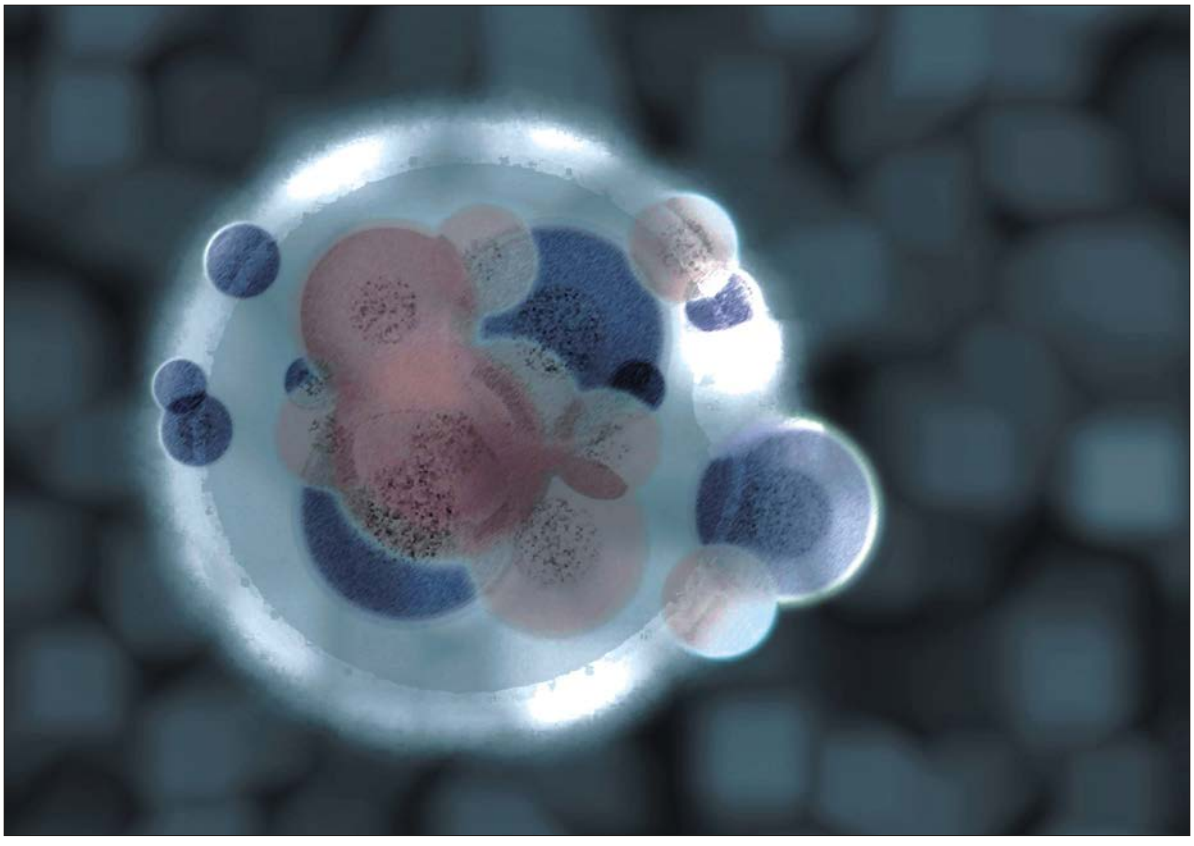

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Suitability of Some Local Bast Fibre Plants in Pulp and Paper Making

O.F. Olotuah
Department of Plant Science and Biotechnology,
Adekunle Ajasin University, Akungba-Akoko, Nigeria

Abstract: Morphological and Anatomical analyses were carried out on eight bast fibre plants from two families; Malvaceae and Fabaceae in Akungba-Akoko. In the anatomical study, the fibres were extracted and a total of fifty cells were measured for each species. Certain fibre properties, the cell lumen, diameter and cell wall thickness were determined from which the Runkel ratio, slenderness ratio and flexibility ratio were obtained to consider the suitability of the plants in pulp and paper making. The studies on fibre properties showed that the fibre lengths ranged between 2.20 mm for Hibiscus sabdariffa and 3.92 mm for Sida acuta with variations within the measured lengths of a species. The best fibre distributions were observed in *Hibiscus cannabinus* with 78% and *Urena lobata* 80%, having lengths of more than 2.5 mm and a Runkel ratio of less than one.

