Chemical Grade Pulp from Some Hard Woods from Andhra Pradesh

DR. N. D. MISRA
L. G. GUPTA and
K. ASHWATHNARAYAN

Andhra Pradesh forests abound in different species of hardwoods. Out of nearly 120 species of hardwoods found in Adilabad division of forests, seventeen more common species, as offered by the forest department, were tested for their pulping qualities to find out if bleachable grade pulp could be produced from either, and also to study the possibility of mixed cooking of each species with bamboo and bleaching mixed with normal bamboo pulp. Strength properties of pulp and its fibre characteristics were also determined to compare usefulness of each wood with that of bamboo and Salai (Boswellia Serrata) wood.

Acacia Sundra or Catechou wood pulp was found difficult to bleach free from coloured shives. Colouring matter present in this wood resisted bleaching process. The wood was also found hard in chipping. As such, Acacia Sundra could not be used for producing bleachable grade pulp. It can, however, be used for making unbleached grade paper and board.

Cleistanthus Collinus (Nalla Kodsa) wood was hard in chipping. Its cooking was also difficult. With 20% T.A.A. as Na_2O, the pulp produced had a high Permanganate number of 25.7. Rejection was high and unbleached yield was low, 37.8% on chips Bleaching of this pulp was also difficult. This wood also is not suitable for producing bleachable grade pulp. It can, however, be used for making low grade unbleached paper or board.

Lagerstromia Parviflora (Chinnagi, Lendia), although easily chipable, could not yield bleachable grade pulp even with 20% TAA as Na_2O, when pulp produced was semi-cooked and full of shives. It could not be bleached. This showed that Lagerstromia Parviflora cannot be accepted[1] for paper making.

Terminalia Tomentosa (Nalla Maddi) was hard in chipping. With 20% TAA as Na_2O, the pulp produced was hard (P. No. 30.0) and unbleached yield was very low (35-36%). This wood is not suitable for producing bleachable-grade pulp[2] and may however be used for making low grade unbleached paper and board. Phyllanthus Amblica (Amla) wood have medium quality pulp with low yield and high rejection, with 20% TAA as Na_2O. Bleaching was slow and low (72°-73°GE). Due to such properties, this wood is not suitable for producing high grade bleachable pulp. It may, however, be used for unbleached paper and board.

Diospyros Malanoxylon (Tendu or Abnus), as its name implies, contains jet-black coloured heart wood, which is difficult to bleach. This makes it unsuitable for making chemical grade pulp, bleached or unbleached, because the unbleached pulp also contains blackish colour.

Madhuca Latifolia (Mowha, Ippa) was found extremely hard in sawing and chipping, so much so, that the band saw would break and chipper knives would crack. On account of this reason, Mowha could not be accepted for making chemical grade pulp by conventional processes. Unfortunately, with ageing and drying, Mowha wood becomes harder and harder — difficult to cut or chip.

Sterculia Urens (Tapsi) was found to give strongest pulp and one of the best quality of unbleached and bleached pulp among many hardwood species tested so far. It behaves as a soft wood and is light in density. Its alkali demand is also very low, since a TAA of 16% Na_2O could produce soft pulp with easy bleachable qualities.

Gmelina Arborea (Gummidu Teku), Lannea Grandis (Dumpidi), Terminalia Balerica (Tani, Bahera), Garuga Pinata (Gargu), Dalbergia Paniculata (Sopera) and Chloroxylon Swetenia (Bilugu) woods can be easily cooked and are easily bleachable. Although their fibres are short, yet these woods can be used in optimum proportions with normal bleached and unbleached bamboo pulp.

Anogissus Latifolia (Tirman) wood is also easily bleachable, but its alkali requirement is high.

Eucalyptus Hybrid was taken up in these tests to compare its pulping qualities with other woods.

EXPERIMENTAL

i) Logs of wood samples were debarked and chipped. Size of chips in each case was maintained as far as possible below 1½". To have uniformity in bulk density data of chips, chips taken for this purpose were dried at 105°C (±2°) to constant weight. Physical appearance of each wood, its bark and bulk density data are given in Table No. 1.

