri* by impregnation of the filaments in a mixture of sodium hydroxide and sodium sulphite solution and further refined in Sprout Waldron disc refiner. The resultant pulp of yield 55.28% with initial brightness of 26.93% was bleached with hydrogen peroxide to a brightness of 44.44%. Papers made from the bleached and unbleached pulps gave good strength properties, with tensile strength of 2.54 and 2.05 kN/m and tear strength of 778.67 and 880 mN, respectively. The piassava itself had cold water and 1% sodium hydroxide solubles of 4.83% and 9.00% respectively, while 1:2 ethanol-benzene extract was 2.73%.

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1.0 INTRODUCTION

Raphia hookeri which are abundant in Southern Nigeria are presently used in making brushes, storage bags, tablemats, car seats and robes (due to its stiffness and high strength). *Raphia hookeri* has average fibre length of 2.41 mm and 1.71mm for the stem and petiole respectively (Odeyemi, 1987).

The chemi-mechanical pulping process was adopted because the resultant pulp had characteristics that occupy the middle range when stone groundwood pulp is compared with chemical pulp, with a yield of up to 88% (Britt, 1970). With this process, uniform match-stick size chips were obtained by cutting the piassava prior to impregnation with chemicals. The impregnated chips were refined, bleached, washed and screened prior to handsheet formation.

In addition, the physical and chemical properties of *Raphia hookeri* strands were determined in order to evaluate their suitability as a source of chemi-mechanical pulp for paper-making.

2.0 MATERIAL AND METHODS

2.1 Material – The Raphia piassava were obtained locally from three locations – Watt Market in Calabar; Uyo Main Market and Itam Market in Itu.

2.2 Methods – The piassava were chopped manually into uniform lengths of 3.5cm with the aid of sharp scissors and matchet to produce match-stick size chips.

The moisture content of the samples was determined using gravimetric method. The specific gravity, percentage ash and silica contents of the raw material were also determined using TAPPI standards. The macerated and fibrillated Raphia fibres were viewed with the aid of projection type microscope for morphological study (Cartwright, and Findlay, 1946).

The solubility tests carried out included: 1% NaOH solubles, Benzene: ethanol (1:2) soluble, cold and hot water soluble determination (Sasanwo, 1976).

Two batches of 800g BD chips each were pressed (separately) with the aid of Moore hydraulic Press for 15 minutes and then impregnated with a mixture of sodium hydroxide and sodium sulphite under the conditions indicated in Table 1 below.

TABLE 1: IMPREGNATION CONDITIONS

Batches	1	2
Strength of NaOH (g/l)	35.20	31.20
Strength of Na_2SO_3 (g/l)	25.50	21.20
Impregnation Temperature (°C)	70	75
Of Impregnation liquor	13.80	13.80
Time of Impregnation (mins.)	30	45

The impregnated chips were refined using a laboratory Sprout Waldron disck refiner under the operating conditions stated in Table 2 and a pulp yield of 55.28% obtained.

TABLE 2: REFINING CONDITIONS

	Initial chips M.C(%)	Resultant Pulp Consistency (%)	Resultant Pulp Free ness (CSF)	pH		Temperature	
				Initial	Final	Initial	Final
1	13.35	11.80	202	13.8	12.8	39	95
2	15.75	5.50	570	13.8	12.3	40	98

Hot bleach liquor (60°C), comprising Diethylene Diamine Pentaacetic Acid (DTPA), $Na_2S_1O_3$, $MgSO_4.7H_2O$, H_2O_2 and H_2O in various proportions was added to Mg BD refined pulp according to the bleaching conditions in Table 3 (Denly, and Omori, 1986): Trunk, and Merg, 1986).

