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APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

CLASSIFIED INVESTIGATION NO. 2
BLEACHED CHEMICAL PULP FROM KENAF

REPORT NO. 8
CHEMICAL PULP FROM KENAF BAST

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CHEMICAL PULP FROM KENAF BAST

By Chien Chu*, Naiyana Niyomwan*, and Anchalee Puangvichit*

SUMMARY

Bleached chemical pulp was prepared from retted kenaf bast fibre by delignification with chlorine dioxide. Thai kenaf retted fibre was treated with ClO_2 in water at 90°C and pH 3.0 for 20 minutes with liquor ratio 5:1. Alkali extraction followed, using 2% caustic soda with liquor ratio 6:1, at 70°C for ½ hour. Bleaching was done in two stages with 2% available chlorine as hypochlorite, then 0.75% available chlorine as ClO_2. The bleached yield attained 80% with 82% brightness.

Air-dry kenaf bast ribbons stripped from Thai kenaf stalks were cooked by NSSC process at 160°C for 2 hours with 8% sodium sulphite and 1% sodium bicarbonate. The NSSC pulp was refined and delignified with 4% chlorine dioxide at 80°C and pH 3.0 for one hour. Then alkali extraction with 2% caustic soda followed. Bleaching to 78% brightness was done with hypochlorite containing 5% available chlorine on pulp weight. Bleached yield of 60% was attained.

Both high yield chemical pulps have good quality comparable to bleached coniferous sulphite pulp.

Kraft pulping of Thai kenaf bast ribbons was made by cooking with 16.5% active Na_2O and 20% sulphidity at 170°C for 1½ hours. The pulp with 52% yield was bleached to 82% brightness with 8% chlorine in C/E/H bleaching sequence. Of the three pulps the bleached kraft pulp with high freeness of S-R 890 ml and a bleached yield of 45% has the best quality in respect to pulp strength, featuring, at freeness 460 ml, breaking length 6761 m, tear factor 220, burst factor 53, folds 478, and bulk 1.65.

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INTRODUCTION

The most valuable part of kenaf is the bast, which constitutes about one-third the weight of kenaf stalks. The trend of shrinking market of kenaf fibre due to competition from synthetic substitutes impels exploration of alternate uses of kenaf, especially for domestic market as raw material for pulp. This is especially attractive if kenaf is cultivated for both seed and pulp. The seed provides additional income when kenaf stalks are grown for pulp. Fractional processing of stalks for different kinds of pulp from the bast ribbons and woody cores respectively could have some advantages of low pulping cost and high yield.

The chlorine dioxide pulping for holocellulose pulp from kenaf bast is proposed. The relatively small lignin content in kenaf bast requiring correspondingly small consumption of chlorine dioxide should make chlorine dioxide pulping quite economical.

Chidester and Shafer (1962) reported chemical composition and fibre length of Cuban kenaf stalks, bark, and core as shown in Tables 1 and 2.

TABLE 1. CHEMICAL COMPOSITION OF CUBAN KENAF AND U.S. HARDWOODS (Chidester and Shafer 1962)

Material	Chemical composition				Solubility in 1% NaOH extract (%)
	Lignin (%)	Holocellulose (%)	Alpha cellulose (%)	Total pentosan (%)	
U.S. hardwoods (av.)	22	75	47	19	14
Kenaf stalk	17.5	70.3	45.1	15.9	31.3
Kenaf ribbon	12.0	77.0	56.6	14.3	23.1
Kenaf woody core	19.8	69.5	46.3	15.5	27.6

TABLE 2. LENGTH OF FIBRES OF CUBAN KENAF SULPHATE PULPS AND WHITE LAUAN SULPHATE PULP (Chidester and Shafer 1962)

Source of fibres	Length of fibres		
	Average (mm)	Maximum (mm)	Minimum (mm)
White lauan	1.70	2.65	0.99
Kenaf stalk	2.21	6.97	0.53
Kenaf bast fibre	2.74	7.60	0.98
Kenaf woody core	2.07	7.14	0.45

Compared with hardwoods, kenaf bast fibre has low lignin, long fibre length, and high holocellulose.