Fibre dimentions and fibre composition of unbleached and bleached pulps for each species were determined as given in Table No. 2 below. Fibre classification was carried out in the L & W Fibre Classifier having horizontal sieve disk.

ii) Cooking tests were carried out to match the cooking conditions followed in the plant with bamboo. To find the change of pulping behaviour with different systems of cooking, in some cases two or more systems were adopted as indicated below. In most of the cases, cooking conditions were maintained same.

Dr. N. D. Misra, Technical Supdt., L. C. Gupta and K. Ashwathnarayan, Chemists in S. P. M. Ltd. Kaghaznagar.

TABLE No. 1 PHYSICAL QUALITIES OF WOODS TESTED.

S. No.	Botainical name of Hard Wood	Local Name	Appearance & bark characteristics	Chipping Quality	Bulk density of debarked wood (chips) kgs./m^3 (b.d. basis)
1	2	3	4	5	6
1.	Acacia Sundra	Sundra, Catechou	Deep coloured heart wood, difficult to bleach.	Hard in chipping	—
2.	Anogissus Latifolia	Tirman	Logs of light yellow colour, heart wood portion very small, faint annular rings, bark thin, smooth and of light brown colour.	Wood dense, chipping easy	263.5
3.	Chloroxylon Swetenia	Bilugu	Heavy in density. Bark thin of brownish surface, whole wood of pale yellow colour.	Chipping easy	254.3
4.	Cleistanthus Collinus	Nalla Kodsa	Brownish colour, with hard, dark, thick and cracked bark, difficult to remove, wood heavy, no sharp demarcation in heart and sap woods.	Hard in chipping	250.0
5.	Dalbergia Paniculata	Cidar, Sopera	Light coloured wood, with thin bark.	Chipping easy	—
6.	Eucalyptus Hybrid.	—	Thin ash colour, smooth bark, wood of light colour.	Easy in chipping	—
7.	Garuga Pinnata	Garugu	Light colour with no heart wood. Bark brown coloured.	Quite easy in chipping	270.0
8.	Gmelina Arborea	Gummadi Teku	Lighter colour with darker annular rings outside and central portion of light colour. Contained thin soft bark of light brown colour.	Easy in chipping	190.6
9.	Lagerstromia Parviflora	Chinnagi, Lendia	Light brown colour with thin, rough and cracked bark. No sharp demarcation in heart and sap woods. Central portion darker colour. Wood was not hard.	Easy in chipping	—
10.	Lannea Grandis	Dumpidi	Lighter with light coloured heart wood. Whole body of log one colour. Light brown coloured bark, smooth in structure and soft.	Easy in chipping	185.3
11.	Phyllanthus emblica	Amla	Softer texture, brownish heart wood.	Easy in chipping	—
12.	Sterculia Urens	Tapsi	Lighter in density with pinkish coloured, smooth bark with light pale yellow colour.	Easy in chipping	149.0
13.	Terminalia Balerica	Thanni, Bahere	Light yellow coloured soft wood with thin, smooth light blackish coloured bark	Easy in chipping	195.2
14.	Terminalia Tomontosa	Nalla Maddi, Sajaain	Dark brown colour with hard, thick and dark coloured bark strongly adhering to main logs and cracked all over the surface. Heartwood is larger and sap wood is negligible, heavy in density.	Hard in chipping	230.0
15.	Diospyros Malanoxylon	Tendu, Abnus	Deep black coloured heart wood.	Hard in chipping	—
16.	Madhuca Latifolia	Mowha, Ippa	Dark coloured wood.	Extremely hard in cutting and chipping	—

1	2	3	4	5	6
17.	Boswellia Serrata	Anduk, Salai	Light ash coloured bark, wood of light colour.	Easy chipping	223.4
18.	Dandro Calamus Strictus	Bamboo	—	— a) $\frac{3}{4}'' - 1''$	225.0
				— b) $1'' - 1\frac{1}{2}''$	192.5

