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STUDY OF SOME NIGERIAN HARD WOOD USED FOR PULP AND PAPER MAKING

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ABSTRACT

The properties of pulp and paper obtained from blending of Nigerian hard wood, Gmelina Arborea (GMA) and imported soft wood pine were studied. The properties of pulp obtained from other Nigerian hard woods: Butyrospermium Parkii (BPP) and Pinus Caribarea (PCP) were compared with that of pulp from GMA. It was observed that 60:40 ratio of Gmelina (GMA) and imported pine wood pulp beaten for 35 minutes in Jokro mill has produced good quality paper. Some properties of that paper viz., moisture content, basis weight, bulk properties, tensile properties, stiffness test, tear test and tear factor were reviewed.

INTRODUCTION

In tropical countries like Nigeria, hard wood trees are in abundance, hence the emphasis is on the utilization of short fibres from these trees for making paper. Previous research (1-11) has indicated that these short fibre pulps would most likely produce inferior quality paper. To reduce the huge amount of pulp importation, locally available pulp may be blended with imported pulp which will certainly produce better quality paper than that paper obtained from purely local wood pulp.

The characteristic of a paper mostly depends upon the chemical and mechanical treatments of the individual pulp used. There exists a variation of pulp properties from the same wood due to collection from different parts of the same tree, but these properties are related to the optimal condition of liquor concentration, digestion temperature and cooking time in producing these pulps. Consequently each process affects the pulp yield and quality. In this paper attempt has been made to find the properties of pulp and paper prepared by blending with different ratio of local made pulp with that of imported one.

EXPERIMENTAL

Three unbleached wood pulps from Gmelina Arbonea, Butyrosperimum Parkii and Pinus Caribarea were supplied by the Nigerian Paper Mill Jebba, Nigeria; and their specifications are given in Table 1. Billerud kraft pulp from Sweden was used for blending with Melina.

Method

Standard methods (12-24) in terms of pulp and paper tending were used to characterize the pulp's moisture content, ash content, permanganate number, fibre length and width

Pulping and Paper Sheet Making

18.0 g aid dry pulp soaked in 2.5 cm^3 of water for 15 minutes, disintegrated by standard laboratory disintegrator, for 15 minutes (or different times). Pulp thus obtained was filtered and squeezed to remove water and was put in a beator box with 200 cm^3 of water. The pulp was spread evenly between to lead plate and red bars. The pulp was then beaten in Jokro Muhle, DRP. 556839, (manufactured by Messers P.V. Wolhff and Sohne Limited G.M.B. No. 293) at 50 revolutions per minute.

Standard method (7, 13, 24, 25) was used to determine the freeness value (^oSR).

Sheet Preparation (7, 31-35)

Different pulps suspension with consistency of 0.2-0.25% were used to prepare a sheet of paper of weight basis about 64 $g.m^{-2}$. A standard sheet former, Karl-Schnuder, KG-Type and a paper wire of 10 wire per cm with a circular surface area of 0.031 m^2 were used to prepare many sheets.

To determine the effect of beating time on the pulp freeness and fibre dimensions, 18.0 g of each pulp was beaten for different times, and samples were withdrawn during the beating for testing the freeness. A small stock was kept aside for the determination of fibre dimensions microscopically.

Properties of Paper Sheet

Different blend ratio (w/w) of hard wood (Melina) and soft wood (pine-imported) pulp were made. The blend samples contained 0, 20, 40, 60, 80 and 100 percentages of hard wood pulp. Five sheets of (2 g wt) each stock were formed on the laboratory sheet former. The paper sheets were conditioned (74% r.h at 27°C ± 1°C 24 hours) and their following properties were examined.

(i) moisture content (26)
(ii) tensile test (24, 27)
(iii) burst strength test (27)
(iv) stiffness test (31)
(v) tear test (28, 29)
(vi) basis weight of the paper (24, 26, 27, 29)
and (vii) density of sheet (24).

TABLE 1.

Pulping Condition of Nigeria Woods

Condition	Gmilina Arborea	Butyrospermium Parkii	Pinus Caribarea
Moisture Content of wood (%)	19.6	45.4	15.4
Sulphidity (%)	27.6	27.5	20.0
Maximum cooking temperature	170	170	170
Time (h) to reach maximum temperature	1	1	2
Pressure at maximum temperature kg/cm^2	6.0-7.0	6.0-7.0	6.5-7.0
Liquor ratio	5:1	5:1	5:1
Gross yield %	43.8	50.1	51.9
Active alkali as Na_2O on oven dry wood %	18.0	19.6	20.0
Active alkali consumed on oven dry wood %	13.7	14.2	14.8

TABLE 2.

Wood Pulp Characteristic

Property	Type of Pulp			
	Gmelina Arborea	Pinus Caribarea	Butyrospermum Parkii	Imported Blllerud
Moisture content%	7.1	3.8	6.6	8.6
Ash content %	1.0	3.0	2.0	2.0
Permanganate number %	20.0	11.0	20.0	23.0
Mean fibre length (mm)	0.94	1.97	0.96	-
Mean width (mm)	0.023	0.038	0.013	-

TABLE 3.

