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APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

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BLEACHED CHEMICAL PULP FROM KENAF

REPORT NO. 1
BLEACHED MAGNEFITE PULP FROM KENAF

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F O R E W O R D

The competition of synthetic fibres and the trend to bulk shipment of agricultural produce are affecting the world kenaf market. Use of Thai kenaf as raw material for pulp and paper production can help to stabilize the kenaf trade in Thailand.

Following a study on "Newsprint from kenaf"* based on kenaf waste wood and kenaf ribbons, it now appears that kenaf stalks, especially stalks of the seed crop, can also play an important role as raw material for many grades of paper. Hence the research work was extended to pulp and paper from kenaf stalks.

* "Newsprint from kenaf" by Chien Chu, Churn Downdak, Ampika Krairit, and Naiyana Niyomwan. Report No. 2 on R.P. 1/17. (ASRCT unpublished report.)

BLEACHED MAGNEFITE PULP FROM KENAF

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

SUMMARY

Bleached chemical pulp was obtained by magnesium bisulphite process from kenaf stalks of both Cuban variety (Hibiscus cannibinus) and Thai variety (Hibiscus sabdariffa). Kenaf chips were cooked at 146-150°C in magnesium bisulphite solution at liquor to chip ratio 4:1 and pH value 3-4 for 4½ hours. The cooking solution contained a total of 16-18% SO_2 on ovendry chips. Cooking yield was about 50 per cent. Bleaching to about 80% brightness was obtained with about 8% chlorine. The bleached yield was 42 per cent.

The physical properties of bleached pulp indicated good quality superior to hardwood kraft pulp and comparable to softwood sulphite pulp except for tearing strength.

INTRODUCTION

In earlier reports+ some economic factors in assessing kenaf stalks for pulping purposes were studied under Research Project 1/17. The demand for pulp and paper in Thailand and the unsteady market of retted kenaf fibres prompted further research on the production of pulp and paper from kenaf for import savings and diversification of kenaf market for domestic needs.

Printing paper is the major item of imports, although some is made locally with imported pulp. The Bang Pa-in Paper Mill makes printing paper at 40 tonnes per day from bleached rice straw pulp and 20% imported bleached wood pulp. The Kanchanaburi Paper Mill produces only about 10 tonnes of printing paper from bleached bamboo pulp with 20% imported bleached hardwood pulp. The production costs of both mills are high and their operation is not profitable.

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* Technological Research Institute, ASRCT.

+ (1) "Prospects of utilizing kenaf for pulp and paper" by Chien Chu. Report No. 1 on R.P. 1/17. (ASRCT unpublished report); (2) "Utilizing kenaf for chemical pulp: A pre-feasibility study" by Tolgay Cavusoglu and Chien Chu. Report No. 3 on R.P. 1/17. (ASRCT unpublished report.)

The magnesium bisulphite process, also called magnefite process, has been used for pulping hardwood. This process is proposed for pulping kenaf stalks to produce a high yield of bleached chemical pulp suitable for making printing paper. The magnefite process for kenaf stalks would lend itself well to medium and even small sized pulp and paper mills with capacities in the range of 50 to 100 tonnes of paper per day.

EXPERIMENTAL AND RESULTS

Details of the experiments are tabulated in Table 1. The general procedures followed are outlined below.

(a) Preparation of bleached bisulphite pulp

Fresh or air dry kenaf stalks, about 1 kg on dry basis, were chopped to about 1" lengths. The chips were cooked in a stainless steel 10-litre laboratory tumbling digester with automatic temperature control. The amount of cooking liquor was adjusted so that a liquor to air dry chips ratio about 4:1 was maintained.

The magnesium bisulphite solution used in the pulping was prepared by absorbing SO_2 gas in water containing 2% magnesia in suspension, until the total SO_2 content reached 6% in concentration and the pH value attained 3.5.

