LEUCAENA LEUCOCEPHALA (Subabul) A Potential Raw Material for Newsprint Manufacture

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Newsprint story in India began with the start up of the National Newsprint and Paper Mills Limited at Nepanagar (M. P.) towards the end of 1955. The Mill had a capacity of 30,000 tons a year and was based on Newsprint furnish of 60% stone Ground wood from *Bosewellia serrata* (Salai) and 40% chemical pulp from Bamboo available in plentiful supplies. Mill expansion to 250 TPD (75,000 tons per annum) had been embarked by putting up a 90 TPD cold soda pulping plant and 150 TPD paper machine. The cold soda process was mainly based on the hardwoods (Salai). Envisaged level of strength properties and shade could not be achieved satisfactorily by cold soda pulping of Salai. The cold soda pulping of bamboo at Nepamills was a revolutionary attempt in attaining high yield and favourable strength properties. But bleaching of Bamboo cold soda pulp is posing a problem and best attempts are afoot to achieve higher brightness and better shade to improve the overall quality of Newsprinr furnish.

On the other hand depleting resources of conventional raw materials like Salai and Bamboo has forced the Paper Industries in general to look for alternative resources despite hopeful and giant schemetic afforestation by the Govt./Forest Deptt.

In its stride for alternative resources of raw material for good quality of pulp Nepa has opted for ascertaining cold soda pulping of various species and Subabul in particular.

Subabul shouid be considered for afforestation obviously for its fast growth, high wood volume, improved soil fertility, water conservation, fodder value and most remarkably as pulp wood, *Leucaena leucocephala* popularly known as Subabul is a leguminous thornless perenial shrub indigenous to Tropical America and is a good coppicer. In the recent years this species has been grown in India with favourable results[1] and it has been estimated that a hectare of plantation yields about 200 tons of wood in a cycle of 4 years.

Extensive experiments on cold soda pulping of Subabul have been successfully carried out at Nepamills and plant trials are in offing. As this species will have to be grown for pulp manufacture, investigation are directed to get best results for each variable. Keeping these factors in view, the changes in physical, and chemical nature of Subabul with age and their effects on the pulp quality have also been studied.

EXPERIMENTAL :

Subabul wood logs of four different age groups of 3 years, 4 years, 5 years old trees were obtained from Bhartiya Agro Industries Foundation, Urlikanchan, Dist. Pune (Maharashtra) for experimental purpose. The bark was removed manually and chips were prepared in the Papco Chippers of Nepamills. The chemical analyis of the wood[2] was carried out as per TAPPI standard methods except for holocellulose which was determined by sodium chlorite method of Wise et al, [3,4,5]. The physico-chemical data on Subabul of different ages are furnished in Table 1.

Cold soda treatments were carried out on chips from different ages of trees using various conditions in order to study the effect of impregnation on the quality of high yield cold soda pulps. Chemical pretreatments were carried out with 25 gpl. (10%) and 37.5 gpl. (15%) NaOH solution and for each treatment cooking time of 2 hours and 3 hours was given, keeping the pressure 11 kg /Cm^2 and chips to liquor ratio of 1:4. Cooking code numbers and the sample description are given in Table 2.

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TABLE—1

PHYSICAL DATA ON **LEUCAENA LEUCOCEPHALA** (SUBABUL) WOOD OF DIFFERENT AGES*

S. No.	Particulars	3 years	4 years	5 years	6 years
1.	Basic density of wood, g/cm³	0.51	0.54	0.58	0 50
2.	Bulk density of chips, g/cm³	0.199	0.212	0.218	0.220
3.	Bark %	7.90	7.20	6.90	6.70
4.	Ash %	0 80	0 77	0.76	0.72
5.	Cold water solubility %	1.01	1.08	1.11	1.12
6.	Hot water solubility %	2.10	2 35	3.00	3.18
7.	1% NaOH solubility %	13 71	14 12	16.21	16.92
8.	Alcohol—Benzene Solubility %	1.80	1.78	1 84	2.11
9.	Lignin %	22.37	23.14	25.64	25.96
10.	Holocellulose %	73.41	72.56	69.66	68.92
11,	Alpha cellulose %	43.75	43 49	42 38	42 29
12.	Beta cellulose %	13.11	12 43	11.48	11.59
13.	Gamma Cellulose %	17.55	17.44	17.12	17.22

*All percentages are expressed on O.D. wood basis.

