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Kenaf

Kenaf is one of the most promising raw materials for papermaking Northern Regional Research Laboratory, Peora, Illinois conducted extensive U.S.A.¹ studies on the agronomical and papermaking aspects of this raw material in view of its faster rate of growth (4 to 5 months for complete growth) and high yield (over 20 tonnes/hectare). Strictly speaking, the term Kenaf should be reserved for Hibiscus Canna binus; however, Hibiscus Sabdariffa (Roselle) is also often referred to as Kenaf. In India, Hibiscus Sabdariffa is grown more widely than H. Cannabinus A part of Andhra Pradesh de-

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Pulping Studies of Kenaf (Roselle) and Cotton Stalks

Kenaf (Roselle) and Cotton stalks were cooked by kraft, N.S.S.C., Cold Soda and Thermo-mechanical pulping techniques. The kruft and N.S.S.C. pulps were bleached. Kenaf's as well as Cotton stalk's kraft black liquors were analysed. The chemical characteristics of both the Kraft and N.S.S.C. pulps were determined.

The present study reveals the possibility of using Kenaf (Roselle) Kraft pulps for blending with short fibred pulps for wrapping or writing/printing papers. Cold Soda Cotton stalks pulps seem promising for hardboard or newsprint manufacture.

pends on Kenaf crop; about 2 lakh acres of land in Srikakulam and Vizag districts of Andhra Pradesh are under Kenaf cultivation The bast fibers of Kenaf, after extraction from the plant, are used mainly for ropes, carpets, sacks, etc. The juice of green Kenaf, consisting mostly of fructose, glucose and nitrogenous matter, seems to be a promising nutrient for fermentation media. The stick without bark, presently used as fuel, may be suitable for pulping in Asplund type defibrators.

The present investigation was

conducted on the tops of dried stalks of *Hibiscus Sabdariffa* (Roselle) cuitivated in an experimental plot of 4 hectares in Chandrapur division, Maharashtra. Kale² estimated the cost of producing a ton (4 ha. yielded 40 tonnes) of *H. Sabdariffa* to be around Rs. 50. No fertilizer was used and the harvesting operations were done manually.

Table 1 lists the proximate analysis and fiber dimensions of H. Sabdariffa used in the present study; the fibers are intermediate

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Sr. No	Particulars		Cotton Stalks	Roselle Stalks	
1.	Cold Water Solubility	%	16.6	5.8	
2.	Hot Water Solubility	<i>%</i>	24.9	8.2	
3.	Alcohol-Benzene	%	4.5	3.3	
<u>4</u> .	Solubility 1% Caustic Solubility	0/	53.2	23.0	
5.	Lignin	0/	24.5	18 3	
6.	Pentosans	0/0	11.9	17.0	
7.	Holocellulose	%	47.5	67.1	
	(Acid Chlorite)				
8	Alpha-Cellulose	%	24.1	37.8	
9	Ash	%	4.2	3.7	
10.	Fiber Length	mm			
	Max.		2.70	3.89	
	Min.		0.38	0.48	
	Avg.	•	1.03	1.76	
11.	Fiber Width	Microns			
	Max.		23	30	
	Min.		8	9	
	Avg.		13	21	
			Table 2		

Table 1 :- Proximate Analysis & Fiber Dimensions of Cotton and Roselle Whole Stalks :

between bamboo and hardwood fibers in length; the l/d ratio is closer to woods than to bamboo. Lignin of whole roselle stalks is less than in bamboo and softwood but approaches hardwood lignin content.

Kraft, Soda and N.S S.C. processes were tried on whole stalks. The cooking conditions, yields, K. Nos., etc. are listed in Table 2 The Soda Cook with 12.4% Na₂O on OD stalks was hard; its K. No. was 23.7 after refining the pulp in lab Bauer refiner. The screened unbleached yields were close to 50% in the Kraft (18%, 16% and 12% Na₂O on OD stalks), soda and N.S.S.C. cooks.

