The Pulping Characteristics of *Pinus Khasya*

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The present work relates to the possibility of making bleached and unbleached pulp from Pinus Khasya for wrapping, packing, writing and printing purposes. Bark percentage (volumartic basis), apparent density and fibre dimensions were determined. Chemical analysis was carried out with saw-dust of —35 +65 mesh fraction. Pulping by sulphate process was carried out. Digestion conditions and pulp yields were determined. Evaluation of physical properties of pulp obtained under different conditions were carried out and properties at 45° SR were compared with those of commercial pnlp at the same freeness.

Introduction

The Planning Commission has suggested the targets of capacity for paper and Board and Newsprint at 1 5 million tonnes and 0.4 million tonnes against present installed capacity of 0.94 million tonnes and 0.04 million tonnes respectively. Amongst many factors, the availability of cellulosic raw-materials for meeting the future needs of the rapid growth of the paper industry continues to be of major concern to the paper industry. The dwindling resources of bamboo cannot sustain the major expansion programme during the coming plan period. The utilisation of non-conventional materials like hardwood, bagasse, agricultural residues and wastes will go a long way in solving the raw material problem of the industry. But usually these materials have short fibres and they will require blending with long fibre pulp to different extent to yield various end products So long bamboo has been the major source for supplying long fibre pulp in our country. The Himalayan softwoods can also be utilised for the purpose but due to high terrain and inaccessibility they could not be utilised economically. In many tropical countries, pines are being planted and utilised for making long fibre pulp. The Goverment of Orissa has an ambitious plan of plantation of different woods including Pinus Khasya. At the request of Forest Department, Government of Orissa, pulping study (sulphate pulping) of Pinus Khasya, which was planted about 30-35 years back on experimental plot, was undertaken to find suitability for making paper grade pulp.

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Description of Sample

A sample log (Pinus Khasya) was collected from the forest area in the district of Mayurbhanj which has an average annual rain-fall of 145 to 170 cm[1], and is situated at the height of 2000-3000 ft above the sea level. This plant generally grows well in the hilly regions of Khasi and Naga Hills. Its height varies from 33 to 50 metres[2] in those regions. The height of the species grown in Mayurbhanj Forest varies from 20 to 35 metres and girth diameters varies from 25 to 45 cms. The sample log under present investigation was approximately 30-35 years old and was 24 metres long. Its average girth was 1 metre. The log was hand-debarked in the laboratory.

Bark Percentage

The volume percentage of bark was measured at different heights based on the following equation:

$$\text{Bark percentage } \% = \frac{G_o^2 - G_u^2}{G_o^2}$$

Where

G_o = Girth over the bark.
G_u = Girth under the bark.

TABLE I
(Bark percentage (by volume)

Height Metres	G_o (cm)	G_u (cm)	Bark percentage %
1	144.78	134.62	13.5
3	128.27	120.65	11.5
5	107.95	104.14	7.6
7	105.40	102.87	4.7
9	104.14	101.60	4.8
11	95:25	91.44	7.8
13	91.44	88.90	5.4
15	77.47	74.93	6.4
17	74.93	72.39	6.6
19	43.18	41.91	5.7
21	43.18	40.64	11.4

The bark percentage varies from 5-14% and it is well within range of 10-20% for many species as reported by Rydholm[3].

Apparent Density

Apparent densities were determined at different heights of the trunk according to Tappi standard T 18m 53[4]. The results are given in Table II.

TABLE II
Apparent densities

Height in metre	3	7	11	15	19
Density gm/c.c.	0.498	0.441	0.401	0.388	0.380

The density of Pinus Khasya is within the normal range of 0.31 to 0.56 for commercial pulpwood as reported by Rydholm[5].

Chemical Analysis

The chemical analysis was carried out with dust fraction —35+65 mesh and results are recorded in Table III as percentage on the basis of oven dry saw-dust.

