Pulping of Hardwoods with and Without Bank

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ABSTRACT

This paper deals with the findings of the pulping studies of eight species of hardwoods, viz. anogeissus latifolia, adina cardifolia, burraserra serrata, garguga pinnata, lannea grandis, pteracarpus marsupium, terminalia tomentosa and xylia xylocarpa with and without bark. Except anogeissus latifolia and pteracarpus marsupium there is an increase in net yield of unbleached pulp per tree with the inclusion of bark even though there is a decrease in the digester yield However for all the species, inclusion of bark results in pulp of darker colour and lower strength and more bleach chemical consumption and bleaching losses.

The potential of hardwoods as a source of fibrous raw material for Indian Pulp and Paper Industry has now been well recognized. However, continuous denudation of forests has led to ecological imbalances and shortage of these fibrous raw materials. It has become imperative to find out ways and means for their effective and fuller utilization. Whole tree pulping and modified pulping processes are some of the developments towards this, Though debarking of woods has become conventional way of preparing the woods for pulping because of certain problems like more chemical consumption, unclean, inferior quality pulp etc, a literature survey (1-8) has revealed that debarking is not necessary for all species with some reservations regarding quality of the paper. The expected advantages with the inclusion of bark would be—

a) More yield of pulp from tree
b) Savings of debarking charges
c) No more bark disposal problems.

Hence, a detailed study was undertaken to find out the suitability of some of the hardwoods available in A.P. region, viz.,

i)	anogeissus latifolia	(a. latifolia)
ii)	adina cardifolia	(a. cardifolia)
iii)	burraserra serrata	(b. serrata)
iv)	garuga pinnata	(g. pinnata)
v)	lannea grandis	(l. garndis)
vi)	pteracarpus marsupium	(p. marsupium)
vii)	terminalia tomentosa	(t. tomentosa)
viii)	xylia xylocarpa	(x. xylocarpa)

with bark for making quality paper. The findings of the study are presented in this paper.

EXPERIMENTAL :

Debarking of hardwoods and determination of bark percentages. Each wood log was manually debarked and the percentage of bark was computed on O.D. basis. Then the debarked woods were chipped separately. The characteristics and percentages of bark of each species are presented in Table—1.

Proximate analysis : The proximate analysis of wood and bark were done as per standard procedures. The results are given in Tables — 2 & 3.

Pulping : Kraft pulping was carried out for each species of wood with and without bark under similar conditions. In the case of wood with bark cookings, the bark was added to the chips on the basis of its original percentage of wood. The screening of the unbleached pulp was carried out in laboratory strainer. The permanganate number, unbleached pulp viscosity and strength properties at 40° SR were determined. The results are presented in Table—4.

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TABLE—1

CHARACTERISTICS OF BARK

S.No.	Name of the wood	Bark content on O. D. basis %	Bark Characteristics
1.	Adina Cardifolia	23.73	20-25 mm thick, Yellow colour bark, easy to peel off.
2.	Anogeissus Latifolia	4.29	4-6 mm thick, brown colour bark, difficult to peel off.
3.	Burraserra serrata	9.39	10-12 mm thick, slightly difficult to peel off.
4.	Garuga Pinnata	9.94	12-15 mm thick, easy to remove.
5.	Lannea grandis	10.07	15mm thick, easily removable.
6.	Pteracarpus marsupium	10.43	35-40 mm thick, light brown coloured, easy to peel off.
7.	Terminalia tomentosa	14.20	Thick bark, easy to peel off.
8.	Xylia Xylocarpa	9.04	10-12 mm thick, contain resinous material, slightly difficult to remove.