Conditions for Kraft, Soda & N.S S.C. cooks of Roselle (Hibiscus Sabdariffa) Stalks :

Sr. No.	Type of Cook	Chemicals applied, % on O.D. Stalks	Bath Ratio	Cooking Temp. °C	Time to Temp., Hrs.	Time at Temp., Hrs.	Permanga- nate Num- ber	Screened yield,% on O.D. Stalks	Reject % on O.D. Stalks	s, 1 Cl pH (at 2:	Blac har 5°C	ck L acter TW) 4	iquor istics Free Alkali
1.	Kraft	18% as Na ₂ O, Sulphidity 25.5%	1:6	165	2.0	1.5	12.4	49.7	0.70	12.3	7	5.6	gpl as NaOH
2.	Kraft	16% as Na ₂ O. Sulphidity 21.9%	1:5	165	2.0	1.5 ,	13.0	49.2	0.75	12.0	8	3.2	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
3.	Kraft	12% as Na ₂ O. Sulphidity 23.6%	1:5	165	2.0	1.5	16.0	47.4	4.4	12.0	7	5.6	**
4.	Soda	12.4% as Na2O.	1:5	165	2.0	1.5 (Pas refin	23.7 sed through er one pass)	52.4 lab	0.9	11.4	4	4.0	33 -
5.	N.S. S.C.	42% as Na ₂ SC Na ₂ SO ₃ :NaH 5.6 : 1	0 ₈ 1 : 5 Co ₃	170	2.0	5.0 (Pas refir	18.0 sed through ther one pass)	52.7 lab	2.1	8.5	8	14.7 Na	gpl as a ₂ SO ₈

Table 3

Unbleached Pulp Evaluation	of the	above Cooked	Pulps	(Vallev-Beater)	5
-----------------------------------	--------	--------------	-------	-----------------	---

Cook No.	Initial Final Freeness, Freeness,		Beating Time,	Strength Properties of pulp at 250 ml CSF				Fiber Classification (Clark) of Unbeaten pulps					
	mi CSF	ml CSF Mts.	Mts.	Brea- king Lengtl M	Burst Factor	Tear Factor	Double r Folds, MIT	Sheet Density, gm/cc	+20 %	20 +50%-	50 +-65%-	<u>65</u> +125%	-125 % %
1 2. 3. 4. 5.	475 550 580 350 400	250 250 250 250 250 250	20 22 23 8 15	8370 7405 7200 6201 7355	46.1 56.9 43.8 44.3 46.6	126 122 68.5 60.5 119.1	32.6 874 182 271 443	0.63 0.69 0.73 0.62 0.64	26.6 30.0 37.0 41.7 20.0	31.2 33.0 23.0 28.5 16.1	12.0 10.5 9.0 14.0 18.2	5.5 3.0 3.0 2.2 5.0	24.7 21.5 28.0 24.6 40.7

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Rejects in kraft pulp at 12% active alkali were higher, 4.4% on stalks.

Unbleached pulp strength evaluation of the above cooks is shown in Table 3 at 250 ml CSF. All the kraft pulps (18%, 16% and 12%) are about 100-200 ml CSF slower than the unbleached bamboo kraft pulp. 16% active alakali on OD stalks has given the best over-all strength. The N. S. S. C. pulp comes next. The soda cook has shown the lowest strength.

Pulp from Cook No. 2 (16% active alkali on OD stalks) is analysed for Pentosans, Alpha-Cellulose, Lignin, 1% Caustic solubility, etc. (Table 4). The Pentosans and Alpha Cellulose are at the same levels as in bamboo pulps, The Lignin content is less (possibly because of the low K. No 13.0) at 3.0% than in bamboo pulp (5-7%).

Table 5 lists the strength characteristics of the unbleached and bleached pulps of Cook No. 2. Tear factor decreases and Double folds increase steadily with beating. The Breaking lengths were maximum at 150 ml CSF for both the unbleached and bleached pulps. The strength properties of the pulp are higher than those reported^{3,4} in literature on pulps of Kenaf grown in India. Black liquor characteristics of cook No. 2 are given in Table 6. The silica content in black liquor (0 43% vs 3.0% on total solids) and the organics to inorganics ratio is somewhat higher than in bamboo kraft black

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liquor
$$\left(\frac{61.5}{38.5} : \frac{55}{45} \text{ for } 16\% \text{Na}_2\text{O} \right)$$
 cook).

Table 7 lists the pulp characteristics of N.S.S.C. pulp, unbleached and bleached. The -125fraction in N.S.S.C: pulp is higher (40% vs 25%), whereas Alpha-Cellulose, Pentosans, etc. are about the same as in kraft pulp (Table 4).