TABLE—2

SAMPLE SPECIFICATIONS OF SUBABUL COLD SODA TREATMENTS

1. LL **Leucaena Leucocephala**
2. 1 2 3 and 4 refers to age 3 years. 4 years, 5 year and 6 years respectively.
3. A and B refers to 25 gpl (10%) and 37.5 gpl (15%) concentration of NaOH respectively.
4. a and b refers to 2 hours and 3 hours treatment time respectively.

Code	age (years)	NaOH gpl	NaOH %	Cooking time hrs.
LL_1Aa	3	25.0	10	2
LL_1Ab	3	25.0	10	3
LL_1Ba	3	37.5	15	2
LL_1Bb	3	37.5	15	3
LL_2Aa	4	25 0	10	2
LL_2Ab	4	25.0	10	3
LL_2Ba	4	37.5	15	2
LL_2Bb	4	37.5	15	3
LL_3Aa	5	25 0	10	2
LL_3Aa	5	25.0	10	3
LL_3Ba	5	37 5	15	2
LL_3Bb	5	37.5	15	3
LL_4Aa	6	25 0	10	2
LL_4Ab	6	25.0	10	3
LL_4Ba	6	37.5	15	2
LL_4Bb	6	37 5	15	3

After the treatment, the chips were removed. The spent liquor collected was analysed for residual alkali, Tw°, pH and total solids. The results are recorded in Table 3.

The treated chips were disintegrated in laboratory Sprout Waldron single disc 12" refiner connected to a 25 HP motor. The RPM of the disc was 1450. The plate pattern C 2976 was

TABLE—3

CONDITIONS AND RESULTS OF COLD SODA PULPING OF SUBABUL

Sample detail code No.	Strength NaOH applied	Chemical applied as NaOH	Chemical consumed as NaOH	Cooking time	Total yield	Unbleached pulp brightness	Spent Liquor Tw°	pH	Total solids
	gpl	%	%	hours		%ISO			%
LL_1Aa	25 0	10	6.65	2	86.2	38.4	4.0	10.8	3.27
LL_1Ab	25.0	10	7.15	3	85.1	38.2	4.2	10.7	3.65
LL_1Ba	37.5	15	8 55	2	83.2	37.5	5 4	11.2	4.19
LL_1Bb	37 5	15	8.95	3	82 5	37.0	5.8	11.0	4.55
LL_2Aa	25.0	10	6 61	2	85 6	36.1	4.1	10.8	3.30
LL_2Ab	25.0	10	7 11	3	84.7	35 8	4.2	10 9	3.72
LL_2Ba	37.5	15	8 29	2	82.8	35.0	5.5	11.1	4.33
LL_2Bb	37.5	15	8.68	3	82.2	34.8	5 8	11.2	4.71
LL_3Aa	25.0	10	6.0	2	84.9	33.3	4.3	10.9	3.61
LL_3Ab	25.0	10	6.50	3	84.1	33.1	4.4	10.8	4 02
LL_3Ba	37.5	15	8.38	2	82.1	32.1	6.1	11.2	4.63
LL_3Bb	37.5	15	8 63	3	81.8	31.5	6.9	11.0	4 94
LL_4Aa	25.0	10	5.52	2	84.2	29.8	5.8	11.1	4.54
LL_4Ab	25.0	10	6.08	3	83.3	29.2	6.1	10.8	4.57
LL_4Ba	37.5	15	8.01	2	81.2	27.8	7.8	11.4	5.89
LL_4Bb	37.5	15	8.51	3	80.7	27.1	7.9	11.1	5.96

employed during refining and kept constant through out the experiments Fiberizing was done by successive passes at 0.1, 0.075, 0 05 and 0.03 inch plate clearance. The disintegrated pulps were washed thoroughly with water, The total yield of the pulp was determined. Refining was then started at 8% consistency at passes 0.005, 0.002, 0.002 and 0.001 inch plate clearance respectively until the required levels of freeness were reached. The pulp samples were collected at each refining stage.

Pulps were classified in the Bauer McKnett fibre classifier using 28, 48, 100 and 200 mesh screens. The results are given in Table 4.

Evaluation at different freeness level of the refined pulps were done, hand sheets were tested for their strength characteristics. The results are recorded in Table 5.

