Selection of Alternate Raw Material Among the Locally Available Species

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Paper manufacturing in India is increasing day by day to meet the demand. Hence raw-material shortage is getting acute. This is one of the reasons why Indian paper industries are going towards recycled fibers.

Due to stringent pollution control norms agro based pulping industries are being switched over to secondary fiber or compelled to shut pulping operation.

Hence search for alternate wood species suitable for prevailing cooking condition is inevitable to sustain in the integrated pulp & paper industries.

At Ballarpur Industries Ltd, Unit: Sewa, five locally available species namely Kadam (Anthocephalus Chinensis), Sema-Tuma (Prosopis Juliflora), Tad (Borasus Flabelliformis), Arjuna (Terminalia Arjuna) and Albizia (Albizia Prosera) have been evaluated for pulp and paper making. By analyzing the results, a hardwood species Prosopis Juliflora have been selected based on packing density, pulp yield, alkali consumption and suitability for mixing with other species in a common cooking schedule.

In this paper wood density, pulping and bleaching characteristics, fiber classification and strength properties has been discussed. The forestry and plantation characteristics of Prosopis Juliflora has also been talked about.

INTRODUCTION

With the change in our life style and growing population, the increase in literacy and greater economic activities of society, the demand of different varieties of paper and paper products have increased in our country. In the past two decades the per capita paper consumption[1] has risen to three folds.

To meet the increasing demand, Indian entrepreneurs are expanding their existing paper making capabilities and executing new projects. Hence raw-material shortage is getting acute day by day. This is one reason that new projects are going towards recycled fibers. Due to stringent pollution control norms agro based pulping industries are being switched over to secondary fiber or compelled to shut the operation.

Availability of bamboo is very very limited as the natural bamboo forests have already been eroded. Plantation of bamboo did not click due to high cost of plantation and low annual yield. Hence bamboo fiber, in the furnish, have been reduced to 20-30% and tropical hardwoods like Eucalyptus, Casuarina, Subabul and Acacia have taken its place since a decade.

In the present scenario, these social / farm forestry hard woods are not sufficient to meet the demand. For these hardwoods there is a competition from timber industries also.

Hence search for alternate wood species suitable for prevailing cooking condition (for mixed cooking) is inevitable to sustain in the integrated Pulp & Paper industries.

Five locally available species namely Kadam, Sema-tuma, Tad, Arjuna & Albizia have been evaluated for pulp & paper making by Ballarpur Industries Ltd, unit: Sewa.

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Table -1

Sl No	Particulars	UOM	Prosopis Juliflora	Albiza Prosera	Terminalia Arjuna	Kadam	Tad
1	Chips bulk density	Kg/m^3	236	262	259	197	250
2	Active alkali charged	%, as Na2O	17.5	17.5	18.5	17.0	21.0
3	White Liquor Sulfidity	%	22	22	22	22	22
4	Bath ratio	-	1:3	1:3	1:3	1:3	1:3
5	Cooking Schedule:-						
	Time to 132°C	Minutes	60	60	60	60	60
	Time at 132°C	Minutes	60	60	60	60	60
	Time from 132 to 160°C	Minutes	60	60	60	60	60
	Time at 160°C	Minutes	45	45	45	45	45
6	Permanganate No	-	14.9	16.2	16.9	14.8	19.4
7	Screened Yield	%	48.2	46.0	47.8	47.1	45.8
8	Knots & rejects	%	1.3	1.5	0.8	0.2	0.6
9	Total yield	%	49.5	47.5	48.6	47.3	46.4
10	Residual A.A. in B/L	gpl	9.4	8.9	10.1	9.5	8.0