The necessary amount of magnesium bisulphite solution was added to the chips so that a total of 12 to 18% SO_2 on ovendry chips was contained in the cooking liquor. The digester, after being filled with the chips and cooking solution, was closed and heated to 120°C in one hour and maintained at this temperature for one hour for impregnation. The digester was heated again to a maximum temperature ranging from 146 to 150°C in one-half hour and maintained at the maximum temperature for a period of 4-4½ hours. At the end of the cooking period, the digester pressure was relieved by venting for about 15 minutes to atmospheric pressure before opening the digester. The crude pulp was washed and passed through a laboratory single disc refiner for defibering. The refined pulp was washed and centrifuged. The wet cake from the centrifuge was slushed and used in bleaching. Yields are given in Table 1.

TABLE 1
PULPING AND BLEACHING CONDITIONS IN THE MAGNESIUM BISULPHITE PULPING OF KENAF STALKS

Cook No.	276	399	411	426	249	133
Raw material	Thai kenaf, air dry	Cuban kenaf, fresh	Cuban kenaf, fresh	Cuban kenaf, air dry	Cuban kenaf, air dry	Thai kenaf, air dry
Cooking solution, pH value	3.5	3.2	4.0	3.9	4.0	3.2
Total SO_2,%	5.0	6.0	5.8	3.8	3.8	3.2
Free SO_2, %	2.5	2.9	3.0	2.0	1.9	1.7
MgO, %	1.9	2.0	2.1	1.6	1.6	2.0
Total SO_2 on ovendry chips, %	16.8	18.0	18.0	16.0	12.0	16.5
Liquor to chips ratio, ml/g	3.3	5.0	5.1	4.0	3.3	5.3
Max. temp., ^{o}C	150	150	146	146	145	150
Time to max. temp., h	2	2	2.5	2.0	1	1 ½
Time at max. temp., h	4	4.5	4.5	4.5	4	4
Pulp yield, % on ovendry chips	50.1	51.2	48.5	52.8	61.0	48.4
Permanganate no.	14.6	20.2	20.2	-	-	18.4
Bleaching sequence	C/E/D	DC/E/D	C/E/H	C/E/D	H/P	H
Chlorination stage (DC), ½ hour						
ClO_2, %	-	0.76	-	-	-	-
Cl_2, %	7.0(1 hour)	4.0	5.5	6.0		
Alkali extraction stage (E), ½ hour						
NaOH, %	2	1.5	1.5	1.5	-	-
Hypochlorite bleaching stage (H), 2 hours, available chlorine, %	1.0	-	0.5	-	6.0	5.0

TABLE 1 (continued)

Cook No.	276	399	411	426	249	133
Raw material	Thai kenaf, air dry	Cuban kenaf, fresh	Cuban kenaf, fresh	Cuban kenaf, air dry	Cuban kenaf, air dry	Thai kenaf, air dry
Hydrogen peroxide bleaching stage,						
(P) H_2O_2 %	-	-	-	-	2.0	-
Chlorine dioxide bleaching stage,						
(D) 70°C, 3 hours	0.38	0.76	-	0.76	-	-
ClO_2, %						
Total equivalent chlorine applied, %	9.0	8.0	6.0	8.0	6.0	5.0
Bleached yield						
% on ovendry unbleached pulp	83.2	79.4	86.8	80.6	72.4	84.0
% on ovendry chips	41.7	40.7	42.2	42.2	44.0	40.7
Paper no.	136	180	182	190	114	79
Physical properties of handsheets (50% R.H., 23°C)						
Basis weight, g/m^2	55.1	77.2	80.7	81.7	56.1	55.6
Bulk, ml/g	1.23	1.21	1.19	1.17	1.14	1.18
Burst factor	23.8	40.0	31.0	32.5	34.8	27.9
Tear factor	56.6	82.8	63.5	60.7	60.0	50.3
Breaking length, m	5,182	6,872	7,214	6,830	7,750	5,933
Brightness, %	77	80	70	80	59	58
Folding endurance	80	193	32	20	570	158
Initial freeness, S.R. ml	720	650	750	740	810	860