Key words: Bast fibre, pulp, paper making, fibre properties, Akungba-Akoko

INTRODUCTION

Paper in its various forms has become indispensable to the civilized man. In the stationery grade, it has from time immemorial served and remains as a most important medium for the recording and preservation of history. In other grades, paper is extensively used in the newspaper and the print media, to mention a few specific uses (FAO, 1991).

It has been estimated that Nigerian's annual consumption of pulp and paper products grew from a modest figure of 14,000-27,000 tonnes in 1960-1965 to 212,000-248,000 tonnes in 1971 to 1985 with a peak of 322,000 tonnes in 1976 for a population of 77 million (NPM, 1988).

As a result of this increase, all eyes are on countries where raw materials from the forests exist to provide the anticipated capacity beyond 1986.

Until recent researches on the suitability of local plants for pulp making, the wood have been considered best suitable sources of fibres for pulp and paper production (NPM, 1988). In paper production, it is generally thought that a good proportion of fibres should be 2-4 mm long to obtain a satisfactory strength and good paper quality (Baker, 1995). Considering the measures of obtaining the trees, the cost and importation method, it was therefore observed that these factors profound a retarded pace of producing the paper as demanded for. This retardation in production stimulated the research for an option as against the use of trees.

The discovery of Kenaf, *Hibiscus cannabinus* gave an impetus to the study of plants as being suitable for paper pulp. Technical and economic researches carried out on pulping and paper-making characteristics of Kenaf showed that it was brighter and better looking with better ink lay down, extremely good print contrast and reduced rub-off. Kenaf was also described as an ideal pulp source capable of offering an unlimited amount of pulp as Newspaper testing Kenaf newsprint have found it equal to, if not better than conventional wood pulp newsprint, (Sunday Tribune, 1989). However, Raffia palm and Bamboo were also considered but as only secondary alternatives to the pine wood.

This study reports on the results of anatomical studies of selected plant species carried out in Akungba, Nigeria, showing their fibre properties in relation to pulp and paper production.

MATERIALS AND METHODS

The study was conducted at Adekunle Ajasin University, Akungba-Akoko between 2004 and 2005. The plant materials investigated from Malvaceae were *Hibiscus cannabinus* L., *Urena lobata* L., *H. sabdariffa* L., *H. mutabilis* L., *H. lunarifolius* L., *Wissadula amplisima* L. *R.E. Fries Sida acuta* Burn. F. and from Fabaceae, *Cajanus cajan* L. Millsp. They were obtained from mature boles with no visible defects. The plants were chopped into match stick sizes and macerated using Schulze's method (Strasburger and Koernicke, 1923)

Two drops of Saframin O in a preparation of water was used in staining. A piece of the stained specimen was placed on a slide, squashed with dissected pin and then teased apart before mounting in water for examination under the microscope. Fibre properties were determined using a calibrated microscope at reasonable

magnifications of 10X objective for the fibre lengths and 40X objective for fibre diameter, cell lumen and cell wall thickness. For each species of plant considered, a total of fifty cells were measured. Since the data were not measured at the same magnification, there were then two calibrations of the microscope.

The measurement of the fibre properties were made to enable the derivation of morphology ratios of Runkel, Coefficient of flexibility and slenderness in predicting the suitability of the fibres in paper making.

Data analysis: Data obtained were subjected to analysis of variance and significant means were compared using the least significant difference (LSD) ($p \leq 0.05$) and the DMRT. Since measurements were taken at two magnifications of the microscope, measurements taken at 10X objective were multiplied by 9.8 and those at 40X objective were multiplied by 2.45.

RESULTS AND DISCUSSION

The Table 1 shows the means of the various parameters considered. The fibre length which is logically looked to as an indicator of the strength potential, especially for the derived fibre products ranged from 2.20 to 3.92 mm in the species with no significant difference and the variations in the quantities were not also significant at 95% confidence interval. The average length of these fibres are quite longer than those of the hard and soft woods.

The sampling of Pettroff *et al.* (1971) revealed an average of 1.7 mm and the sampling of Tamolang *et al.* (1957) and (1958) revealed an average length of hard and soft wood of 1.5 mm and these are not different from the Agency for International Development (AID) samples. Similarly, the mean fibre widths were not significantly different ($p>0.05$) in *Sida acuta* and *Wissadula amplisima*, as well as in *H. cannabinus*, *Urena lobata*, *H. mutabilis*, and *H. lunarifolius* except in Cajanus cajan with a lower value. The lumen which is a function of the cell diameter, are not significantly different ($p>0.05$) except in *H. cannabinus* with 12.88 μm.