TABLE NO. 2

FIBRE CHARACTERISTICS OF HARDWOODS TESTED

Serial No.	Name of Hardwood	Quality of pulp	Fibre Classification: %Fibre + 40 mesh	% Fibre −40+60 mesh	% Fibre — 60+80 mesh	%Fibre — 80 mesh
1	2	3	4	5	6	7
1.	Acacia Sundra	Unbld.	14.5	27.6	14.5	43.4
2.	Anogissus Latifolia	a) Unbld.	41.5	25.2	6.6	26.7
		b) Bld.	42.0	36.0	7.0	15.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		2.1	1.484	0.975
		Diameter (Microns)		27.6	11.7	4.6
		Slenderness Ratio :			127.0	
3.	Chloroxylon Swetenia	a) Unbld.	41.3	26.5	11.7	20.5
		b) Bld.	28.8	50.7	3.3	17.2
4.	Cleistanthus Collinus	a) Unbld.	60.0	13.0	2.0	25.0
		b) Bld.	—	—	—	—
		1) 60% chlorination	68.4	18.6	4.0	9.0
		2) 25% chlorination	74.6	9.4	4.6	11.4
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		2.1	1.5	0.975
		Diameter (Microns)		41.4	19.2	4.6
		Slenderness Ratio :			78.0	
5.	Dalbergia Paniculata	a) Unbld.	10.0	21.0	28.0	41.0
6.	Eucalyptus	—	—	—	—	—
7.	Garuga Pinnata	a) Unbld.	35.0	42.0	5.0	18.0
		b) Bld.	16.0	51.0	12.0	21.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		1.65	1.284	0.825
		Diameter (Microns)		50.6	19.96	4.6
		Slenderness Ratio :			63.0	
8.	Gmelina Arborea	a) Unbld.	13.0	58.0	6.0	23.0
		b) Bld.	4.0	58.00	12.0	26.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		1.5	1.086	0.75
		Diameter (Microns)		36.8	16.9	4.6
		Slenderness Ratio :			64.2	
9.	Lagerstromia Parviflora	—	—	—	—	—
10.	Lannea Grandis	a) Unbld.	8.0	59.0	9.0	24.0
		b) Bld.	5.0	57.0	14.0	24.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		1.5	1.077	0.6
		Diameter (Microns)		32.6	14.6	4.6
		Slenderness Ratio :			73.7	

1	2	3	4	5	6	7
11.	Phyllanthus Emblica	—	—	—	—	—
12.	Sterculia Urens	a) Unbld.	61.0	9.0	4.0	26.0
		b) Bld.	64.0	3.0	5.0	28.0
		Fibre Dimension:		**Max.**	**Ave.**	**Min.**
		Length (m.m).		2.975	2.792	1.725
		Diameter (Microns)		36.8	16.0	4.6
		Slenderness Ratio:			174.0	
13.	Termenalia Belerica	a) Unbld.	62.0	14.0	1.0	23.0
		b) Bld.	64.0	13.0	4.0	19.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		2.1	1.34	0.6
		Diameter (Microns)		27.6	11.98	4.6
		Slenderness Ratio :			111.0	
14.	Termenalia Tomontosa	a) Unbld.	39.0	32.0	5.0	24.0
		b) Bld.	42.0	30.0	4.0	24.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		1.725	1.253	0.6
		Diameter (Microns)		27.6	9.9	4.6
		Slenderness Ratio :			126.0	
15.	Boswellia Serrata	a) Unbld.	+60 = 76.0			
		b) Bld.	+60 = 81.0			
		Fibre Dimension:		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		1.6	1.2	0.7
		Diameter (m.m.)		0.03	0.026	0.022
		Slenderness Ratio:			46.0	
16.	Dandro Calamus Strictus (Bamboo)	a) Unbld.	60.0	6.0	3.0	31.0
		b) Bld.	67.0	5.0	2.0	26.0
		Fibre Dimension :		**Max.**	**Ave.**	**Min.**
		Length (m.m.)		3.0	2.1	1.2
		Diameter (m.m.)		0.015	0.011	0.007
		Slenderness Ratio :			190.0	

iii) In case with test cooks nos. 2 (a & b), 3 (a & b), 4, 7 (a, b and c), 8 (a & b), 9, 10, 12 (a & b), 13 (a & b) and 14, cooking was carried out by Impregnation method i.e. 4-stage steaming process as given below, with a total cooking cycle of 4½ hrs.