TABLE—2

PROXIMATE ANALYSIS OF WOOD AND BARKS

Sl. No.	Name of the wood	Ash %	1% NaOH solubility %	A — B Extractives %	Lignin %	Holocellulose %	Pentosans %
1.	A. Cardifolia						
	Wood	0.26	28.80	8.94	31.60	58.75	12.45
	Bark	4.33	55.80	20 03	27.04	48.60	12.26
2.	A. latifolia						
	Wood	2.72	15.96	3.04	29.50	64.95	13.25
	Bark	8.93	51.42	10.39	32.50	48.40	12.90
3.	B. serrata						
	Wood	1.38	21.21	4.23	30.26	64.99	12.71
	Bark	9.17	48.20	4.91	33.71	52.70	9 35
4.	G. pinnata						
	Wood	1.40	17.97	1.01	26,84	70 41	14.20
	Bark	7.27	45.75	4.21	28.88	59.40	12.73
5.	L. grandis						
	Wood	2.22	21.76	1.97	24.47	70.58	13.06
	Bark	7.55	46.44	5.72	27.64	60 30	9.97
6.	P. marsupium						
	Wood	0.80	16 25	9.25	28.90	61.63	12.20
	Bark	5.10	57.69	30.11	19.23	46.73	9.85
7.	T. tomentosa						
	Wood	1.57	19.60	4.87	29.0	64.67	12.04
	Bark	18.48	38.51	8.79	28.9	44.80	5.92
8.	X. xylocarpa						
	Wood	1.68	18.28	5.64	28.34	64.10	10.94
	Bark	9.88	40 88	9.21	30.74	50.18	10.77

Note : All values on ovendry basis.

TABLE—3

BARK ASH ANALYSIS

Sl. No.	Name of the wood	Ash %	Acid Insolubles %	Calcium as Ca %	Magnesium as Mg %
1.	A. cardifolia	4.33	0.52	1.98	0.59
2.	A. latifolia	8 93	0.27	4 6'	0.19
3.	B. serrata	9.17	1.50	3.93	0.57
4.	G. pinnata	7.27	0 99	2.18	0.20
5.	L grandis	7.55	0 93	2.10	0.49
6	P. marsupium	5.10	0.22	2.44	0.37
7.	T. tomentosa	18 48	0.42	11.80	0.19
8.	X. xylocarpa	9.88	0.53	5.45	0.31

Note : All values on (O.D. Basis) bark meal.

TABLE—4

COOKING AND BLEACHING RESULT

Sl. No.	Name of the wood		Screened Yield %	Screen Rejects %	Unbleached Viscosity cps	Permanganate No.	Total Chlorine demand, %	bleaching losses %	Bleached pulp Yield, %	Brightness % Elrepho	Viscosity cps
1.	A. cardifolia :	A	36.9	0.5	21.1	24 5	9.8	9.7	33.1	80.0	7.2
		B	33.6	3.8	21 0	25.8	10 0	11.7	28.8	79.5	6.7
2	A. latifolia	A	44.6	1.3	20.2	22.0	10.0	13.2	37.9	80.5	6.4
		B	40.1	3.6	20.0	23.6	10 6	16.6	35.1	80.5	6.4
3.	B. serrata :	A	42.0	0.7	20.7	20.2	8.5	10.0	37.5	77.0	6.2
		B	39.3	1.5	20.0	22.5	9.1	12.0	34.5	76.0	5.6
4.	G. pinnata :	A	46.9	1.6	23.8	16.9	7.2	7.0	43.6	80.5	7.7
		B	45.2	2.6	22.6	19.6	8.0	10.0	42.5	79.0	7.0
5.	L. grandis :	A	45.0	0.2	25.7	16.4	6.5	11.40	39 9	80.0	10.8
		B	43 3	0.5	23.7	18.4	7.6	14 30	37.1	80.5	8.1
6.	P. marsupium :	A	46.2	1.0	19.1	26.7	10.5	8.7	42.3	73.5	8.0
		B	40.7	1.6	17.9	29.8	10.9	11.3	36.1	73.0	6.7
7.	T. tomentosa :	A	42.4	0.6	22.5	27.1	11.0	13.3	36.8	78 0	8.3
		B	41.1	1.7	19.2	30.6	11.4	23.3	31.6	78.0	5.8
8.	X. xylocarpa :	A	41.6	0.5	14.5	22.5	9.8	10.3	37.3	75.5	7.0
		B	39.4	1.2	12.3	24.4	9.9	10.7	35.2	72 5	5.6

N A : Debarked Wood; B : Wood with Bark.

Cooking Conditions :— 15.5% Active Alkali as Na_2O; 168°C, 1.25 hrs to 135°, 0.5 hr at 135°C 1.25 hr from 135 to 168°C and 1.50 hr at 168°C.