TABLE III
Chemical analysis of Pinus Khasya

Test	Percentage	Method used
Alcohol-Benzene solubility	3.44	Tappi T6 OS-59[4]
1% Caustic soda solubility	12.70	Tappi T4 OS-59[4]
Holocellulose	58.40	Wise, Murphy, D' Addieco[6]
Alpha-cellulose	38.80	Tappi T203 OS-61[4]
Lignin	30.05	Tappi T13 OS-54[4]
Pentosans	10.34	Tappi T19 m-50[4]
Ash content	1.70	Tappi T15 OS[4]

Fibre Dimensions

The fibre measurements[1] were made on redispersion of pieces of standard sheet made from unbeaten sulphate pulp (digestion condition ; active alkali 18%, maximum temperature 170°C, time at maximum temperature–4 hours). The fibres were mounted in aqueous medium and length of 100 fibres were measured. Width of the fibres and their wall thickness were also measured as the width and wall thickness of fibres are as important[8] as the length as regards their influence on paper making.

The length of the fibre is much higher than that of *Pinus Khasya* from Zambia and Philippines[9] but the width of the fibre wall and wall thickness are comparable. The flexibility ratio plays an important part in determining the tensile strength[10] of paper and fibre under investigation has a high flexibility ratio which indicates good tensile strength for the paper. For good quality pulp wood average wall fraction should be below 40%. The percentage wall fraction is found to be 24 and it is expected that the paper from *Pinus Khasya* will have good strength properties.

Disgestion and Pulp Evaluation

The chips used for pulping were prepared by sawing the log into disc of about 1″thick and then splitting along the grain with a mechanical guillotine to give chip of approximately 1″ long and ¼″thick. Samples were made from disc at different heights of the trunk and

mixed together for digestion experiments. The method used was sulphate process as this was found to be the most promising method of pulping of tropical woods in tropical conditions. The concentration of chemicals is calculated according to the following definition :

(a) Active Alkali = $NaOH + Na_2S$ expressed as Na_2O on the basis of oven-dry wood.

(b) Sulphidity = $\frac{Na_2S \times 100}{NaOH + Na_2S}$ all the compounds expressed as Na_2O.

Temperature of 170° was maintained as in the sulphate process best results can be obtained by keeping the temperature near to it. A sulphidity of 25 percent was used in each of the experiments, chosen, because published information shows there to be generally little variation in pulp quality with changes in sulphidity in the range of 20 to 30 percent. Wood to liquor ratio was maintained at 1:5. Time to maximum temperature and time at maximum temperature was maintained at 1 and 4 hours respectively. Experiments were carried out in stainless steel electrically heated autoclave of 4 litre capacity. The quantities of active alkali for cooking were varied from 16 to 22%. The cooked chips were washed free of superficial black liquor and broken up in a propellor type disintegrater to simulate the disintegration occuring during a commercial digester. The pulp was screened and collected over a 120 mesh sieve. Digestion condition and pulp yields are recorded in Table V.

TABLE IV

Fbre dimensions and various ratios derived from these

Average length of fibre, mm		...	3.56
Average width of fibre, micron		...	51.98
Average wall thickness, micron		...	6.14
Felling power	$\frac{\text{length}}{\text{width}}$	...	68
Flexibility ratio	$\frac{\text{lumen width}}{\text{fibre width}}$	...	0.76
Percentage wall fraction	$\frac{2 \times \text{cell wall thickness} \times 100}{\text{fibre width}}$	...	24

TABLE V

Digestion condition and pulp yields

Cook No.	Active Alkali %	Unscreened pulp* yield	Reject %*	Screened pulp yield*.	Kappa No.	Active alkali consumed %*
P_1	16	43.4	1.0	42.4	32	11.8
P_2	18	42.4	0.3	42.3	28	12.9
P_3	20	41.26	0.16	41.1	20.7	13.6
P_4	22	—	—	39.4	18.7	14.1

* On the basis of oven dry chips.

