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# Properties of Kenaf (*Hibiscus cannabinus* L.) Bast Fibre Reinforced Bagasse Soda Pulp in Comparison to Long Fiber

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**Abstract:** This research was conducted to evaluate the possibility of substituting Imported Long Fiber Pulp (ILFP) with Kenaf Bast Fiber Soda Pulp (KBFSP) in production bagasse paper. Different cooking times were used for KBFSP and corresponding kappa numbers were measured to find kappa number 21.6 similar to the ILFP. Pulps with the same freeness were prepared and their morphological properties were compared with together. Result showed that KBFSP needs lower beating value than ILFP to reach the same freeness. At constant pulp freeness, KBFSP had longer fibers and lower cell cavity diameter than ILFP. KBFSP had significantly greater slenderness ratio and Runkle ratio than ILFP. In general, it appears that KBFSP has potential to substitute with ILFP to produce bagasse papers with acceptable properties.

**Key words:** Bagasse · Freeness · Imported Long Fiber · Kenaf Bast Fiber · Soda Pulp

## INTRODUCTION

Because the wood resources are inadequate, the utilization of non-wood pulps instead of wood pulps in the production of different kinds of papers is growing in many countries. Non-wood plants are abundant, have short cycles and rapid regeneration and are of comparatively low price [1].

Bagasse short fibers have attracted attention as a potential non-wood raw material for the pulp and paper making and many researches has studied the possibility of making pulps from bagasse [2-6].

Besides these benefits, papers of high strength could not be produced with pure bagasse pulp. So, long fiber soft-wood pulps, generally mix with bagasse pulps to produce papers with adequate mechanical properties. Amount of long fiber pulp used, depends on the final paper properties but, as previously said, there are often insufficient softwood resources in many countries.

Today's, huge amounts of kenaf are planted around the world. The average length of kenaf bast fibers (3-4 mm) are in the range of the long fiber softwood.

So, these fibers have potential to substitute with long fibers in production of bagasse papers.

This study was conducted to evaluate fiber characteristics of kenaf bast fiber soda pulp for substituting with long fiber pulp in bagasse pulps. In fact, by measuring fiber characteristics, the paper maker is able to trouble shoot the paper process.

Kenaf bast fiber soda pulp and softwood long fiber soda pulp with the same freeness, were produced and morphological properties compared with together.

## MATERIALS AND METHODS

The kenaf samples at this research were prepared from Varamin Cotton Investigations Center. Kenaf bast fibers have been separated from stems and after washing and drying, used for pulping.

KBFSP at different cooking times were prepared and corresponding kappa numbers were measured to find kappa number 21.6 similar to the unbleached imported long fiber pulp. Kappa numbers of pulp were measured according to TAPPI; T236 om-85. Also, Bagasse Soda Pulp with kappa number 13.5, similar to that prepared by Pars Paper mill, was produced. The maximum pulping temperature was 165°C; alkaline was 20% based on sodium hydroxide and ratio of liquor to dry weight of the raw material was 8:1.

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Different PFI mill (Model of LABTECH) revolutions were used to obtain pulps with the same freeness. Freeness of pulps were determined according to TAPPI; T227 om-94. Pulp fiber sampling was made before and after refining and Franklin method [7] was used to measure the dimensions of pulp fiber. In this regard, fifty pulp fibers were selected and physical properties like length, diameter, diameter of cell cavity and thickness of fiber walls in the middle of fibers were measured. Measurement of fibers dimension was calculated by image analyzer.

Slenderness ratio (SR) or felting power, which is a measure of the tear properties of pulp in paper production [8] was calculated from L/D (L= fiber length, D= fiber diameter). Runkle ratio (RR), which is a measure of the suitability of fiber for paper production was calculated from 2 W/K (W= fiber wall thickness, K= fiber lumen diameter [9].

## RESULTS AND DISCUSSION

Relationship between KBFSP kappa numbers and cooking times were drawn and regression equations were measured as shown in figure 1.

Based on regression equations, optimum cooking time in KBFSP to reach kappa numbers 21.6, was 52 minutes and 44 seconds. KBFSP yield at this cooking time was 55.6 %.

Table 1 shows the effect of refining degree on pulps freeness. It was observed that in all pulps, as the refining value increased, pulp freeness decreased. This is expectable because more refining means more production of fines in pulps therefore the tendency for maintain water in pulps increases and pulp freeness decrease. The results show that KBFSP needs lower beating value compared to ILFP to reach Canadian Standard Freeness (CSF) of 400 mL. It can be concluded that by substituting ILFP with KBFSP, pulping process energy will save.