TABLE 1 (continued)

Cook No.	276	399	411	426	249	133
Raw material	Thai kenaf, air dry	Cuban kenaf, fresh	Cuban kenaf, fresh	Cuban kenaf, air dry	Cuban kenaf, air dry	Thai kenaf, air dry
Final freeness, S.R. ml	310	470	455	465	340	150
Time of beating, min	5.0	2.5	3.0	3.0	5.0	1.0
Sizing of handsheets						
Rosin size, %	2.0	1.5	1.5	1.5	2.0	1.0
Aluminium sulphate anhydrous, %	4.0	3.0	3.0	3.0	4.0	2.0
Kaolin, %	5.0	-	-	-	5.0	5.0
Tamarind kernel powder, %	2.0	2.0	2.0	2.0	2.0	-
Whitin (brightening agent), %	0.3	0.3	0.3	0.3	0.3	-
Remarks					H_2O_2 bleach pH at 10.5, 65°C, 2 hours	1% sodium tripoly-phosphate was used in sizing

Bleaching was done in three to four stages as C/E/H or C/E/H/D sequence with a total of 6 to 8 per cent equivalent chlorine based on 100 g air dry unbleached pulp as follows:

(i) Chlorination stage (C)

Chlorination of 100 g unbleached pulp was done at 3% consistency with 6 to 8 per cent available chlorine for one half hour at room temperature in acidified sodium hypochlorite solution with pH value about 1.8. The chlorination was done in a closed polyethylene 5-litre bottle. The amount of chlorine applied was determined by the permanganate no. of the unbleached pulp. After chlorination, the pulp was washed.

In one experiment cook No. 399, chlorine generated from acidified sodium hypochlorite solution at pH 1.8 was mixed with chlorine dioxide generated by adding sodium chlorite to the acidified hypochlorite solution. The bleaching time was 0.5 hour at room temperature about 30°C.

(ii) Caustic extraction stage (E)

Caustic extraction of the chlorinated pulp at 10% consistency was carried out in a beaker at 70°C for 0.5 hour with 1.5 per cent caustic soda on pulp weight. The pH value at this stage was controlled at 10-11. The extracted pulp was washed.

(iii) Hypochlorite bleaching stage (H)

Hypochlorite bleaching for one half hour at 10% consistency and 40°C was done in a beaker with sodium hypochlorite solution containing 0.5 per cent available chlorine on pulp weight. A rinse of the bleached pulp was applied.

(iv) Chlorine dioxide bleaching stage (D)

Chlorine dioxide bleaching for 3 to 5 hours at 70°C and 10% consistency was done in a polyethylene bottle with cover. The chlorine dioxide solution was prepared by acidifying sodium chlorite solution to pH 4.0 with 10% hydrochloric acid. The amount of chlorine dioxide based on pulp weight was 0.75 per cent. The bleached pulp was rinsed with cold water.

(v) Acid washing stage (A)

Acid washing for 0.5 hour at 5% consistency and room temperature was carried out in a beaker with 0.5% SO_2 based on pulp weight.

The bleached yield of pulp was about 80 to 85 per cent of the unbleached pulp. The brightness attained was about 75 to 80. See Table 1 for details.

(b) Preparation of paper handsheets and physical tests

Handsheets were prepared from the bleached pulps with 1-2% rosin size, 2% alum, 2% tamarind kernel flour as a dispersing agent, and 0.3% brightening agent. All handsheets were conditioned for 24 hours at 23°C and 50% relative humidity. TAPPI standard testing methods were used in the physical tests.