From Tabie V, it is evident that the pulp yield, kappa number and screen rejects decreases with increase in active alkali percent. Pulps obtained by using digestion conditions of Cook No. P_1 & P_2 were used for evaluation of unbleached pulp and pulp obtained by using digestion condition of P_3 was used for bleaching and subsequent evaluation of bleached pulp. Both unbleached and bleachod pulps were beaten in a Valley Niagara beater using 5·5 kg load on the bed plate. Standard sheets from unbleached and bleached pulps were made at different freeness value of pulp using standard method of Ungar[8] and tested after conditioning at 65 ± 2% relative humidity and 25± 1°C. Results of standard evaluation of the unbleached pulps and the commercial pulp are given in Table VII and are illustrated in the graphs.

Bleaching

The pulp of Cook No. P_3 having Kappa Number of 20.7 was used for bleached trial. A 4 stage bleaching consisting of chlorination, alkali extraction, 3rd stage hypochlorite and 4th stage hypochlorination, was carried out. Details of bleaching conditions and results are given in Table VI. The brightness was determined using an Elrepho reflection photometer using a filter with an effective wave length of 457 m and Barium Carbonate standard as 100.

TABLE VI

Cook P_8		
Kappa No. (unbleached pulp)	...	20.7
Yield of unbleachen pulp on oven dry wood percent	...	41.1
Chlorination:		
Chlorine on oven dry pulp, percent	...	5
Consistency	...	3%
Temperature	...	22°C
Time	...	1 hr.
pH at the end of the reaction	...	2
Chlorine consumed as chlorine on oven dry pulp percent	...	4.4
Alkali Extraction:		
Caustic Soda, on oven dry pulp, percent	...	3
Consistency	...	6%
Temperature	...	60°C
Time	...	1 hr.
pH at the end of the reaction	...	11.7
Hypochlorite Treatment (1st Stage).		
Sodium hypochlorite as available chlorine on oven dry pulp, percent	...	2.5
Consistency	...	6%
Temperature	—	35°C
Time	...	2 hrs.
PH at the end of the reaction	...	9.1
Hypochlorite consumed as available chlorine on oven dry pulp, percent	...	2.47
Hypochlorite Treatment (2nd stage)		
Sodium hypochlorite as available chlorine on oven dry pulp, percent	...	1
Other conditions are similar to 1st stage Hypochlorite treatment.		
Hypochlorite consumed as chlorine on oven dry pulp, percent	...	0.6
Total chlorine added, as chlorine on oven dry pulp. percent	...	8 5
Total chlorine consumed, as chlorine on oven dry pulp, percent	...	7.5
Yield of oven-dry bleached pulp on oven-dry unbleached pulp, percent	...	92
Yield of oven dry bleached pulp on oven dry wood, percnt	...	37.8
Brightness of bleached pulp Elrepho, 457 mμ (Barium carbonate=100%)	...	79

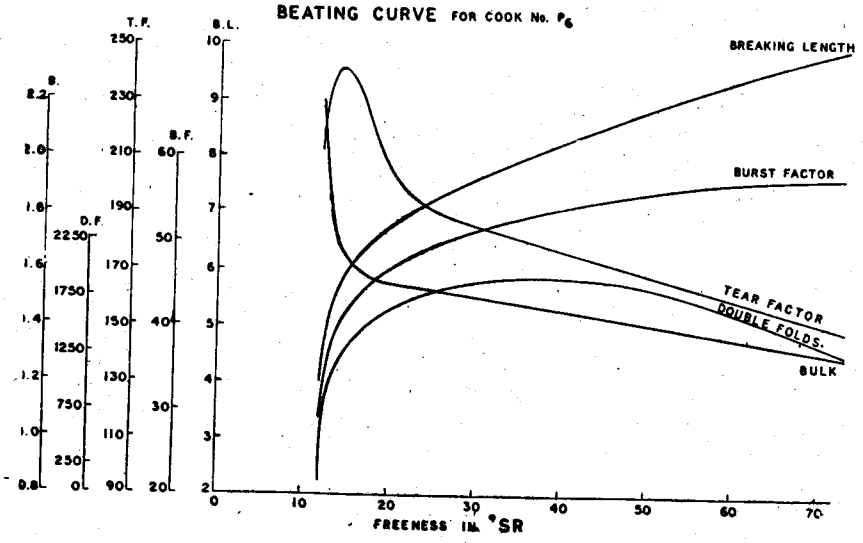
TABLE-VII : Physical characteristics of Sulphate pulp (bleached & unbleached)–Valley beaten.