Table - 2 BLEACHING EXPERIMENTS: BLEACH SEQUENCE: C - Ep - H - H - D

Sl. No.	Particulars	Units	WOOD SPECIES				
			Prosopis Juliflora	Albizia Prosera	Terminalia Arjuna	Kadam	Tad
1	Ub. Pulp P. No	-	14.9	16.2	16.9	14.8	19.4
2	Chlorination:-						
i	Chlorine applied	% as Cl2	4.5	4.6	4.6	4.4	5.4
ii	Chlorine consumed	%	4.45	4.55	4.56	4.28	5.38
iii	Retention Time	minutes	40	40	40	40	40
iv	Temperature	°C	ambient	ambient	ambient	ambient	ambient
v	Consistency	%	4.0	4.0	4.0	4.0	4.0
vi	End pH	-	2.0	1.9	2.1	2.0	1.8
3	Extraction (peroxide):-						
i	Alkali applied	%	2.6	2.6	2.6	2.6	2.6
ii	Peroxide applied	%	1.4	1.4	1.4	1.4	1.4
iii	Retention Time	minutes	90	90	90	90	90
iv	Temperature	°C	70	70	70	70	70
v	Consistency	%	10.5	10.5	10.5	10.5	10.5
vi	End pH	-	11	11.2	10.9	11.3	11.1
vii	CE. K. No.	-	2.0	2.2	2.0	1.9	5.3
4	Hypo Stage I :-						
i	Hypo applied	% as Cl2	1.7	1.8	1.7	1.6	3.0
ii	Hypo consumed	% as Cl2	1.37	1.56	1.52	1.29	2.85
iii	Buffer alkali applied*	*	0.03	0.03	0.03	0.03	0.03
iv	Retention Time	minutes	165	165	165	165	165
v	Temperature	°C	40	40	40	40	40
vi	Consistency	%	10.5	10.5	10.5	10.5	10.5
vii	End pH	-	7.2	7.3	7.1	7.0	6.9
5	Hypo Stage II :-						
i	Hypo applied	% as Cl2	0.3	0.5	0.4	0.4	0.7
ii	Hypo consumed	% as Cl2	0.24	0.42	0.37	0.32	0.58
iii	Buffer alkali applied*	*	0.03	0.03	0.03	0.03	0.03
iv	Retention Time	minutes	180	180	180	180	180
v	Temperature	°C	40	40	40	40	40
vi	Consistency	%	10.5	10.5	10.5	10.5	10.5
vii	End pH	-	7.4	7.2	7.1	7.1	7.1
6	Chlorine Dioxide:-						
i	Chlorine dioxide applied	% as ClO2	0.9	0.9	0.9	0.9	0.9
ii	Chlorine dioxide consumed	% as ClO2	0.75	0.71	0.83	0.71	0.78
iii	Retention Time	minutes	180	180	180	180	180
iv	Temperature	°C	72	72	72	72	72
v	Consistency	%	10.5	10.5	10.5	10.5	10.5
vi	End pH	-	3.8	3.7	3.7	3.6	3.0
7	Brightness (L&W Elrepho)	% ISO	87.5	88.3	88.4	87.0	75.5
8	Viscosity (0.5% CED solution)	cps	7.1	6.3	6.1	6.0	7.6

EXPERIMENTAL

Wood samples were collected from nearby areas of Orissa & Andhra Pradesh. They are debarked and chipped separately in mill's drum chipper and stored for carrying out all experiments.

COOKING

The respective chips were kraft cooked in a six-bomb autoclave digester with a target P-number of 14.0 ± 0.5. Initially all the five varieties of chips have been charged with 17.5% alkali and after getting the P-number some species were cooked with higher chemical dose to get required P-number. A two-stage cooking schedule was followed for all the species through out the experiments. The schedule was, time to 132°C - 60minutes, at 132°C - 60 minutes, then 132 to 160°C - 60minutes and at 160°C - 45 minutes. Bath ratio maintained was 1:3. Sulfidity in white liquor was 22% and active alkali was 90%. All data are presented in Table 1.

BLEACHING

After washing the knots were hand picked and pulp was screened in a Somerville screen. They are bleached in the prevailing mill sequence C-Ep-H-H-D, with a target brightness of 88% ISO. The results are given in Table 2.

FIBER CLASSIFICATION

The bleached pulps were classified in Bauer Macnett fiber classifier and results are reported in Table 3. For comparison mill pulp (mixed furnish) was also taken for classification.

REFINING AND PHYSICAL STRENGTH PROPERTIES

All the bleached pulps were refined to 40°SR in PFI mill. Standard hand sheets of 60 gsm were prepared in British hand sheet making machine. Sheets were tested for physical strength properties. Results are given in Table 4.

DISCUSSION

COOKING

On analyzing the cooking results (Table-1) Kadam (Anthocephalus Chinensis), found to be best fit to the desired cooking schedule with a target P-number of 14 ± 0.5. But the chips bulk density (Packing density) is low 197kg/m^3. Hence by using it, the effective capacity of a digester will reduce, as yield per batch will go down. The unbleached pulp yield of Kadam (47.1%) is comparable to Arjuna, Albizia & Prosopis Julifflora.

Tad (Borasus Flabelliformis) requires high alkali consumption. With 21.0% alkali charge, the P-Number was 19.4 . The unbleached pulp yield was 45.8 %, the lowest among this group. The Tad log contains good amount of pith also. Hence it is not at all suitable for mixed pulping.

Albizia Prosera & Terminalia Arjuna is comparable to each other and consumes little more alkali to get 14.0 P-number (Table-1)

Packing density of Sema-Tuma (Prosopis Juliflora) is similar to Casurina. At the prevailing alkali dose (17.5%) & cooking schedule, P-number is 14.9 in case of Juliflora. Hence this can be cooked in the mixed furnish along with other species.

BLEACHING

Screened unbleached pulps were bleached in a five stage bleaching sequence C-Ep-H-H-D. Except Tad all other species showed good response to bleach chemicals. Total chlorine consumed by Tad is 8.8%, Hydrogen Peroxide 1.4% and Chlorine Dioxide 0.9% to get brightness 75.5% ISO only (Table-2).