In paper production, it is generally thought that a good proportion of fibres should be 2-4 millimeters long to obtain satisfactory strength and good paper quality (Manfred, 1994), however, the average fibre lengths for all the eight plants sampled ranged from 2.20 mm for *H. sabdariffa* to 3.92 mm for *Sida acuta* at 5% level of significance. In this study, fibre wall thickness showed a greater range of variation than did the fibre length. The thickest walls recorded were 10.05 μm in Wissadula amplisima and 8.35 μm in Sida acuta, which also has the longest fibre measurement. *Cajanus cajan* had the lowest average wall thickness for the eight samples. These values agree with Manfred, (1994) report on fibre length and width.

Table 2 shows the means of slenderness ratio, flexibility ratio and Runkel ratio which are derived quantities from the fibre properties. These ratios are measures of the ability of the fibres to conform to each other in the paper sheet. Runkel showed that, provided the fibre length was average, a plant would be suitable, if the ratio was less than one (Valkomer, 1969). Low Runkel ratios (high flexibility ratios or Coefficients) characterize thin-walled fibres which after beating and subsequent drying collapse readily to form flat ribbon-like structure which provides relatively large areas for bonding with other adjacent fibres. The greater the conformability of the fibres, the better the fibre-fibre-bonds. By comparison, *H. cannabinus* and *Urena lobata* with an overall average Runkel ratio of 0.92 and 0.98, respectively indicate very good quality paper making qualities, while Sida acuta with a high slenderness ratio, average fibre length of 3.92 mm and a Runkel ratio of more than unity could still produce

Table 1: Mean values of fibre dimensions of the studied plant species

Fibre properties	*H. cannabinus*	*U. lobata*	*H. sabdariffa*	*C. cajan*	*H. mutabilis*	*H. lunarifolius*	*W. amplisima*	*S. acuta*
Length (L) mm	2.48±0.05a	2.52± 0.05a	2.20±0.08a	2.40±0.06a	3.23±0.12a	2.49±0.04a	3.22±0.06a3	0.92±0.14a
Width (D) μm	24.77±0.08cd	21.58±1.30c	21.51±0.70c	11.69±0.67b	20.57±1.63c	21.32±1.16c	26.90±1.21a	28.82±0.72a
Lumen (I) μm	12.88±0.40a	10.87±0.75ab	6.13±0.27b	5.37±0.39b	10.17±0.90b	9.11±0.43b	6.81±0.38b	6.76±0.37b
Cell Thickness (t) μm	5.95±0.24a	5.35±0.30a	7.84±0.33a	3.16±0.22b	5.30±0.42ba	6.10±0.41a	10.05±0.44a	8.53±0.24a

Values are means of 50 counts. Mean followed by the same alphabet are not significantly different at 0.05 level of test using DMRT

Table 2: Means of derived quantities from the fibre properties

Derived quantities	*H. cannabinus*	*U. obata*	*H. sabdariffa*	*C. ajan*	*H. mutabilis*	*H. lunarifolius*	*W. amplisima*	*S. acuta*
Slenderness ratio L/D	100.12±0.06b	116.77±0.04b	102.78±0.11b	105.30±0.09b	106.02±0.07b	116.79±0.03b	119.70±0.05b	164.57±0.19a
Flexibility ratio (I/D) × 100	52.00±0.05b	50.37±0.58b	28.50±0.39a	45.94±0.58a	49.01±0.55b	42.73±0.37a	25.32±0.31a	28.38±0.51a
Runkel ratio (2xt/I)	0.92±0.60b	0.98±0.40b	2.56±1.22a	1.18±0.56a	1.04±0.46b	1.34±0.95a	2.95±1.16a	2.52±0.65a

a good quality paper. This corroborates the view of Dharm Dutt *et al.* (2004b), in their similar studies on *Eulaliopsis binata*, *Cajanus cajan* and *Sesbania sesban*, where they reported that Cajanus cajan showed high degree of conformability within the sheet due to lower value of Runkel ratio, Slenderness ratio, Wall fraction and Rigidity coefficient. This results in greater degree of fiber collapse. Similar work from Dharm Dutt *et al.* (2004a) on *Ipomea carnea* reported that although the fibres were short, yet it gave stronger paper due to high collapsing index. In view of this, most of the local bast fibres plants having some of these desirable properties could be tested for newsprint production of which they may produce papers of fairly good quality.

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