Variation of Freeness with Beating Time of Different Wood Pulps

Beating Time min.	Freeness in SR^{o}			
	Gmelina Arborea	Butyrospermium Parkii	Pinus Ceribarea	Billerud Imported Kraft
0	15	16	15	12
10	25	18	19	17
20	26	20	23.5	20
30	-	22	-	22
40	40.5	25	62	27
50	42.5	30	-	41
60	55.5	35	-	-
70	65	49	-	-
80	83	80	85	-

TABLE 4.

Variation of Fibre Dimension Blended Pulp (60:40 Melina/Pine) Beaten for Different Times and Freeness

Beating time Min.	Freeness $S^{o}R$	Length $(mm)_a$	Width $(mm)_b$
No beating	12	1.35	0.029
15	21	0.84	0.026
25	32	0.83	0.034
35	40	0.66	0.038
40	57	0.62	0.029

[a]mean of 50 fibres

[b]mean of 50 fibres.

TABLE 5.

Variation of Paper Properties with Pulp Blends

Properties	Blend ratio Melina/Pina w/w					
	0/100	20/80	40/60	60/40	80/20	100/0
Beating time (min)	35	35	35	35	35	35
Freeness $S^{o}R$	50	45	43	42	40	42
Basis Weight $(g.m^{-2})$	64.0	64.1	64.0	64.2	64.0	64.1
Burst Strength $(mg.cm^{-2})$	0.56	0.60	0.90	2.8	2.0	1.8
Burst factor	8.8	9.4	14.1	34.8	31.3	25.0
Breaking load (kg)	2.7	3.0	3.1	5.7	4.2	3.4
Breaking length (m)	2813	3125	3250	5037	4375	3542
Tear factor	69.8	73.8	72.8	79.5	90.5	65.0
Stiffness (Taber's limit)	130	132	135	134	135	140
Sheet density $(g.cm^{-2})$	0.39	0.32	0.34	0.43	0.43	0.43
Moisture content (%)	3.8	3.9	3.5	3.9	9.0	3.7

RESULTS AND DISCUSSION

Table 1 shows the pulping condition of GMA, BPP and PCP woods. Table 2 gives the properties of the pulp obtained from their woods.

Pulp Characteristic

Moisture content is lowest for PCP and highest for imported pulp. The Gmelina Arborea (GMA) has moisture content in between. Nigerian pulp contains very little ash (1% compared to imported pulp 2%).

The permanganate number of a pulp indicates indirectly the presence of lignin. Lennert N. Salman and Ernst L. Black (13) showed that the amount of lignin affects the tensile properties. High content of lignin is responsible for extensibility of paper. The GMA pulp has same permanganate number as imported pulp. When fibres were viewed under a microscope (x 10), the hard wood fibres were found smaller in size (-0.94 - 0.96 mm), thicker cell walls, narrow lumen but over all smaller width and stiffer than soft wood fibres.

Table 3 gives the variaties of freeness with beating time for three wood pulps. As beating time is increased, the freeness gradually increases. When a pulp is made by mixing 60% Gmelina with 40% pine pulp, totally new properties are observed. Freeness for the soft wood is maximum, but when it is mixed and blended with different ratio its freeness decreases. Table 4 gives variation of fibre dimension, freeness with different heating time. The changes in freeness (35 min beating times) with different blend of pulp are given in table 5. There is no appreciable change in freeness at higher rated of imported pulp blend.

Paper Characteristics

Table 5 presents the variation of paper properties as the ratio of Melina is increased from zero to 100% in the blended pulp. Figure 1 gives the effect of beating time on certain properties of paper. Some of the observations are as follows:

Maximum breaking length, breaking load, tear factor, burst factor and burst strength were observed for a blend of 60% Melina and 40% soft wood pulp. It is noticed that hard wood pulp has not produced strong papers, but when blended with soft wood pulp, good quality paper is ensured.

It is evident that the beating time provides a higher relative bonding area (R.B.A.), causing an increase in the overall interfibre bond strength which is mainly associated with the burst and tensile strength of the paper. However, just after 35 minutes of beating, the breaking length begins to decrease. This effect is attributed to the fact that not only the interfibre bonds are responsible for the tensile rupture in paper, but the individual fibre (17) tensile strength (18, 19) makes some contributions, hence, as the beating progressed, the fibre underwent many structural changes, becoming shorter, thinner, more amorphous and plastic such that their tensile strength is reduced. There is definite indications (7, 18, 19) for correlation between the strength properties and the sheet density. Other factors affected by similar structural changes, are the stretch (% elongation at break), breaking length and stiffness of the sheet; the former increasing with beating time while the stiffness of the fibres changes within the limit, of 130-140. Due to uniform beating of individual fibre becomes more flexible and plastic.

It is concluded that Nigerian wood pulps compare favourably with imported pulps, and also respond well to mechanical treatments. Hardwood pulps present normal beating curves and show good strength properties for unbleached hand sheets, made from 60:40 Melina/pine (soft wood) pulp blend, which were developed between 30 and 40 minutes of beating with freeness between 40° and 46° SR.

From the properties it is expected that such papers should be capable of withstanding the changing weather conditions and hence should form good wrapping papers, or may be used for making cartons for packing.

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