Clark in 1971 reported kraft pulping of Cuban kenaf bast with 16.4% Na_2O and sulphidity 33.9% at 170°C for 2 hours. The screened yield was 52% with initial freeness S-R 860 ml, and maximum strength index 3500. The pulp consumed 8.3% chlorine in C/E/H bleaching to 80% brightness with a bleached yield of 45%.

The low yield of kraft process impels investigation of other processes for higher yield and lower chemical consumption. Thus in the present study two new processes are tried for kenaf bast.

EXPERIMENTAL AND RESULTS

Preparation of bleached pulp from retted kenaf bast fibre

Retted fibre strands of Thai kenaf were chopped into 2-cm staple. The fibre staple was soaked in a sodium chlorite solution with liquor ratio 5:1 in a polyethylene bottle. Chlorine dioxide gas was generated from the sodium chlorite solution by acidifying the solution with dilute 10% hydrochloric acid to pH 3.0. The chlorine dioxide solution was heated to 90°C and held at that temperature for 20 minutes. The amount of sodium chlorite (technical grade, 90% pure) is about 12% on raw material. This amount corresponds to about 4.6% chlorine dioxide or 12% equivalent chlorine based on the weight of fibre. The combined delignification and bleaching action of chlorine dioxide produced brightened staple. After washing, alkali extraction with 2% caustic soda on pulp weight was done for ½ hour at 70°C and 10% pulp consistency. The extracted staple was washed and then bleached at 40°C for 3 hours with sodium hypochlorite containing 2% available chlorine on pulp weight. The bleached pulp was washed and further bleached with 0.4% chlorine dioxide at 60°C for 3 hours. The pulp was washed and rinsed in 0.2% SO_2 water for ½ hour. The bleached yield of pulp was 80% on retted fibre. The pulp had initial freeness of S-R 930 ml.

Preparation of bleached pulp from kenaf bast ribbons

Thai kenaf bast ribbons, about 750 g air-dry weight, were shredded to 2 cm staple. The charge was cooked at liquor ratio 3:1 with 8% sodium sulphite and 1% sodium bicarbonate for 2 hours at 160°C in a rotary digester with electric heating. The resulting pulp was washed and disc refined. The crude yield was 68.3% on raw material.

About 200 g of the crude pulp was treated in a closed polyethylene bottle with liquor ratio 4:1 and 4.0% chlorine dioxide on the pulp weight. The chlorine dioxide was generated by acidifying sodium chlorite in the liquor to pH 3.0 with dilute HCl. The ClO_2 treatment was done at 80°C for one hour with occasional shaking. Then the pulp was washed and extracted at 70°C for ½ hour in an alkali liquor containing 2% caustic soda on pulp weight. The pulp consistency was about 10%.

Bleaching was done at 10% consistency for 3 hours at 40°C with sodium hypochlorite solution containing 5% available chlorine on pulp weight. The pulp was then washed and brightened in 0.2% SO_2 water for ½ hour. The bleached yield was 60% on chips. The initial freeness of pulp was S-R 525 ml, and the pulp was beaten in a Valley beater to S-R 300 ml freeness in two minutes.

Preparation of bleached kraft pulp from kenaf bast ribbons

Shredded air-dry Thai kenaf ribbons were cooked at liquor ratio 3:1, 170°C for 1½ hours with 16.5% total Na_2O and 20% sulphidity, another 1½ hours having been taken to reach the maximum temperature of 170°C. The yield was 52%. The pulp was bleached with 8% chlorine in C/E/H sequence to brightness 81.5%. The bleached yield attained 45%.

Preparation of handsheets and results of physical tests

Preparation of handsheets was made in the usual way as described in previous reports with sizing materials consisting of 0.3% Whiten as optical brightener, 1.5% rosin size, and 3.0% alum. The handsheets were conditioned in a room at 23°C and 55% humidity for physical tests according to TAPPI methods. The results of tests are shown in Table 3.