The bleached pulp strength evaluation of cooks 1 to 5 is shown in Table 8. The bleached pulp yields are good for all cooks

Table 4—Pulp	Characteristics (Unblesched & Bleached) of
	Cook No. 2 (Kraft)

Sr.	Particulars	Unbleached Pulp	Bieached Pulp
1.	Ash %	1.20	1.02
2.	1% Caustic Solubility %	11.0	5.5
3.	Copper Number		1.27
4.	Viscosity (0.5% CED,) CPS	34.5	9.5
5.	Lignin %	3.0	0.1
6.	Pentosans %	15.0	16.0
7.	Alpha-Cellulose %	81.1	83.2

Table 5-Strength Characteristics of the Unbleached and Bleached Pulps of Cook No. 2 at different levels of Freeness (Valley-Beater)

Si N	r. Partic o.	Particulars			Unbleached Pulp (K. No. 13)			Bleached Pulp (81 °PV)				
1.	Initial Freenes ml CSF	s 550					500					
2.	Freeness Beater to, ml CSF	n `—	350	250	150	0		350	250	150) 0	
3.	Beating Time, Mts.	⁻	13	22	30	50		11	18	26	60	
4.	Breaking Lengt Metres	h, 6435	8175	7405	8895	7490	6803	7560	8764	9072	8081	
5.	Burst Factor	45.8	55.8	56.9	62.5	58.6	40.0	53.2	53.0	50.0	49.2	
6.	Tear Factor	147	129	122	101	76.3	114	92.4	85.5	56.0	40.0	
7.	Double Folds, MIT	124	591	874	1687	3060	91	112	160	170	294	
8.	Sheet Density, gm/cc	0.62	0.69	0.69	0.82	0 82	0.64	0,71	0.76	0.76	0.83	

(43% to 45%), somewhat greater than in bamboo pulps (yield 40-42%), at 80° PV brightness. Soda cook shows the lowest over-all strength. N.S.S.C. pulp has the highest Double folds and Tear factor and takes only 7 mts. to drop to 250 ml CSF as against 15-18 mts. for kraft pulps. The initial freeness of the N.S.S.C. pulp is 370 ml CSF as against 430-500 ml CSF for kraft pulps. The pulp brightness of Soda Cook even on consuming 12.5% Chlorine was only 65°PV.

The unbleached soda pulp was $24^{\circ}PV$ as against $30-32^{\circ}PV$ brightness for the kraft pulps and $35^{\circ}PV$ brightness for the unbleached N.S.S C. pulp. The bleaching conditions in Chlorination, Extraction, Hypo I and Hypo II are given in Table 9,

Table 10 shows the cooking conditions for Cold Soda and Thermo-mechanical cooks of Roselle stalks. The refined yields are around 75%. Strength properties of the pulps are given in Table 11. At 100 ml CSF, the bulk is much lower than in groundwood pulps for newsprint. The opacities and strengths are, Under however, very good. proper refining conditions, it seems newsprint grade pulps may be produced from Roselle stalls by Cold Soda or Thermo-mechanical pulping processes. In this connection, it is worthwhile to pulp stalks (without bark) by the high vield pulping techniques and pulp the bark by chemical pulping and then examined if chemical pulps of bark blended with high

Table 6 Analysis of Black Liquor of Cook No. 2(K. No. 13) of Roselle Stalks:

Sr. No.	Particulars	Results
		ter an
1.	°TW	. 8
2.	рН	10
3	Total Titratable Alkali, gpl as Na ₂ O	10,8
л. Л	Free Alkali gpl as NaOH	3.2
-T. 5	Total Solids %	8.4
5.	Inorganics (as such at 900°C). %	38,5
0. 7	Organics (25 such at 500 C), 78	61.5
1.	$\Delta_{\rm rid}$ Incomplete $^{0/2}$	0.72
8.		0.43
9.	Silica, γ_0	6120
10.	Calorific Value	0120

Table 7

Pulp Characteristics of Cook No. 5 (N.S.S C.) of Roselle Stalks:

Sr. No.	Particulars		Unbleached (K. No. 18)	Bieached (80.5°PV)
1.	Ash	%	2.0	1.1
2.	1% Caustic Solubility	%	6.8	15.0
3.	Copper Number			1.27
4.	Viscosity (0.5% CED),	CPS	15.7	9.4
5.	Lignin	%	5.48	0.2
6.	Pentosans	%	14.7	15.4
7.	Alpha-Cellulose	%	80.2	84.0
8.	Fiber Classification (Clark)	%		
	+20 Mesh		20.0	22.7
	<u>-20 + 50</u> "		16.1	17.2
	50 + 65 ,,	i	18.2	19.0
۰.	—65+125		5.0	3.0
	—125 ,,		40.7	38.1

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yield pulps of stalks (without bark) could produce pulps for newsprint manufacture. This will be the subject of further research in our laboratory.