Table - 3

FIBER CLASSIFICATION OF BLEACHED PULP

	% retained on the screen					
Mesh size	Prosopis Juliflora	Albizia Prosera	Terminalia Arjuna	Kadam	Tad	Mill Pulp
+14	0.2	0.2	1.7	0.2	5.7	5.1
-14, +28	1.0	1.3	23.1	10.9	29.7	7.5
- 28, +48	49.2	44	33.2	44.1	27.3	21.4
- 48, +100	24.4	24.7	14.6	21.8	14.4	35.6
- 100	25.2	29.8	27.4	23.0	22.9	30.4

Table - 4

STRENGTH PROPERTIES OF BLEACHED PULP HAND SHEETS

Sl. No.	Particulars	Units	Prosopis Juliflora	Albizia Prosera	Terminalia Arjuna	Kadam	Tad	Casurina
1	Initial Freeness	°SR	11	12	14	13	9	16
2	PFI Mill refining Time	Sec	150	135	140	130	60	-
3	Pulp Freeness	°SR	40	39	41	40	40	40
4	Grammage	g/m2	59.5	60.0	62.0	61.2	61.8	60
5	Thickness	micron	76	82.0	82.0	73	101	80
6	Bulk	cc/g	1.28	1.37	1.33	1.19	1.63	1.33
7	Breaking Length	m	5360	5250	5280	5690	2470	5600
8	Tear Factor	-	54	53	51	48	78	58
9	Burst Factor	-	41	36	40	36	20	41
10	Double Fold	No.	38	28	32	16	12	29

Picture-1 PROSOPIS JULIFLORA

Prosopis Juliflora consumed 6.06% total chlorine, 1.4% hydrogen peroxide and 0.9% chlorine dioxide. Brightness achieved was 87.5% ISO, close to the targeted brightness 88.0% ISO (Table-2)

Bleached pulp viscosity (Table-2) of Juliflora pulp was 7.1cps (0.5% CED soln.), comparable to Sewa mill pulp.

From the fiber classification data (Table-3) it is found that Tad pulp has longer fibers. In case of Tad pulp, +14 mesh retained 5.7% and 14, +28 mesh retained 29.7% where as Prosopis juliflora and Albizia retained 0.2% in +14 mesh & 1.0 to 1.3% in +28 mesh. But Tad fibers were bulky and brittle.

While comparing with mill pulp (Table-3) (M.H. + Bamboo), the fines fraction (-100 fraction) of all the species is less. After Tad Kadam is the best with respect to fiber classification. Next to Kadam, Arjuna, Juliflora and Albizia are in the series.

PHYSICAL STRENGTH PROPERTIES OF BLEACHED PULPS

Among the five species Kadam has highest breaking length (5690 m) and lowest Tear factor (48) and lowest bulk (1.19 cc/g).

Prosopis Juliflora has breaking length (5360m) next to Kadam and highest tear factor (54) after Tad. It took maximum refining time (150sec in PFI mill) to achieve 40°SR. It has highest double fold among all (Table-4).

Albizia & Arjuna have comparable breaking length and tear factor in between Juliflora and Kadam.

Tad took the lowest refining time (60sec in PFI mill) to 40°SR and highest bulk (1.63 at 40°SR), highest tear factor (78) and lowest breaking length (2470 m), lowest burst factor and double fold. Again it proves that the Tad fibers are bulky and brittle.

CONCLUSION

Considering all the properties like pulping, bleaching, refining and strength properties of these species, it can be concluded that Prosopis Juliflora, Albizia Prosera and Kadam can be utilized in the mills furnish.

As the chip bulk density of Kadam is very low (197 kg/m^3, where as others 230 260 kg/m^3) the digester output will come down, hence it is eliminated.

While comparing Albizia and Juliflora, the former will consume little more alkali as the P-number is higher than the later. By observing the fiber classification and sheet properties, Juliflora is better than Albizia. Hence a plant trial for Prosopis Juliflora was recommended.

PLANT TRIAL

Debarked Prosopis Juliflora procured and used at the rate of 5% of the total furnish. Casurina was reduced from the furnish in the same proportion as Juliflora introduced. Without changing the alkali charge and cooking schedule the P-number obtained in the same range of 14±0.5. Hence bleach demand was unchanged and average brightness achieved was 88% ISO. No change in pulp properties observed.

Machine runability and paper properties was unaffected by introducing Juliflora.

Now it is being used since last two years by substituting Casuarina to the tune of 5% of the total furnish. Bilt:Sewa is getting the benefit of cost difference between Casurina & Juliflora and at the same time Casurina is preserved for later use or production enhancement.

PROSOPIS JULIFLORA

It is a perennial deciduous thorny shrub or small tree that can grow up to 10m height with a trunk up to 1.2m in diameter.

It grows in arid and semi arid lands. It is a first growing, salt-tolerant and drought-tolerant tree that can grow in areas receiving as little as 50mm of rainfall per year. It is found in the nature, abundantly grown in the degraded lands. Not only in dry land, it is also seen in irrigated agriculture land and adjacent high rainfall areas. Prosopis species has been declared as noxious weeds in many countries.

The literature survey on Prosopis Juliflora revealed that it is being used as fuel wood, a very good resource to produce charcoal, timber, woodcarvings and animal forage (mostly for goat). Now it is explored as a pulping wood.

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