DISCUSSION

Air dry kenaf stalks were more resistant to delignification than green kenaf. Green kenaf gave brighter pulp with less consumption of bleaching chemicals and higher strength. This was also true with pulping of fresh kenaf by kraft process. It appears that fresh kenaf is more accessible by cooking solution. In kraft pulping of fresh kenaf reported by Clark *et al*. (1967)*, better pulp with less bleach consumption was obtained when compared with kraft pulp from dry kenaf.

In pulping kenaf, low concentration of magnesium bisulphite solution as cook No. 249 for dry Cuban kenaf gave higher yield of unbleached pulp with good strength but difficult to bleach. For semi-bleached grade with brightness about 59 this perhaps has some advantages in strength and yield as indicated in cook No. 249 and may lend well to newsprint furnish for its low cost of cooking and bleaching chemicals in the simple H/P bleaching sequence.

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* CLARK, T.F., UHR, S.C., and WOLFF, I.A. (1967).—A search for new fiber crops. X. Effect of plant maturity and location of growth on kenaf composition and pulping characteristics, TAPPI 50(11): 52A-56A.

TABLE 2

PHYSICAL PROPERTIES OF HANDSHEETS PREPARED FROM KENAF AND WOOD PULPS

Physical property	Bleached Cuban kenaf magnefite (Cook No. 399)	Kenaf kraft pulp[1/]	Unbleached eastern hardwood kraft[1/]	Unbleached western softwood sulphite[1/]	Unbleached southern softwood kraft[1/]
Freeness, S.-R., ml	455	600	600	800	750
Burst factor	40	72	25	34	66
Breaking length, m	6,872	11,500	4,690	5,460	9,240
Tear factor	83	93	42	121	120
Folding endurance	193	1,140	10	80	1,580

1/ CLARK, T.F. and WOLFF, I.A. (1962).—A search for new fiber crops. VI. Kenaf and wood pulp blends. TAPPI 45(10): 786-789.

The bleach demand of cook No. 411 for fresh Cuban kenaf was quite low with only 6% chlorine for a fair brightness of 70. This was accomplished by high concentration of 18% total SO_2 in the magnesium bisulphite cooking solution and a relatively lower cooking temperature at 146°C. The good strength of pulp bleached by a simple C/E/H sequence could be a good example for making a pulp suitable for printing paper in an integrated pulp and paper mill.

Cook No. 399 for fresh Cuban kenaf features high yield and good strength with a fair bleach consumption of 8% equivalent chlorine by more complicated DC/E/D bleaching sequence. This pulp with brightness 80 is amenable to market pulp grade for large pulp mill with capacities above 100 t/d.

Although kenaf magnefite pulp is not as strong as kenaf kraft pulp, the magnefite process has the advantage of easy recovery of cooking chemicals and involves less investment in the magnefite recovery system when compared with the complicated kraft recovery system. Hence for medium sized pulp mill in the range of 50-100 t/d of bleached pulp, magnefite process would have the advantage of lower investment especially for an integrated pulp and paper mill.

Whereas other physical data are quite consistent, the folding endurances showed great difference as indicated in cook No. 426, which perhaps may be considered as an exceptional case of low value. It appeared that more severe cooking and bleaching sequence caused lower folding endurance due to the effect on more sensitive and fine bast fibres as contrasted in cooks Nos. 426 and 249.

When kenaf magnefite pulp is compared with wood pulps, the kenaf pulp has better smoothness and higher strength than softwood sulphite pulp, except for tearing strength and opacity, and better than hardwood kraft pulp. Hence its market value should be slightly lower than softwood sulphite pulp but higher than hardwood kraft pulp.

CONCLUSION

For the manufacture of printing paper from kenaf stalks, magnesium bisulphite process appears promising for its good yield of bleached pulp at about 42 per cent with moderate bleach consumption at 8% chlorine, and easy recovery of cooking chemicals as magnesia and sulphur dioxide by the established combustion method. The quality of bleached magnefite pulp is good, better than hardwood kraft pulp, and comparable to softwood sulphite pulp, except for lower tearing strength and opacity.

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