Bleaching experiments were conducted using calcium hypochlorite in single stages. The bleaching conditions are given in Table 6. Pulps were evaluated for their optical and strength characteristics. The results are given in Table 7.

TABLE—4

BAUER MC KNETT FIBRE CLASSIFICATION OF UNBLEACHED SUBABUL COLD SODA PULP

Cook Code Nos.	Pulp freeness C S F Ml	+ 28 %	+ 48 %	+ 100 %	+ 200 %	— 200 %
LL_1Aa	155	24.0	31.5	12.5	8.5	23.5
LL_1Ab	205	28.5	25.5	11.8	9.8	24.4
LL_1Ba	185	27.6	26.4	9.8	11.2	25.0
LL_1Bb	190	32.5	23.5	13.7	8.1	22.0
LL_2Aa	140	24.2	30.2	12 5	7.1	26.0
LL_2Ab	155	27.6	28.8	12 2	8.8	22.6
LL_2Ba	175	29.1	27.7	9 7	8 5	25.0
LL_2Bb	195	30.7	25 2	12 8	9.2	22.1
LL_3Aa	185	21.2	28.1	13.1	6 4	31.2
LL_3Ab	155	27.1	24.4	11 8	8 6	28.1
LL_3Ba	145	24.9	31.8	9.7	8 4	25.2
LL_3Bb	165	29.9	26.2	11.8	6 9	25.2
LL_4Aa	125	25.2	22.2	8 8	11.7	30.1
LL_4Ab	145	24.8	26.1	12 5	4 8	31.8
LL_4Ba	115	26.1	27.4	10.8	8.8	26.9
LL_4Bb	140	26.0	39.9	10.1	4.1	28.9

TABLE—5

STRENGTH CHARACTERISTICS OF UNBLEACHED SUBABUL COLD SODA PULP AT FREENESS 200 C S F

Cook Code	Burst Factor	Breaking length Meters	Tear Factor	Air Porosity Sec.
LL_1Aa	21 5	4175	50.1	25.1
LL_1Ab	22.25	4275	49.0	27.3
LL_1Ba	24.0	4800	50.0	29.7
LL_1Bb	24.5	4950	52.0	30.0
LL_2Aa	19.5	4100	48.9	25.5
LL_2Ab	20.25	4200	50.1	26.1
LL_2Ba	22.35	4700	50.0	27.2
LL_2Bb	23.0	4850	51.2	28.8
LL_3Aa	16.25	3350	48.1	24.1
LL_3Ab	17.0	3450	48.8	24.9
LL_3Ba	20.15	3950	49.8	26.2
LL_3Bb	20.75	4050	50.7	27.6
LL_4Aa	14.5	295	46.5	24.0
LL_4Ab	15.25	3100	48.2	25.5
LL_4Ba	18.25	3675	49.0	27 0
LL_4Bb	18.75	3810	50.1	27.5

TABLE—6

SINGLE STAGE HYPOCHLORITE BLEACHING OF SUBABUL COLD SODA PULP

Simple details code No.	Hypo applied as available Cl_2 %	Hypo consumed as available Cl_2 %	Initial pH	Final pH	Brightness % ISO	Bleaching losses %	Bleached Pulp yield on O.D. pulp basis %
LL_1Aa	5.0	5.0	10.8	9.2	47.1	2.0	98 0
	7.5	7.5	10.9	9.1	52.0	2.50	97.50
	10.0	10.0	11.1	9.4	54.5	3.6	96 40
LL_2Aa	5.0	5.0	10.6	9.5	43.9	1.85	98.15
	7.5	7.5	10.8	9 6	48 9	2.54	97.46
	10.0	9 8	11.2	9 0	52.7	3 0	97.0
LL_3Aa	5.0	5.0	10 6	9.2	41.5	1.95	98.05
	7.5	7.5	10 5	9.4	45.8	2.15	97.85
	10.0	10.0	10.8	9.1	48.9	3.10	97 90
LL_4Aa	5.0	5.0	10.9	9.5	37.9	1.98	98.02
	7.5	7.4	10 8	9.4	40.9	2.30	97.70
	10.0	9.9	11.3	9.4	43.1	3.10	96.90