Bleaching : The unbleached pulps were bleached to a brightness level of 77 ± 3% using CEH sequence. The brightness, viscosity and strength properties at 40° SR were determined. The results are furnished in Table—5.

Weak black liquor analysis : Weak black liquors were collected for each cook and the twaddle was adjnsted to 19 at 70°C. The residual active alkali, total solids, organics, inorganics percentage, viscosity and calorific values were determined using standard methods. The results are given in Table—6.

TABLE—5
STRENGTH PROPERTIES OF UNBLEACHED PULPS AT 40° SR

Sl. No.	Name of the wood		Hand Sheet Brightness, % Elrepho	Bulk cc/gm	Burst Index KPa m^2/g	Tear Index $mN.m^2/g$	Breaking length, km	Double Folds, No.
1.	A. cardifolia :	A	18.5	1.61	4.22	8.14	7.67	160
		B	15.2	1.62	4.22	7.46	7.07	133
2.	A. latifolia :	A	18.2	1.78	3.70	5.79	7.08	54
		B	17.5	1.91	3.61	5.79	6.39	36
3.	B. serrata :	A	12.5	1.56	4.41	7.46	5.84	230
		B	12.0	1.67	3.56	6.67	5.37	142
4.	G. pinnata :	A	20.0	1.35	4.77	5.59	7.86	114
		B	17.8	1.43	4.41	5.30	7.14	106
5.	L. grandis :	A	25.0	1.50	4.41	6.57	9.21	171
		B	19.5	1.53	4.23	5.89	8.40	93
6.	P. marsupium :	A	13.0	1.72	4.01	7.36	7.50	126
		B	12.0	1.78	3.81	5.59	6.90	84
7.	T. tomentosa :	A	18.0	1.68	3.85	9.22	6.72	202
		B	16.0	2.35	3.39	7.95	5.65	119
8.	X. xylocarpa :	A	25.0	1.45	3.20	6.57	7.08	75
		B	20.0	1.60	2.94	5.40	6.80	61

A : Debarked Wood B : Wood with bark.

TABLE—6
STRENGTH PROPERTIES OF BLEACHED PULP AT 40°SR

Sl. No.	Name of the wood		Bulk cc/gm	Burst Index kPa m^2/g	Tear Index $mN.m^2/g$	Breaking Length, km	Double Folds N.
1.	A. Cardifolia	A	1.54	4.05	5.79	7.46	20
		B	1.62	3.75	5.20	6.27	20
2.	A. latifolia :	A	1.67	3.06	4.61	5.64	4
		B	1.69	2.84	3.92	5.42	3
3.	B. serrata	A	1.46	3.96	4.41	6.39	12
		B	1.48	3.49	3.92	6.03	6
4.	G. pinnata	A	1.35	4.01	5.70	7.68	17
		B	1.28	3.87	4.81	7.55	12
5.	L. grandis	A	1.25	3.68	4.51	7.84	8
		B	1.37	3.55	3.92	7.53	4
6.	P. marsupium	A	1.51	4.43	6.08	7.80	83
		B	1.53	4.14	5.30	7.40	26
7.	T. tomentosa	A	1.59	4.09	5.98	7.44	31
		B	2.36	3.10	4.12	5.35	4
8.	X. xylocarpa	A	1.36	3.59	5.79	6.77	69
		B	1.43	3.15	5.49	6.51	24

A : Debarked Wood B : Wood with bark.

RESULTS AND DISCUSSION :

Effect of bark :

The bark content of each species varies from one another, Adina Cardifolia is having a very thick bark and its bark content is 23.73%, while the bark content of anogeissus latifolia is only 4.29% (vide Table—1).

The proximate analysis results, vide Table 2, show that the 1% sodium hydroxide solubility of all barks is very high ranging from 40 to 58% as compared to the normal value of 15 to 20% for debarked wood. This points out to the fact that during alkaline cooking, most of the bark will be dissolved out and may not result in any perceptible increase in digester yield.

The alcohol-benzene extractives content of barks of four varieties viz., pteracarpus marsupium, adina cardifolia, anogeissus latifolia and xylia xylocarpa are very high (30%, 20%, 10.4% and 9.21% respectively). Hence, use of these woods with bark would create a lot of foam problems especially during washing.