TABLE 3: BLEACHING CONDITIONS

	Initial	Final
Consistency (%)	26.9	17.5
pH	11.5	10.4
Temperature (°C)	60	65
Peroxide Strength (g/l)	18.5	
Bleaching Time (mins.)	60	
% H_2O_2 on BD Pulps	1.39	

Two sets of handsheets were made – one from the bleached raphia pulp at 191 CSF and another from the unbleached raphia pulp at 202 CSF. Figure 1 shows the flow chart of the chemi-mechanical pulping process of *Raphia hookeri* and handsheet formation. The English Sheet Former was used and sheets formed according to the method described in the Second Report of the Pulp Evaluation Committee to the Technical Section (Paper Makers Association, 1936).

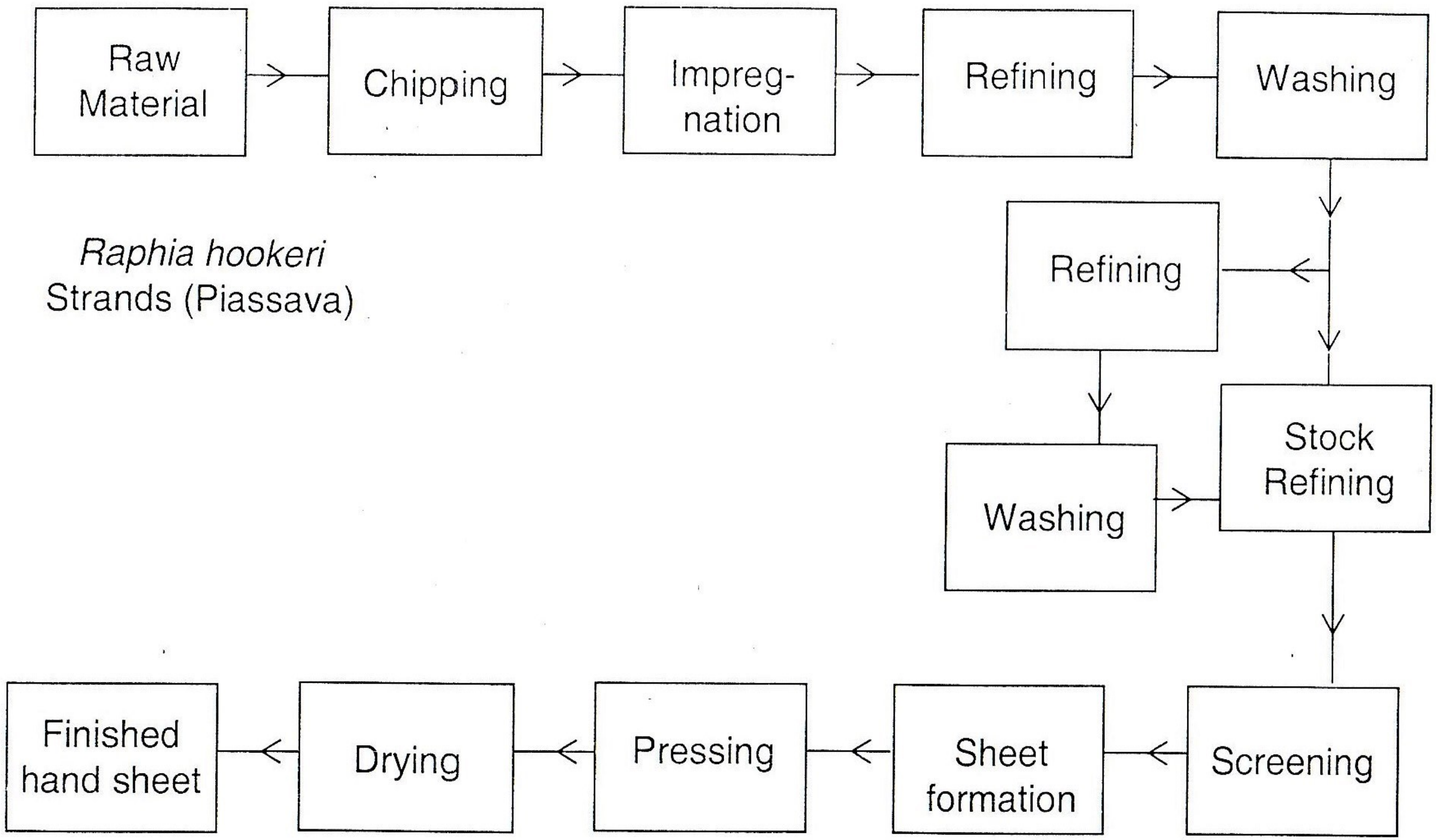


FIGURE 1: FLOW CHART OF CHEMI-MECHANICAL PULPING OF *RAPHIA HOOKERI* AND HAND SHEET FORMATION

3.0 RESULT

TABLE 4: PHYSICAL AND CHEMICAL ANALYSIS OF *RAPHIA HOOKERI*

Quantities	**Values**
Specific gravity	0.372
Moisture content (%)	13.35
Ash content (%)	1.27
Silica content (%)	0.001
Cold water solubles (%)	4.83
Hot water solubles (%)	5.18
1% NaOH solubles (%)	9.03
Benzene-ethanol (1:2) solubles (%)	2.73

TABLE 5: PULP AND PAPER QUALITY TESTING

Quantities	Units	Values	
		IBL	IUBL