TABLE—7

STRENGTH CHARACTERISTICS OF BLEACHED SUBABUL PULP AT 200 ML. CSF

Sample Description	Cooking code No.	Burst Factor	Breaking length meters.	Tear Factor	Air Porosity Sec.
Bleached pulp with 5% Hypo	LL_1Aa	23.1	4325	51.8	25.0
	LL_2Aa	21.0	4250	52.5	26.8
	LL_3Aa	18.25	3560	50.2	25.0
	LL_4Aa	16.25	3175	48.8	24.8
Bleached pulp with 7.5% Hypo	LL_1Aa	23.4	4400	49.9	25.1
	LL_2Aa	21.10	4175	51.1	23.8
	LL_3Aa	18.50	3600	47.9	24.2
	LL_4Aa	16.25	3200	49 8	24.0
Bleached pulp with 10% Hypo	LL_1Aa	24.0	4525	52.1	25.0
	LL_2Aa	21.25	4350	51.2	24.4
	LL_3Aa	18 5	3650	48.7	25 0
	LL_4Aa	16 80	3250	49 1	22.9

For blending purpose Subabul cold soda pulp was prepared from four years old wood and was bleached by 5% hypo to get the brightness of 45.6% ISO. Bamboo cold soda pulp was also prepared in the laboratory and was bleached by using 20% hypo to get the brightness of 37.1% ISO.

Newsprint furnish was made by blending Subabul cold soda pulp with Bamboo chemical pulp and Salai ground wood pulp in different proportions and tested for brightness and strength properties to find the suitable combination. Newsprint furnish was also made by blending Bamboo cold soda pulp with Bamboo chemical pulp and Salai ground wood pulp and the results were compared with Newsprint furnish made by Subabul pulp.

RESULTS AND DISCUSSION ;

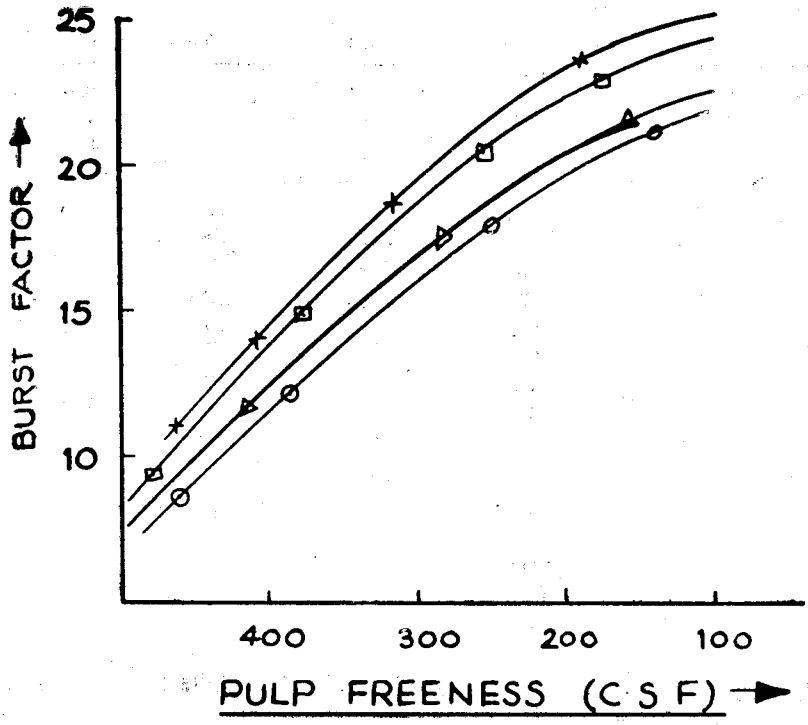
Proximate chemical analysis of the Subabul wood of different ages reveal that basic density, lignin and extractives increase with the age, while on the other hand cellulose percentage reduces. This may possibly be due to increase in the heartwood content with the ageing of wood.