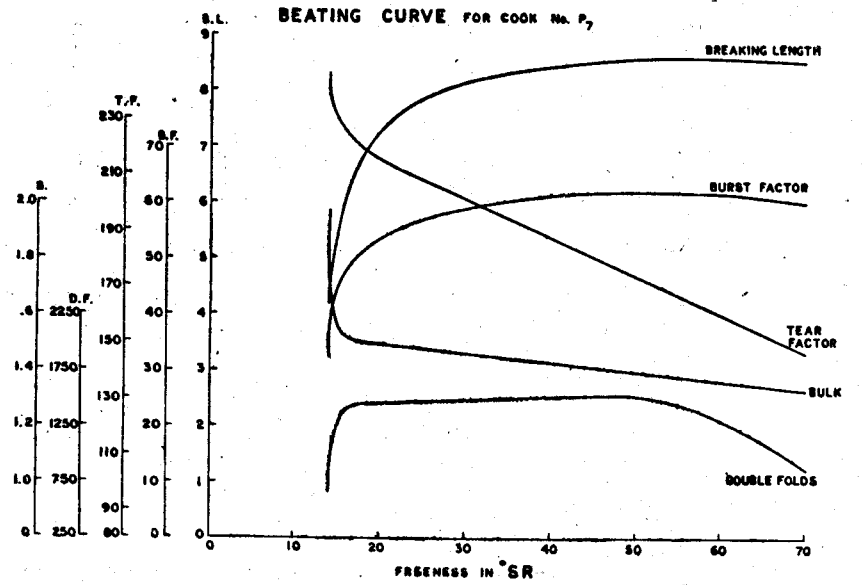
Cook Number	Basis wt. gm/m²	Bnlk cc/gm	Burst factor	Breaking length K. metre	Stretch percent	Tear factor	Double folds (800 gm)	Freeness OSR.	Drainage Time Second.
P_6(Unbleached Kraft pulp)	66.82	1.996	29.18	4.000	3	212.4	120	12	7.8
Active Alkali 16%									
Sulphidity 25%	61.36	1.644	40.25	5.909	3	241.3	1229	14	7.8
Digestion temp 170°C									
Time to max. 1 hr.	58.33	1.525	48.84	6.822	3.45	195.1	1670	22	8.5
Time at max. temp 4 hrs									
Yield	57.47	1.426	56.89	8.409	3.56	173.0	1851	50	9.1
Kappa No.	56.92	1.317	58.15	10.040	3.31	150.0	1660	71	13.4
P_7(Unbleached Kraft pulp)	63.41	1.971	32.33	4.183	1.75	246.11	650	14	6.6
Active Alkali 18%									
Sulphidity 25%									
Digestion temp 170°C	63.42	1.573	45.56	5.654	3.03	229.18	1393	15	6.8
Time to Max. temp 1 hr.	63.44	1.513	51.70	6.987	3.3	217.05	1369	18	7.3
Time at Max. temp 4 hrs									
Yield	62.10	1.465	56.52	7.750	3.3	211.88	1450	27	7.3
	61.51	1.381	61.61	1.615	3.3	173.12	1493	52	9.4
Kappa No.	61.19	1.356	60.63	8.546	3.0	151.27	1166	62	11.0
P_8(Bleached pulp)	62.83	3.46	11.23	2.164	2.56	97.4	—	12	6.3
Active Alkali 20%									
Sulphidity 25%									
Digestion temp 170°	63.34	2.17	24.62	5.198	3.61	164.2	66	14	6 3
Time to Max. temp 1 hr.	62.82	1 766	33.51	7.109	3.5	157.8	687	24	7.6
Time at Max. temp 4 hrs.									
Yield of unbleached pulp									
Kappa No.	59.49	1.592	37 10	7.970	3.5	114.8	1206	59	9.0
Yield of Bleached pulp	62.37	1.443	37.80	8.33	3.35	101.1	1005	79	14.8
Commercial unbleached Kraft pulp.	59.7	2.069	23.4	3.450	—	195	60	22	—
	62.2	1.830	37.0	5.310	3.0	170	149	26	—
	59.4	1.721	39.7	5.780	2.6	141	257	31	—
	61.2	1.670	45.3	6.630	2.5	136	405	37	—
	59.1	1.589	48.6	7.210	2.9	136	428	46	—