Pulp freeness	Caf	191	202
Pulp consistency	%	5.3	2.8
Pulp MI		6.7	7.3
Pulp temperature	°C	30	28
Paper caliper	NM	210.67	202.43
G.D. Grammage	gsm	58.4	60.3
Moisture content	%	12.6	13.3
Apparent density	gsm^{-3}	0.277	0.298
Tear strength	MN	778.67	880
Tear index	mNm^2g^{-1}	13.33	14.59
Tensile strength	kNm^{-1}	2.54	2.05
Tensile index	Nmg^{-1}	43.49	34.00
Strength	%	1.83	1.69
Paper Brightness	%	44.44	26.93

IBL – Bleached Pulp and Paper samples from Raphia.
IUBL – Unbleached Samples of above.

4.0 DISCUSSION

With a low ash content of 1.27% and a corresponding silica content of 0.001% (as recorded in Table 4), the Raphia piassava can be chipped or chopped with less power requirement and minimum blunting of the cutting tool in the conventional mill's practice. The Raphia chips could be washed by flotation method due to its low specific gravity (0.372).

The percentage cold and hot water solubles for the Raphia chips are adequate from the standpoint of chemical consumption during impregnation as 9.03% solubles are recorded for 1% NaOH. Timber with less than 5% benzene-ethanol (1:2) soluble is regarded as non-durable (Cartwright, and Findlay, 1946).