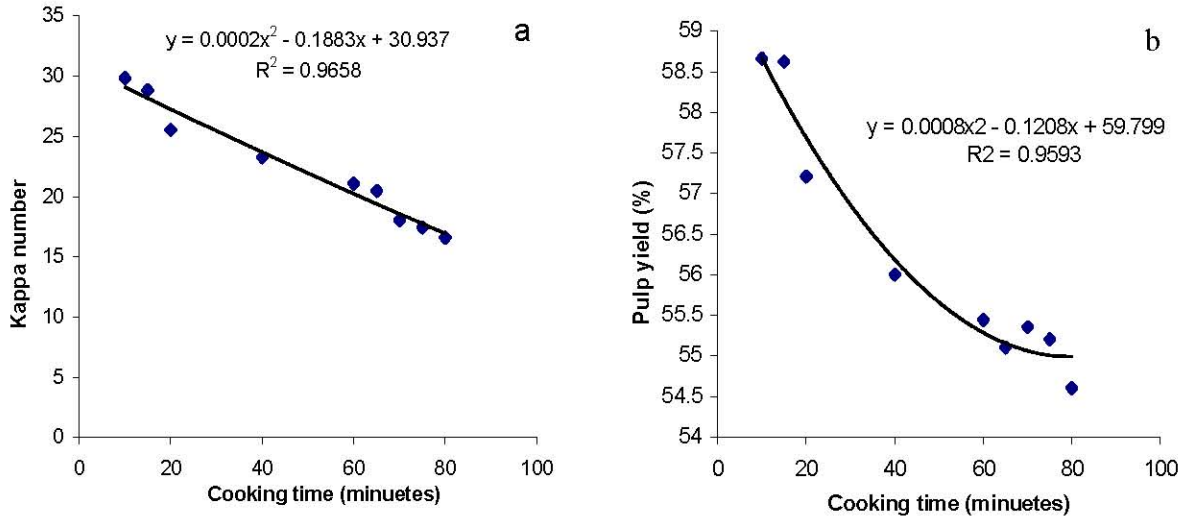


Fig. 1: Effect of cooking time on pulp kappa numbers (a) and pulp yields (b) of kenaf bast fiber soda pulp

Table 1: Effect of different refining degree on pulps freeness

| Pulp | Pulp freeness before beating (mL CFS) | Refining degree (rpm) | Pulp freeness after beating (ml CFS) |
|---|---|---|---|
| Kenaf Bast Fiber | 480 | 2000 | 340 |
| | | 1500 | 370 |
| | | 1000 | 400 |
| Long Fiber | 520 | 9000 | 400 |
| | | 8000 | 420 |
| | | 7000 | 440 |
| Bagasse | 545 | 3500 | 370 |
| | | 3000 | 380 |
| | | 2500 | 400 |

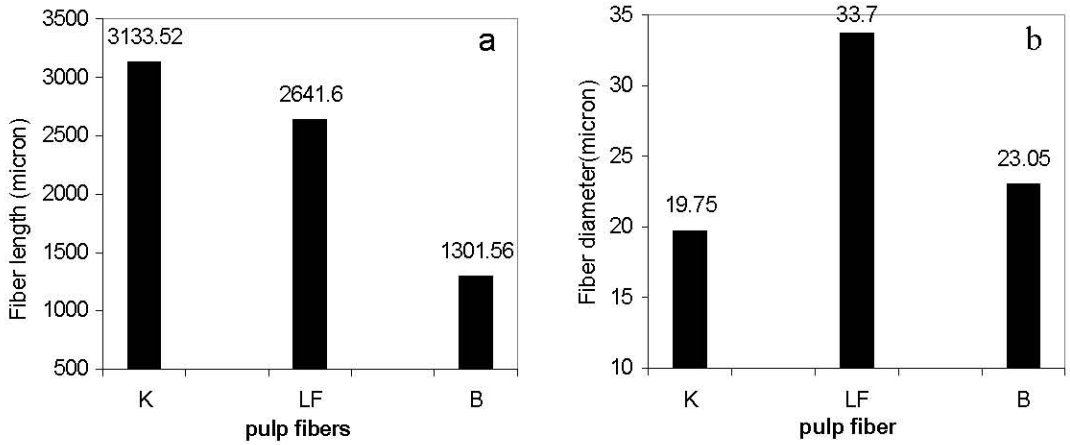


Fig. 2: Average fiber length (a) and fiber diameter (b) of pulps with the same freeness. (K= kenaf pulp, LF= long fiber pulp, B= bagasse pulp)