TABLE 3. PHYSICAL PROPERTIES OF PULPS FROM THAI KENAF BAST AND CONIFEROUS WOODS

Physical tests	Pulp from kenaf retted fibre	Pulp from kenaf bast ribbons	Kraft pulp from kenaf bast ribbons	Sulphite pulp from coniferous wood (commercial)
Initial freeness, S-R, ml	930	525	890	900
Final freeness, S-R, ml	390	300	460	450
Beating time, min	8	2	5	-
Basis weight, g/m^2	59	60	61	-
Breaking length, m	6273	6752	6761	5258
Tear factor	151	187	220	139
Burst factor	36	54	53	33
Bulk, ml/g	1.85	1.64	1.65	-
Folding endurance	101	94	478	227
Brightness, %	82	78	82	85
Bleached yield, %	80	60	45	-

DISCUSSION

The pulp with high yield by ClO_2 process is distinguished by lower tearing strength and lower folding endurance when compared with kenaf kraft pulp, which has better strength but lower yield. When pulp strength is not critical, the high yield pulp may have some advantages of low cost than that of the kraft pulp

As expected from the relatively low lignin content of kenaf bast, ClO_2 pulping produces holocellulose pulps of good brightness in exceptionally high yields. Thus Table 3 shows 80% yield of pulp from retted fibre and 60% from bast ribbons as compared with 45% yield from bast ribbons pulped by kraft process. The high yield holocellulose pulps have lower tearing strength and lower folding endurance than the kraft pulp, but their quality is comparable to that of bleached coniferous sulphite wood pulp. Because of their high yield, they may prove to be economically advantageous, provided raw material and chemical costs are not too high.

In general, chemical costs of pulp manufacture in Thailand are excessive, partly because of import duty on imported chemicals. Consideration should be given by the Government to improving the economics of pulp and paper manufacture by removing import duties on the required chemicals. If chlorine dioxide pulping and bleaching are to be used, consideration should also be given to the economics of manufacturing sodium chlorite from common salt by electrolysis. At the present preliminary stage of investigation, realistic costs of manufacturing holocellulose pulps cannot be assessed.

CONCLUSIONS

1. Preparation of bleached holocellulose pulp from retted kenaf bast fibre can be done by delignification with 4.6% chlorine dioxide at pH 3.0, liquor ratio 5:1 and 90°C for 20 minutes followed by 2% hot caustic soda extraction at 70°C for ½ hour. Bleaching to 88% brightness was accomplished by two-stage bleaching with hypochlorite containing 2% available chlorine and chlorine dioxide bleaching containing 0.75% ClO_2. Exceptionally high yield of 80% bleached pulp with 82% brightness was attained.

2. Bleached chemical pulp from air-dry kenaf bast fibre was prepared by neutral sulphite semichemical pulping at 166°C for 2 hours with 8% sodium sulphite and 1% sodium bicarbonate. The pulp with a yield of 68% can be refined by delignification with 4% chlorine dioxide on NSSC pulp at 80°C for one hour and alkali extraction with 2% caustic soda. A hypochlorite bleaching with 5% chlorine brings the pulp brightness to 78% with a bleached yield of 60%.

3. Bleached kraft pulp from Thai kenaf bast ribbons was prepared by cooking with 15.5% Na_2O and 20% sulphidity at 170°C for 1½ hour. The pulp with yield of 52% was bleached to 80% with 9% chlorine in C/E/H sequence with a bleached yield of 45%.

4. Bleached kraft pulp has the best strength. The bleached NSSC pulp comes next. The bleached holocellulose from retted fibre has the highest bulk with lower strength. But the quality of holocellulose pulp is comparable to bleached coniferous sulphite wood pulp.

ACKNOWLEDGEMENT

The authors wish to express their thanks to the Royal Forest Department for the use of their laboratory facilities.

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