FIGURE 2: MAGNIFIED SKETCH OF MACERATED RAPHIA FIBRES

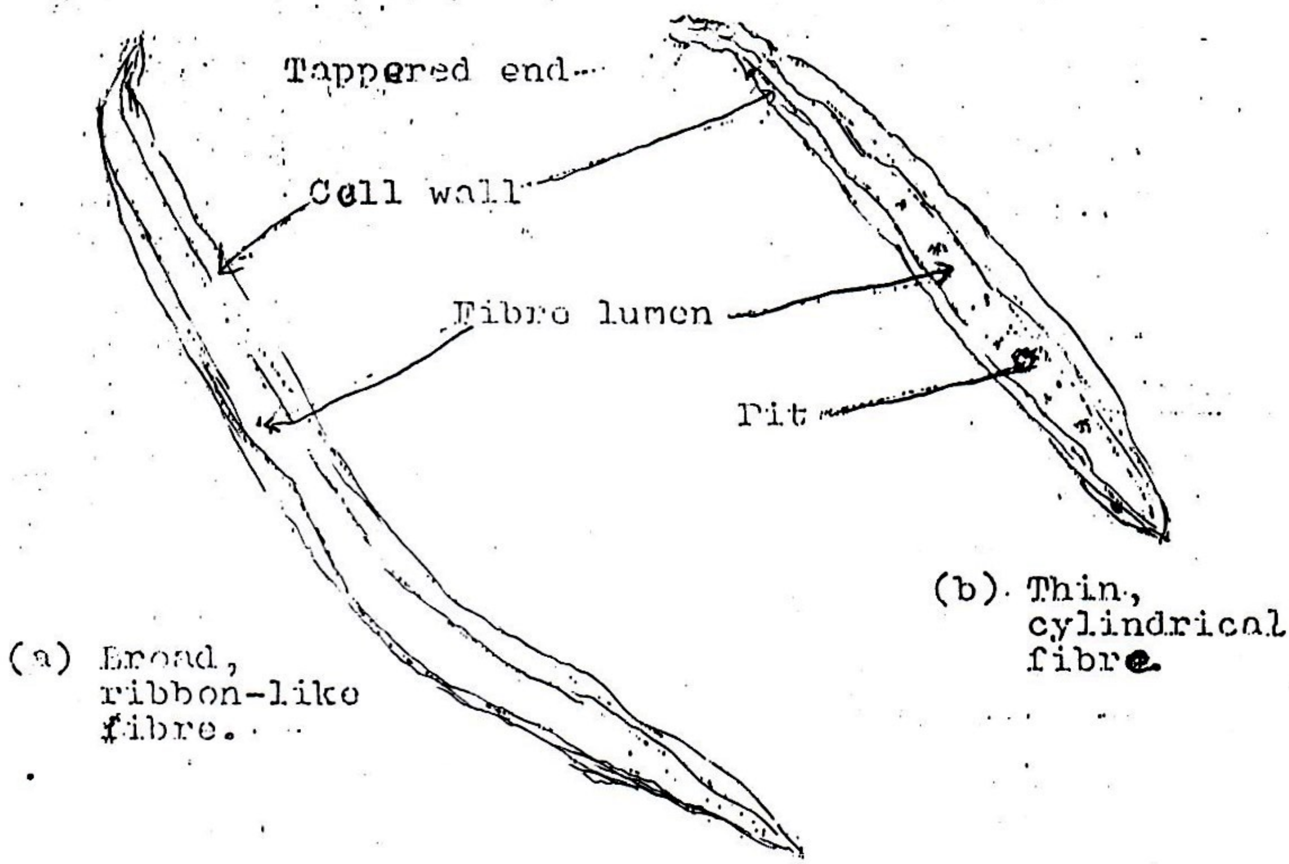
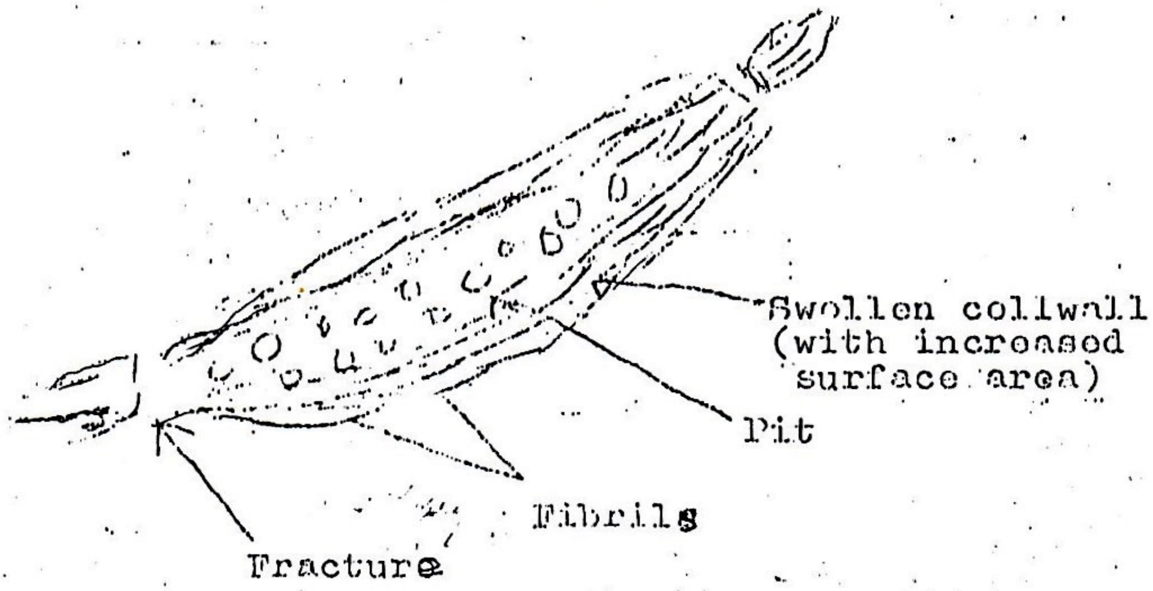