Cotton Stalks

Cotton is an important commercial crop in our country. Around 19 million acres are under cotton cultivation. in India producing 988,000 million tonnes of cotton annually⁵. About 400 kgs of OD stalks are produced per acre of cotton crop cultivation. The stalks are either presently burnt on site or collected and used as fuel.

Cotton stalks used in the present investigation were obtained from Bardoli Taluk in Gujarat; these were manually chipped to 1" length and tried for pulping by kraft, Soda, N.S.S.C., Cold Caustic and Thermo-mechanical processes. The proximate analysis of cotton stalks (Table 1) shows that the material has unusually high water and 1% caustic solubility. The Fiber dimensions put cotton stalks closer to hardwood than to softwood or bamboo.

Kraft cook at 18% Na₂O application (Table 12) gave a poor yield of 29.6% at a K. No. of 13.2. The Soda cook at 18% Na₂O was extremely hard and full of rejects (screened yield 20.4%, rejects 24.6% and K. No of screened pulp 34.0). The refined yields in Cold Caustic and Thermo-mechanical cooks were 71.8% and 80% respectively.

The strength properties of the different pulps (Cooks 1 to 5) are shown in Table 13. The strength of unbleached kraft pulp is superior to unbleached N.S.S.C. but the latter pulp when bleached has higher strength than the blea-

ched kraft pulp. On bleaching, the kraft pulp lost in strength, whereas the N.S.S.C pulp gained in strength. The N.S.S.C. pulps (unbleached and bleached (produce sheets of higher density than do the kraft pulps. The Cold Soda and Thermo-mechanical pulps have low sheet density, high opacity but somewhat poorstrength, especially the er Thermo-mechanical plups. The brightness of Thermo-mechanical pulps is also low, 19°PV compared to 25°PV in kraft, 30°PV in Cold Coustic and 34° in N.S.-S.C.

Table 14 lists the fiber classification results of the Kraft, N.S.S C. and Thermo-mechanical pulps. The -125 fraction (fines) in both Kraft and N. S. S. C. pulps is about the same, around 20%. The Thermo-mechanical pulp has very high percentages of fines at 270 ml and 120 ml CSF (50.6% and 60 5% respectively).

			Т	able 8				
Valley	Beater	Evaluation	of	Bleached	Palps	(Cooks #	1	to 5)

Sr. No.	Particulars	#1	₩2	++3	#4	_ + 5
1.	Unbleached Pulp Brightness, °PV	32	31	30	24	35
2.	Bleaching Sequence	СЕН	СЕН	СЕН Н	ICEH	н сен
3.	Chlorine applied/consumed,	5.0 1.5	5.0 1.5	6.0 1.0 0.7	5 7.0 3.0 3 .	0 6.0 1.5
	% on OD unbleached pulp	$\overline{4.2}$ $\overline{1.3}$	$3.9 \overline{1.42}$	5.4 0.99 0.4	$0 \overline{6.8}^{-} \overline{2.84} \overline{2}$.93 3.8 1 25
4.	Bleached Pulp Yield, % on OD Stalks	43.3	43.0	45.0	43.7	45.0
5.	Final Brightness °PV	79	81	81.5	65.0	80.5
6.	Post Colour Number	6.6	5.0	5.4	5.0	4.1
7.	Viscosity (0.5% CED), CPS		7.0	11.0	9.3	9.4
8.	Initial Freeness, ml CSF	430	500	450	300	370
9.	Beating Time to 250 ml CSF, Mts.	17	18	18	2	7
10.	Breaking Length, M	8427	8764	7932	4590	5950
11.	Burst Factor	52.7	53.0	54.2	30.9	47.9
12.	Tear Factor	119.6	85.5	99.0	120	135.1
13.	Double Folds, MIT	396	160	250	180	722
14.	Sheet Density, gm/cc	0.66	0.76	0.74	0.64	9.70