(a) from room temp. to 110°C (10 p.s.i.)	½ Hr.
(b) at 110°C (10 p.s.i.)	1½ Hr.
(c) from 110°C to 170°C (100 p.s.i.)	1 Hr.
(d) at 170°C (100 p.s.i.)	1½ Hr.
	Total 4½ Hrs.

Average sulphidity in white liquor was maintained around 16% and dilution ratio at 1:3.5. Cooks were performed in open steam heated rotary digester of 200 lt. capacity, except cook No. 7 (c), which was carried out in a small stationary S.S. autoclave of 2.5 lt. capacity and electrically heated.

iv) In case of Test cooks nos. 1(b), 6 & 11(d), cooking cycle of 4 hrs. of following duration with 4-stage steaming system or Impregnation method was maintained :

(a) from atm. pressure to 35 psi. (130°C)	1 Hr.
(b) at 35 psi. (130°C)	1 Hr.
(c) from 35 p.s.i. to 100 psi. (170°C)	1 Hr.
(d) at 100 p.s.i. (170°C)	1 Hr.
	Total 4 Hrs.

In case with Test cook No. 5 (b), this cycle was as follows :

(a) from atm. pressure to 35 p.s.i.	1 Hr.
(b) at 35 p.s.i.	1½ Hr.
(c) from 35 p.s.i. to 100 p.s.i.	1 Hr.
(d) at 100 p.s.i.	½ Hr.
	Total 4 Hrs.

v) Test cooks nos. 1 (a & c), 5(a) and 11 (b & c) were carried out by Two-stage steaming system or Straight Method, raising pressure from atmospheric to 100 p.s.i. in the first stage and maintaining 100 p.s.i. in the second stage of cooking.

In case with cooks nos. 1 (a & b), 5 (a) and 11 (b), total cooking cycle of 4 hrs. consisted of 2 hrs. each in each stage; whereas in case of cook no. 11 (c), it was 5 hrs. consisting of 3 hrs. and 2 hrs. respectively in First and Second stage.

vi) Test Cooks nos. 5 (a & b) i.e. of Dalbergia Paniculata, were carried out in 200 l. rotary digester described earlier; and cooks nos. 1 (a, b & c), 6 & 11 (a, b, c, & d) were carried out in the electrically heated stationary 2.5 l. S.S. autoclave.

vii) T.A.A. and T.E.A. taken in each case, conditions of cook, with properties of resulting Unbleached pulp are given in table No. 3 over leaf.