FIGURE 3: MAGNIFIED SKETCH OF FIBRILLATED RAPHIA FIBRE



With an average benzene-ethanol (1:2) solubles of 2.73% (Table 4), the Raphia piassava are much liable to attack by bio-degradation agents. Hence, the Raphia chips require adequate preservation and should not be stored longer than necessary in order to avoid excessive degradation and consequent loses in yield and quality of the final product.

1.39% peroxide on BD unbleached Raphia pulp was used to achieve a brightness of 44.44% from 26.93% initial brightness thus showing a brightness gain of 17.51%. The decomposition of peroxide which is catalysed primarily by compounds of heavy metals such as iron, copper, catalase, is illustrated below 1:7.

$$2H_2O_2 \xrightarrow{\text{Catalyst}} 2H_2O + O_2.$$

The above reaction, which is not desirable from the standpoint of peroxide consumption during bleaching, was deactivated by the application of the chelating agent (DTPA).

In addition, magnesium sulphate and sodium silicate were used as buffers and stabilizing agents whereas sodium hydroxide was primary employed to provide an alkaline environment required for the bleaching process.

The strength of papers made from Raphia hookeri piassava were remarkable. At the grammage of 58.4 and 60.3 gsm, the mean tensile strengths of 2.54 and 2.05 KNM^{-1} and the corresponding stretches of 1.83% and 1.69% were obtained for the test samples – IBL and IUBL respectively (under the conditions listed in Table 5). The mean tear strengths of 778.67 and 880 nN were recorded for the paper samples IBL and IUBL respectively. The calculated tensile indices for the test samples – IBL and IUBL were 43.49 and 34.00 NMg^{-1} with a corresponding tear indices of 13.33 and 14.59 mNm^2g^{-1} respectively.

4.1 Fibre Morphology

The macerated Raphia fibres were of two classes:

(a) The bread, ribbon-like fibres with a larger fibre width, and

(b) The thin, cylindrical fibres with smaller fibre width.

The macerated fibres are relatively long, smooth, stiff and tappers gradually at the ends with marked thick double wellwall as shown in Figure 2. The fibrillated fibres on the other hand, are shorter, more flexible, hydrated and swollen with increased surface area of contact as shown in Figure 3.

5.0 CONCLUSION

The study proved that;

(1) Chemi-mechanical paper can be made from *Raphia hookeri* piassava.

(2) The Raphia piassava has low ash and silica content hence posing little or no problem during chopping/chipping.

(3) The Raphia pulp can be bleached with hydrogen peroxide in the presence of adequate stabilizers, buffers and chelating agent.

(4) Under the experimental paper making conditions, *Raphia hookeri* produced papers of remarkable strength properties.

(5) *Raphia hookeri* is not only a good source of chemi-mechanical pulp for paper making but also a hopeful indigenous source for kraft pulp where its full strength properties could be properly utilized.

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