The conditions and results of cold soda pulping treatments reveals that chemical consumption varied for each age under the same conditions of treatment. The chemical consumtion was observed to be more in the case of younger wood. The chemical consumption reduced due to increase in basic density with the age causing difficult penetration of the chemical inside the chips. It was observed that in the case of older wood the impregnation was improper at 25 gpl of NaOH. After increasing the concentration of NaOH. to 37.5 gpl, the chemical consumption had increased by about 2 to2.5%and better impregnation was noticed. With increasing the impregnation time from 2 hours to 3 hours there was a little increase of about 0.5% in the NaOH consumption which shows that chemical consumption can be effectively increased only by increasing the concentration of caustic charged. The pulp yield varied from 86.2 to 80.7 and it reduced with the increase in chemical consumption as shown in the fig. 5. All the above experiments were carried out for different ages of wood and less yield was recorded in the case of older wood. The brightness of the unbleached pulp varied from 38.4% to 27.8% ISO for 3 years age to 6 years age respectively The decrease in yield and brightness for older wood may possibly be due to increase in extractives and lignin with ageing. A little decrease of about 1 to 2% in brightness was observed with increase in chemical consumption.

Fibre classification of the unbleached pulps does not show any particular trend because the freeness of these pulps after refining varied in wide range. Fine contents (—200 fraction) were in the range of 25—30% and long fibre fraction (+28 and +48) constituted about 55%.

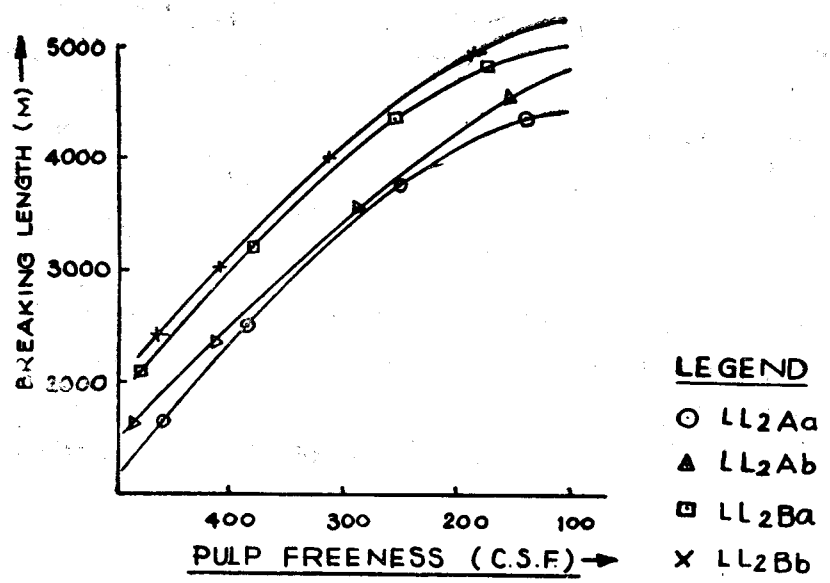
Pulp evaluation data on the unbleached pulp at 200 C S F are given in Table 5. All the pulp developed strength with decreasing freeness and relationship between strength and freeness for 4 years aged wood is shown is fig. 1 and 2. All

STRENGTH PROPERTIES V/S CSF
FOR SUBABUL UNBLEACHED COLD SODAPULP



FIG—1

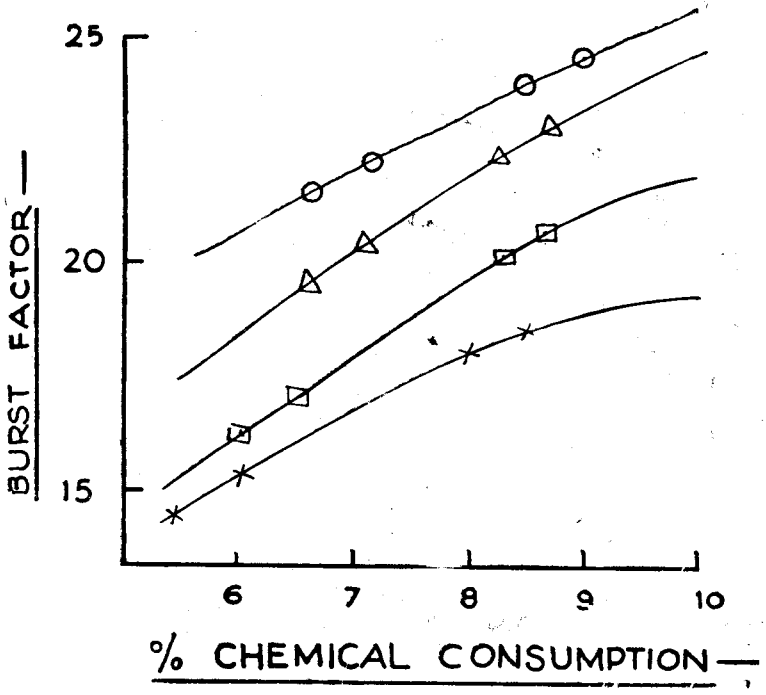
FIG. 2



other pulps also showed the same trend. The strength properties of cold soda pulps at 200 ml C S F were found to increase with increase in chemical consumption. The strength properties in ascending order of age were found to decrease, which was due to improper impregnation possibly because of increase in density and subsequently less chemical absorption. Improvement of strength properties with increase in chemical consumption for each age has been graphically represented in fig. 3 and 4.