TABLE No. 3

COOKING CONDITIONS ADOPTED FOR HARD WOODS

Serial Test Cook No.	Name of Hardwood	Alkali taken TAA % as Na_2O	Total effective Alkali T.E.A. % as Na_2O	Black Liquor °TW	Black Liquor Temp °C	Black Liquor Resi. alkali Na_2O gpl.	Black Liquor P. No.	Kappa No.	Unbld. yield % (on b.d. wt. of chips)	Rejects %	Viscosity in cp. at 20°C 0.5% CED	Cu. No.
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	(a) Acacia Sundra	20.0	18.3	19.0	84.0	18.0	14.0	—	37.2	2.0	10.0	1.4
	(b) Acacia Sundra	20.0	18.3	22.5	84.0	22.5	18.5	—	44.6	1.8	14.8	1.5
	(c) Acacia Sundra	16.0	14.7	14.0	84.0	12.0	21.0	—	40.0	13.0	15.1	1.8
2.	(a) Anogissus Latifolia	18.0	17.0	14.0	79.0	17.3	21.3	37.7	42.7	0.8	20.4	0.84
	(b) Anogissus Latifolia	20.0	18.4	16.5	82.0	21.0	20.0	31.1	42.0	1.0	13.4	1.00
3.	(a) Chloroxylon Swetenia	18.0	16.5	12.0	71.0	14.9	16.5	26.2	48 0	0.8	17.28	0.4
	(b) Chloroxylon Swetenia	16.0	14.7	11.5	79.0	13 4	19 0	27.0	49.0	1.0	17.76	0.52
4.	Cleistanthus Collinus	20.0	18.3	17.0	78.0	24.8	25.7	43.0	37.8	0.4	18.4	0.58
5.	(a) Dalbergia Paniculata	20.0	18.4	—	—	7.8	18.0	—	48.4	0.11	15.6	1.0
	(b) Dalbergia Paniculata	20.0	18.4	—	—	6.0	19.0	—	50.5	0.1	—	—
6.	Eucalyptus	16.0	14.7	8.0	46.0	9.3	21.4	—	45.6	—	—	—
7.	(a) Garuga Pinnata	18 0	16.5	10.5	78.0	13.0	15.7	22 8	42.2	1.7	27.0	0.3
	(b) Garuga Pinnata	16.0	14.7	9.5	85.0	12.9	17.3	24.4	42.4	2.2	24.5	0.3
	(c) Garuga Pinnata	14.0	12.9	21.0	64.0	15.5	17.1	26.0	47.0	0.7	—	—
8.	(a) Gmelina Arborea	18.0	16.6	13.0	82.2	21.7	17.4	26.9	45.5	1.6	15.7	0.56
	(b) Gmelina Arborea	16.0	14.8	10.5	83.3	20.8	21.6	37.0	48 5	2.7	10.4	0.69
9.	Largerstromia Parviflora	20.0	18.4	16.0	76.0	9.9	47.8	91.2	36.8	8.2	—	—
10.	Lannea Grandis	16.0	14.7	10.0	81.1	16.7	20.3	32.3	47.5	Nil	21.1	0.56
11.	(a) Phyllanthus Emblica (Two-Stage)	20.0	18.4	—	—	12.4	20.3	—	40 4	8.0	—	1.46
	(b) Phyllanthus Emblica (Two-Stage)	20.0	18.4	—	—	14.16	20.5	—	40.0	9.2	—	1.44
	(c) Phyllanthus Emblica (Two-Stage)	20.0	18.4	—	—	13.64	19.8	—	43.0	5.6	—	1.44
	(d) Phyllanthus Emblica (Impregnation)	20.0	18.4	—	—	13.64	20.4	—	43.3	4.7	—	1.4
12.	(a) Sterculia Urens	18.0	16.5	13.0	61.0	11.2	17.2	26.0	41.0	0.4	35.0	0.43
	(b) Sterculia Urens	16.0	14.6	7.0	87.0	12.8	17 8	26.3	43.0	0.7	28 8	0.65
13.	(a) Termenalia Belerica	18 0	16.6	12.5	75.5	11.8	—	—	—	Over 50%	—	—
	(b) Termenalia Belerica	20.0	18.3	14.5	81.0	23.5	20 5	32.0	43.8	1.5	17.6	0 57
14.	Termenalia Tomontosa	20.0	18.3	14.0	88.0	18.6	30 0	71.5	35.9	0.5	16.7	3.00

viii) Bleaching tests were carried out as indicated in Table No. 4 below. Conditions of bleaching followed in each case are given against each test cook no., with quality of bleached pulp and its yield.