The very high ash content of all barks, especially t. tomentosa (18.48%) is likely to cause scaling problems in the system. The very high calcium content is also likely to pass in to pulp and thereby affect sizing.

More chemical consumption : The residual active alkali content of black liquor from cooks with bark is comparatively less than that of debarked wood cooks (vide Table—4). This clearly indicates that the inclusion of bark consumes more cooking chemical than the debarked wood.

Gain in Yield :

Except in case of a. latifolia the inclusion of bark resulted in an increase in net yield (vide Table—7). In case of p.marsupium the yield is unaffected. However, in all the cases there is an increase in screen rejects percentage which is likely to increase the load on screening system. The increase in net yield, though an apparent decrease in digester yield, is to be attributed to the recovery of the useful fibers from the bark which would otherwise go untilized. In case of a. latifolia, the bark centent is very less and henee its contribution towards yield is not felt much. However. on bleaching (vide Table – 6) there is an increase in bleaching losses in case of wood with bark pulps. Except in case of g. pinnata and a. cardifolia, the final net yield of bleached pulp is not much different for debarked wood and wood with bark.

TABLE—7

NET PULP YIELD (KGS/TON) OF DIFFERENT SPECIES OF WOOD

Sl. No.	Name of the Wood		Screened Yield	Total Yield	Bleached Yield
1.	A. cardifolia :	A	281	285	252
		B	336	374	288
2,	A. latifolia :	A	427	439	363
		B	401	437	351
3.	B. serrata :	A	381	387	340
		B	393	408	345
4.	G. pinnata :	A	422	437	393
		B	452	478	425
5.	L. grandis	A	405	407	359
		B	433	438	371
6.	P. marsupium	A	415	424	379
		B	407	423	361
7.	T. tomentosa	A	364	369	316
		B	411	428	316
8.	X. xylocarpa	A	378	383	339
		B	394	406	352

A : Debarked Wood B: Wood with bark.

TABLE—8

BLACK LIQUOR CHARACTERISTICS AT 19°TW AND 70°C

S. No.	Name of the Wood		R.A.A. g/l	Total Solids g/l	Viscosity, cps	Organics* %	Inorganics* %	Calorific* Value/ K Cal/Kg
1.	A. cardifolia :	A	12.40	243.3	4.25	60.33	39.67	3268
		B	11.24	244.4	5.00	61.83	38.17	3524
2.	A. latifolia	A	13.18	225.4	3.25	53.73	46.27	3038
		B	10.85	234.8	3.50	56.06	43.94	3086
2.	B. serrata :	A	9.30	213.7	4.00	57.77	42.23	3541
		B	7.36	230.1	4.00	59.85	40.15	3509
4.	G. pinnata :	A	13.15	227.4	3.75	59.79	40.21	3833
		B	12.10	243.6	4.00	60.80	39.20	3888
5	L. grandis :	A	13.24	229.0	4.25	59 59	40 41	3553
		B	12.40	241.0	4.50	59.74	40.26	3611
6.	P. marsupim	A	13.95	232.7	3.00	55 51	44 49	3716
		B	12.40	240.0	4 25	60.96	39.04	3788
7.	T. tomentosa	A	13.56	232.2	4 00	36.83	43.17	3166
		B	13.18	236.9	4 25	58.27	41.73	3499
8.	X. xylocarpa	A	15.11	234.0	4.25	58.85	41.15	3484
		B	13.56	248.3	4.25	58.75	41 22	3654

A : Debark Wood B : Wood with bark.

* : On dry solids basis.

Unbleached pulp characteristics :

The inclusion of barks resulted in—

a) higher permanganate number and hence more chemical consumption

b) more darker and high dirt content and

c) lower strength properties.

Bleached pulp characteristics :

The strength properties of bleached pulps of all species decreased with the inclusion of bark.

Black liquor characteristics :

The inclusion of bark resulted in black liquor of high solids content, more organic percentage, slightly higher viscosity and higher calorific values. This can be traced to the fact that the alkali soluble content of bark is very high compared to the wood.

CONCLUSIONS .

Except in case of garuga pinnata and adina cardifolia there is net increase in bleached yield with the inclusion of bark. Except for garuga pinnata there is a drop in all strength properties.

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