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	1.					and the second
Sr. No.	Particulars		Chlorination	Alkall Extraction	Нуро І	Нуро II
		· .				
1.	Consistency	%	3	10	10	10
2.	pH (Initial & Final)	1.5, 2.5	12.0, 10.5	10.5, 8.0	10.5, 8.0
3,	Temperature	°C	25	25	25	25
4.	Time	Mts.	20	120	150	180
5.	Caustic applied on Unbleached pulp as	OD % s NaOH	n de de de de I → t	1.5 to 2.0	Buffered to keep pH not less than 8.0	Buffered to keep pH not less than 8.0

Table 9 :- Bleaching Conditions for CEH/CEHH Sequences

Table 10 :- Conditions for Cooking Roselle Stalks by Cold Soda and Thermo-mechanical pulping processes

Sr. No.	Type of Cook	Chemicals applied,% on O. D. Stalks	Bath Ratio	Cooking Temp., °C	Time to Temp., Hrs.	Time at Temp., Hrs.	Refined yield, % on O.D. Stalks	K.No. of Screened pulp
1.	Cold Soda	6% as Na ₂ 0	1:6	30	 · .	48.0	75.5	27.6
2.	Thermo— mechanica	1	1.6	160	1	2	74.0	34.4

Table 11 :- Strength Properties of Cold Soda & Thermo-mechanical pulps of Roselle Stalks

÷-		Cold Sod	Thermo-n	nechanical	Pulp	
Sr. No.	Particulars	at mi 200	CSF 90	at ml CSF 450 250		110
1. 2. 3. 4. 5. 6. 7. 8	Breaking Length, M Burst Factor Tear Factor Double Folds, MIT Sheet Density, gm/cc Brightness, °PV Opacity, Tappi Ash °/	3738 19.5 45.3 6 0.58 31 93 2.0	3160 18.9 60.2 5 0.69 30 94 2.0	3427 18.1 79.9 6 0.54 24 99 1.68	3722 23.2 66.4 8 0.59 24 99 1.88	2980 23.6 30.0 9 0.64 22 99 1.80
9.	Fiber Classification % (Clark) $+ 20$ Mesh $- 20 + 50$., $- 50 + 65$., $- 65 + 125$., $- 125$.,	12.5 24.0 23.0 3.5 37.0	55 14.7 19.0 4.0 56.8	30.0 26.2 13.6 4.5 25.7	25.2 22.8 10.0 4.3 37.7	6.0 28.0 15.5 5.0 45.5

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Sr. No.	Type of Cook	Chemicals applied, % on O. D. Staiks	Bath Ratio	Cooking Temp., °C	Time to Temp., Hrs.	Time at Temp., Hrs.	K. No.	Screened yield,% on O.D. Stalks	Rajects % on O.D. Stalks	Black Chara pH °I (at 25°	Liquor cteristi W C)	Free cs Alkali
1.	Kraft	18% as Na ₂ O Sulphidity 19.7%	1:2.5	170	2‡	13	13.2	29.6	1.0	1.02	9.5	6.4 gpl as Nach
2.	Soda	18% as Na ₂ O	1:2.5	170	21	11	34.0	20,4	24.6	12.4	4.0	5.6 "
3.	N.S. S.C.	40% as Na ₂ SO	3 1:2 .5	165	2	5	31.5 (Re Be	56.5 efined in lab uer refiner)	2.8	9.0	7.0	9.0 gpl as Na ₂ SO ₃
4.	Cold Caustic	6% as a O	1:4	30		48	34.8	71.8 (Refined in Bauer)	-	11.8	5.5	3.2 gpl as NaOH
5.	Thermo- mechani	– cal	1:3	170	1	2	36,1	80.0 Refined in Bauer)	-	-	-	

Table 12: Conditions for Cotton Stalks cooking by different pulping processes

Table 13 :- Strength Properties of Cotton Stalks & Pulps by different cooking processes)