The results on single stage hypochlorite bleaching using 5%, 7.5% and 10% available chlorine are given in table 6 which shows that in all cases brightness is increased by 25%, 35% and 41% respectively, of the initial unbleached pulp brightness. Required brightness of 50% I S O can be obtained by using 7.5% hypochlorite. This indicates that these pulps could be bleached satisfactorily. Almost no colour reversion of the pulps was observed which shows that brightness is stable. Table7 gives the strength characteristics of bleached pulp which shows the increase in strength properties after bleaching.

FIG. 3

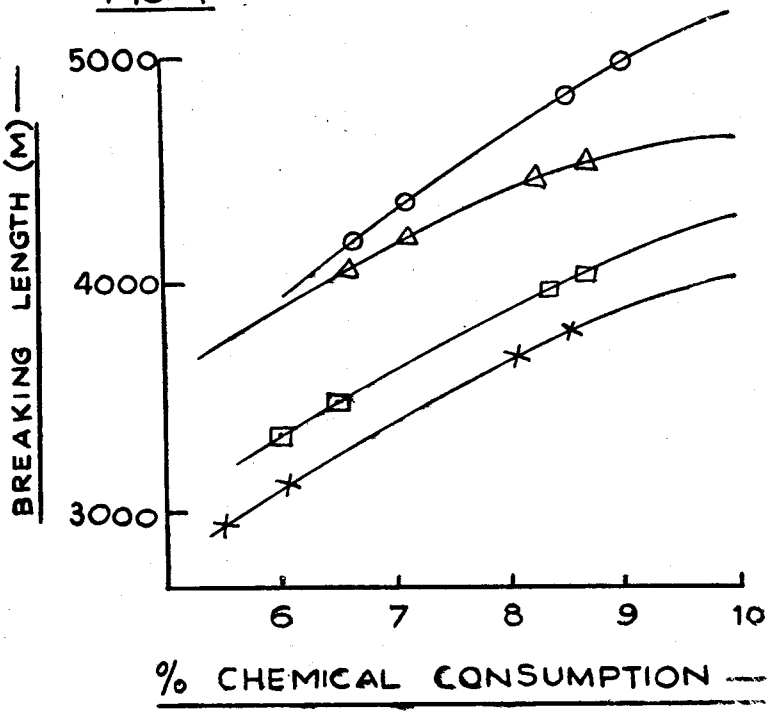


In Table 8 properties of cold soda pulp made from various species have been presented.[6,7] At approximate same chemical consumption, Subabul has shown the best results for strength and brightness. Only tear factor was found to be better in the case of Bamboo. Subabul cold soda pulp showed its superiority over Eucalyptus and Salai cold soda pulp in all respects.

Blending of various grades of pulp was done for making Newsprint furnish. For this purpose cold soda pulp from Subabul and bamboo was prepared under the identical conditions. The results recorded in Table 9 show

that there was a marked difference in strength properties and brightness of these individual pulps. Subabul could be bleached to 45.6% I S O only by using 5.0% hypo while bamboo required 20% hypo to reach the brightness level of 38.1% ISO Newsprint furnish could be made satisfactorily by blending subabul pulp with Bamboo chemical pulp and Salai ground wood pulp. Newsprint furnish made by blending Bamboo cold soda pulp with Bamboo chemical pulp and Salai ground wood pulp showed poor brightness and strength properties in comparision to furnish made from Subabul.

FIG. 4



CONCLUSIONS :

A good quality of cold soda pulp can be prepared by treating Subabul with 10% NaOH solution (25 gpl) for 2 hours at 11 kg/Cm^2.