The strength properties at a freeness of 45°SR are tabulated in Table VIII for comparison.

Table-VIII

Cook No.	P_6	P_7	P_8	Commercial grade unbleached pulp
Breaking length	8.6	8.5	8.0	7.2
Burst Factor	55	61.5	37 5	48
Tear Factor	173	180	124	136
Double folds	1900	1225	1140	410
Bulk	1·43	1·4	1·6	1.6





Conclusion

Table VII shows that there is not much variation of pulp properties for Cook No. P_6 and P_7 for unbleached grade. The properties are higher than those of the unbleached commercial grade used for making kraft paper for wrapping and packing purposes. The bleached pulp has got high strength properties and good brightness value and can be used for making writing and printing papers. Thus the sulphate pulps obtained from *Pinus Khasya* are suitable both for making paper for wrapping,packaging purposes and also for writing and printing paper.

Acknowledgement

The authors are grateful to Prof. P. K. Jena, Director, RRL, Bhubaneswar for his keen interest in the work and for permission to publish the paper. The authors are indebted to Dr. S.N. Mahaptra, Scientist for his help and valuble suggestions during the work. Thanks are due to Shri G.M. Das, Forest Utilisation Officer, Forest Department, Government of Orissa for his suggestion to take up the work and for supplying the raw materials.

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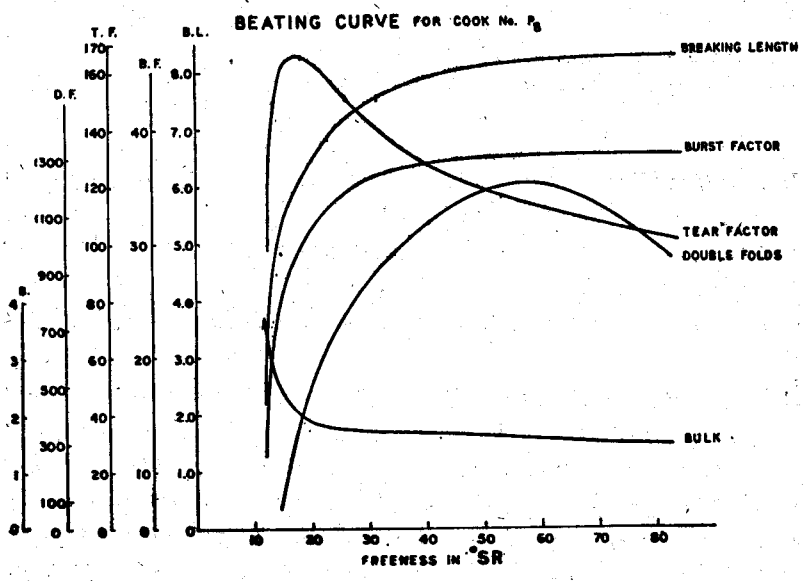

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