Sr. No.	Particulars	Kraft Unblea-	Pulp Bleached	N. S. S. C. Unbigached	Pulp Bleached	Cold Caustic	Therm	o-mechanical at ml CSF	Pulp
		ched 250ml CSF	at 250ml CSF	at 250ml CSF	at 250ml CS	pulp at F 250ml CSF	500	270	120
1. 2. 3. 4. 5. 6- 7.	Breaking Length, M Burst Factor Tear Factor Double Folds, MIT Sheet Density, g/cc Brightness, °PV Opacity, Tappi	4890 42.4 59.4 136 0.61 25 99	4000 37.4 45.0 197 0.75 75.5 83	4570 25.1 55.1 58 0.76 34 92	5640 38,8 56.9 287 0 85 82 84	1270 5.6 25.5 Nii 0.38 30 94	750 5.7 23.0 Nil 0.40 19 99	870 6.5 24.3 Nil 0.46 19 100	590 5.2 28.0 Nil 0.51 19 100

Table 14 :- Fiber Classification(Clark) of Kraft, N. S. S. C. and Theremo-mechanical Cotton Stalks Pulps

Sr. No.	Particulars	Kraft Uablea- ched at ml CSF	Pulps Bleached at ml CSF	N.S.S.C. Unblea- ched ml CSF	Pulps Bleached at ml CSF	Ther pulps	mo-mecl 3 at ml	hanical CSF
1 2 3 4 5	+ 20 Mesh, % - 20 + 50 Mesh, % - 50 + 65 Mesh, % - 65 +125 Mesh, % - 125 Mesh, %	470 7.6 48.0 16.6 7.5 20.3	420 11.2 46.2 15.7 8.9 18.0	400 8.2 37.9 20.9 14.6 18 4	350 3.7 31.8 25.3 20.9 18.3	500 20.0 36.0 20.0 7.0 17.0	27 6.0 13.4 24.5 5.5 59.6	120 6.0 7.0 20.0 6.5 60.5

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Table 15 gives the analysis of Cotton Stalks' black liquor from kraft cook. The organics to inorganics ratio is about same but the silica content is somewhat less than in bamboo kraft black liquor.

Table 16 lists the bleaching details for unbleached Kraft and N.S.S.C. pulps of cotton stalks. The bleached kraft pulp yield is 27% as against 43% for bleached N.S.S.C. pulp on OD cotton stalks.

From the above results, it may be stated that the unbleached and bleached Kraft and N S.S.C. pulps of cotton stalks have strengths equal to straw pulps. The cotton stalk kraft pulps are a bit (10%) weaker than bamboo kraft pulps, except for tear where they are about 100% weaker. The Cold Caustic pulp is evaluated only at 400 ml CSF in the present study; the work should be extended to lower levels of freeness to see how far the reasonably good strength at 400 ml CSF will drop when refined to 100 ml CSF. The good bulk, opacity and strength of Cold Caustic pulp at 400 ml CSF can make this process promising for producing newsprint grade refiner groundwood pulp and for use in hardboard manufacture.

Table 15 :--- Analysis of Black Liquor of Kraft Cook of Cotton -Stalks

Sr.No.	Particulars	Results
1.	pH at 25°C	10.2
2	Free Alkali, gpl as NaOH	6.4
3	°TW at 25°C	9.5
J. 4	Total Solids. %	10.6
5	Organics/Inorganics	55/45
- 6.	Silica, % on total solids	1.5

Table 16-Bleaching details of Kraft & N. S. S. C. Cotton Stalks Pulps

Sr.	Particulats			ft Pulp No. 3 2	·	N.S.S.C. Palp K. No. 31 5			
1.	Bleaching Sequence	С	Е	H	Н	C	Ε	H	
2.	Chlorine applied/ consumed, % on OE	5.0		1.5	1.0	14.0		3.5	
	unbleached Pulp	4.76		1.18	0.35	13.7		2.8	
3.	Bleached pulp yield, % on OD unbleached			27.0			43.6		
· A.	Stalks Einel Brightness °PV			75.5			82		
-4. 5	Pillar Brighticss, TV Dost Colour Number			7.8			6.2		
5.	Viscosity (0, 5% CED).	CPS		11.1			10.5		
7	Conner Number			1.2			1.1		
8	Pentosans. %			17.5			15.0		
Q	Alpha-Cellulose, %			78.8			83.4		
10.	Ash, %			1.2			1.6		

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A. KENAF PULP UNBLEACHED KRAFT (550 ml CSF)×300



B. KENAF PULP UNBLEACHED KRAFT (250 ml CSF)×300



C. COTTON STALKS PULP UNBLEACHED KRAFT (470 ml CSF)×300



D. COTTON STALKS PULP UNBLEACHED (250 ml CSF)×300