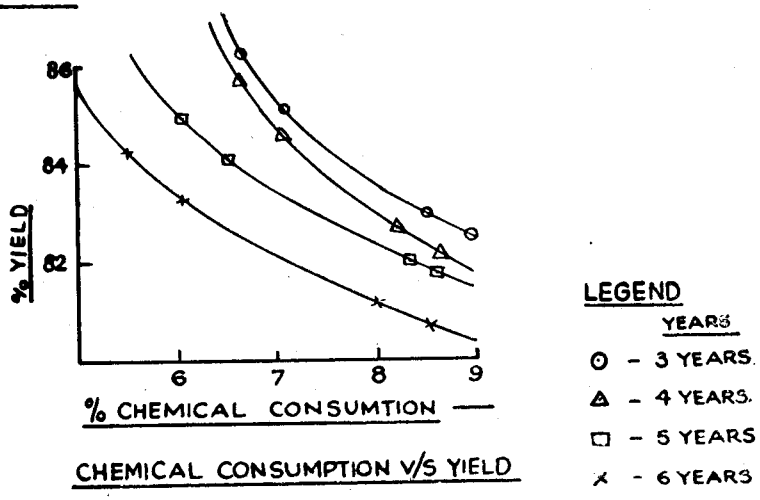
Subabul cold soda pulp can be easily bleached to the brightness of 50% ISO by using 7.5% hypochlorite in single stage and is very economical when compared with Bamboo cold soda pulp, which requires 20% hypochlorite to attain the brightness of 40% ISO.

It has better strength properties when compared with cold soda pulps prepared from Bamboo, Eucalyptus and Salai.

Suitable Newsprint furnish for good brightness and strength can be obtained by lending Subabul pulp with Bamboo chemical pulp and Salai ground wood pulp in a combination of 33.3% of each pulp.

Younger wood gave the pulp of better quality for brightness and strength properties. The probable reasons may be that with ageing heartwood content, basic density, lignin and solubilities increases. This results in darker shade of pulp and improper impregnation of chips causing poor strength properties.

FIG. 5



CHEMICAL CONSUMPTION V/S YIELD

TABLE—8

PROPERTIES OF COLD SODA PULPS OF VARIOUS SPECIES

Particulars	Chemical consumed as NaOH	Total yield	Unbleached Pulp brightness	Burst Factor	Breaking length	Tear Factor	Air Porosity
	%	%	% ISO		Meters		Second
Subabul (4 years)	7.11	85.6	36.1	19.5	4100	49	25.0
Bamboo	7.2	88.2	20.0	15.0	3100	70	12.0
Salai	7.9	85.4	28.0	8.0	2400	25	3.0
Eucalyptus deglupta	7.04	81.6	20.7	18.5	4000	36	21.0
Bagasse (depithed)	8 0	81.0	28.0	19 8	3800	48	—

TABLE—9

STRENGTH PROPERTIES OF BLEND NEWSPRINT FURNISHES

Bamboo Chemical Pulp %	Subabul Cold Soda Pulp %	Bamboo Cold Soda Pulp %	Salai Ground wood pulp %	Freeness CSF	Burst Factor	Breaking length Meter	Tear Factor	Brightness % ISO
100	—	—	—	303	22.8	4350	90.47	48.7
—	100	—	—	180	20.2	3975	46.69	45.6
—	—	100	—	187	14.7	3200	56.3	38.1
—	—	—	100	340	1.14	300	12 0	31.0
33.3	33.3	—	33.3	258	12.6	2475	45.0	39.3
30	30	—	40.0	258	10.9	2100	40.99	38.9
35	30	—	35	268	11.8	2180	44.35	39.9
25	45	—	30	240	13.0	2490	37.63	41.1
30	40	—	30	240	13.36	2500	44.35	42 0
35	35	—	30	268	13.84	2610	49.08	39 7
30	45	—	25	240	14.71	2610	49.08	42.5
50	50	—	—	240	21.86	4050	58.85	46.0
33.3	—	33.3	33.3	300	11.60	1990	50.8	35.8
35	—	30	35	302	11.60	2010	47.08	36.2
35	—	35	30	298	12.36	2240	53.8	37.0

Therefore crop cycle may be limited to four years where the above mentioned parameters are within optimum range. Also the volume of wood available is favourably comparable.

Thus wood and growth characteristics should be closely considered in conjunction with pulping properties when reforestation programmes are undertaken.

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