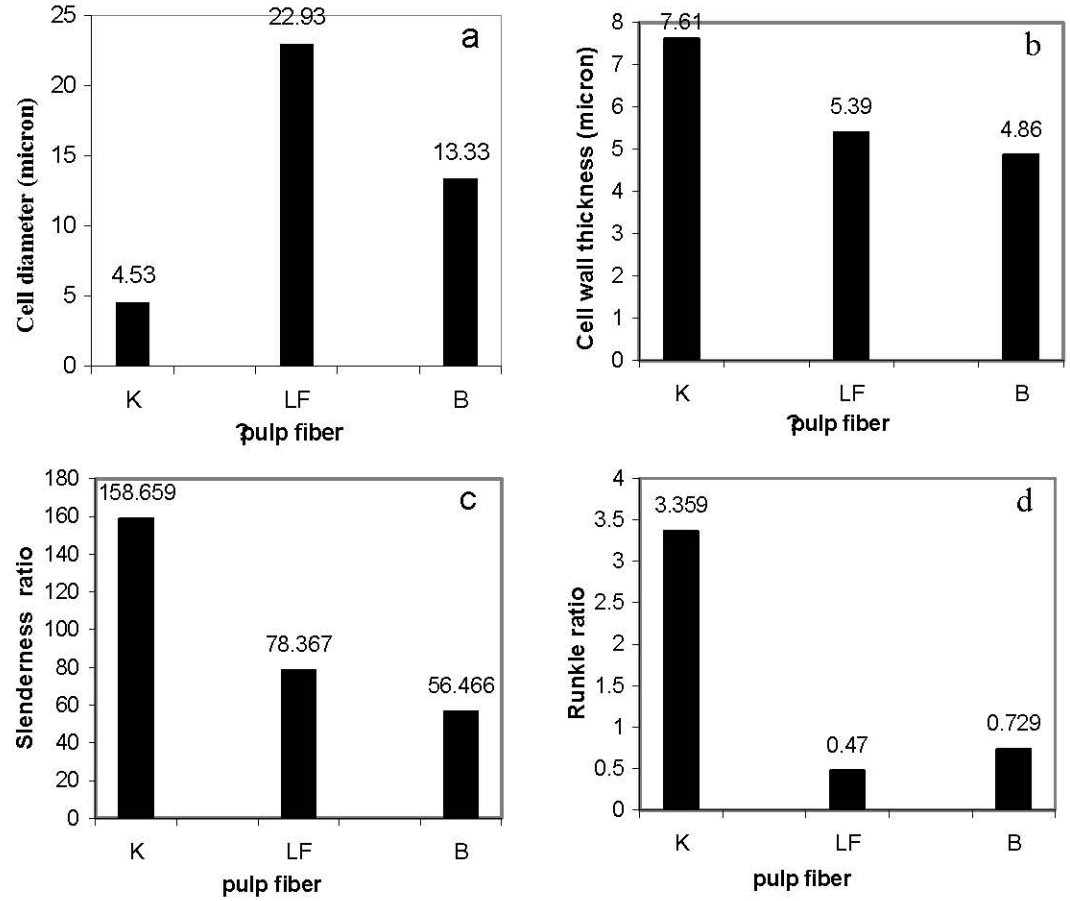


Fig. 4: Average fiber cell cavity (a), cell wall thickness (b), Slenderness ratio (c) and Runkle ratio (b) of pulps with the same freeness. (K= kenaf pulp, LF= long fiber pulp, B= bagasse pulp).

Average fiber length and diameter of pulps with the same freeness are shown in figure 2. As can be seen, at constant pulp freeness, KBFSP had longer fibers than ILFP. This was due to lower beating of KBFSP fibers compared to ILFP to obtain pulps with the same freeness. Because there is general belief that paper with desirable strength properties could be made from long length fiber [10] it could be concluded that bagasse

papers reinforced with kenaf bast fibers would have better strength properties. However, fiber length is not the overriding factor in producing paper with acceptable strength.

Average cell cavity, cell wall thickness, Slenderness ratio and Runkle ratio of pulp fibers with the same freeness are shown in figure 3. At the same pulp freeness, KBFSP had higher wall thickness and lesser cell cavity than ILFP.

KBFSP had significantly greater Slenderness ratio and Runkle ratio than ILFP and appeared to be suitable for substitute with ILFP in production of bagasse papers. Because burst strength of final paper had close relation with Runkle ratio, it appears that KBFSP will produce papers with higher burst strength than ILFP, when mixed with bagasse pulps.

## CONCLUSION

The following conclusions could be drawn from the results of this study:

- KBFSP needs lower beating value compared to the ILFP to reach Canadian Standard Freeness (CSF) of 400 ml.
- At the same freeness of pulps, KBFSP has longer fibers length than the ILFP and has potential to substituting with ILFP and reinforcing bagasse pulps.
- At the same freeness of pulps, Slenderness ratio and Runkle ratio of KBFSP were about twice the ILFP.

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