TABLE NO. 4

CONDITIONS OF BLEACHING ADOPTED FOR HARDWOODS

Serial Test Cook No.	Name of Hardwood	Bleaching Stage	Chlorine consumed %	Total Retention Time (Mints.)	pH maintained	%NaOH taken for Extraction (on b.d. wt. of pulp)	Brightness achieved °GE	Bleached yield (on b.d. wt. of chips)	Viscosity in ep. at 20°C (0.5% CED)	Cu. No
1	2	3	4	5	6	7	8	9	10	11
1. (a)	Acacia Sundra (% TAA 20.0)	All Hypo	10.0	300	9.0	Nil	70.0	40.4	—	—
(b)	Acacia Sundra (% TAA 16.0)	All Hypo	12.5	300	9.0	Nil	67.0	—	—	—
2.	Anogissus Latifolia (TAA 20.0%)	a) Chlorination	9.45	30	2.3	—	—	—	—	—
		b) Extraction	—	60	11.0	2.0	—	—	—	—
		c) I-Hypo	1.55	180	9.5-10.0	0.72	—	—	—	—
		d) II-Hypo	0.40	180	9-9.5	0.3	81.0	36.3	7.0	0.32
		Total	11.40	450		3.02				
3. (a)	Chloroxylon Swetenia (TAA 18.0%)	a) Chlorination	9.0	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11.0	2.0	—	—	—	—
		c) I-Hypo	1.64	180	9.5-10.0	0.72	—	—	—	—
		d) II-Hypo	0.47	180	9.0-9.5	0.3	83.0	44.6	6.12	0.55
		Total	11.11	450		3.02				
(b)	Chloroxylon Swetenia (TAA 16%)	a) Chlorination	9.6	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	2.43	180	9.5-10	0.72	—	—	—	—
		d) II-Hypo	0.65	180	9.0-9.5	0.3	83.0	43.8	4.74	1.1
		Total	12.68	450		3.02				
4. (a)	Cleistanthus Collinus (Case 1-60% chlorination)	a) Chlorination	9.1	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	2.43	180	9.5-10	0.72	—	—	—	—
		d) II-Hypo	0.55	180	9.0-9.5	0.3	78.0	30.2	7.7	1.54
		Total	12.08	450		3.02				
(b)	Cleistanthus Collinus (Case II 25% chlorination)	a) Chlorination	4.0	10	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	7.1	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	1.3	180	9.0-9.5	0.4	76.0	30.2	5.2	0.92
		Total	12.4	430		3.2				
5.	Dalbergia Panisulata (TAA 20%)	a) Chlorination	4.5	15	2-3	—	—	—	—	—
		b) Extraction	—	60	10	2.0	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
		c) I-Hypo	4.7	180	9	—	—	—	—	—
		d) II-Hypo	4.8	180	9	—	79.0	40.4	—	—
		Total	14.0	435		2.0				
6.	Eucalyptus		—	—	—	—	—	—	—	—
7.	(a) Garuga Pinnata (TAA 18%)	a) Chlorination	8.71	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	1.95	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	0.7	180	9-9.5	0.4	82.0	39.2	6.8	1.0
		Total	11.36	450		3.2				
	(b) Garuga Pinnata (TAA 16%)	a) Chlorination	8.3	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	1.72	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	0.56	180	9.0-9.5	0.4	82.0	39.4	6.3	0.9
		Total	10.58	450		3.2				
8.	Gmelina Arborea (TAA 18%)	a) Chlorination	8.3	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	1.65	180	9.5-10	0.6	—	—	—	—
		d) II-Hypo	0.6	180	9.0-9.5	0.3	83.0	39.7	4.8	1.41
		Total	10.55	450		2.9				
9.	Lagerstromia Parviflora		12.0	30			Pulp was still very dark and blackish shives dominated, hence further bleaching abandoned			
10.	Lannea Grandis	a) Chlorination	8.55	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	2.36	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	0.7	180	9.0-9.5	04	85.0	38.0	4.3	3.0
		Total	11.61	450		3.2				
11.	(a) Phyllanthus Emblica (Impreg.)	All Hypo	14.0	240		Nil	72.0	38.3	—	—
	(b) Phyllanthus Emblica (Two-Stage)	All Hypo	14.0	240		Nil	73.0	38.5	—	—
	(c) Phyllanthus Emblica (Two-Stage)	All Hypo	14.4	240		Nil	72-73	38.2	—	—
12.	(a) Sterculia Urens (TAA 18%) i) (60% Chlorination)	a) Chlorination	10.6	30	2-3		—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	2.11	180	9.5-10	0.4	—	—	—	—
		d) II-Hypo	0.85	180	9.0-9.5	0.2	82.0	34.6	6.36	2.1
		Total	13.56	450		2.6				
	ii) (25% Chlorination)	a) Chlorination	9.1	30	2-3		—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
		c) I-Hypo	1.18	180	9.5-10	0.72	—	—	—	—
		d) II-Hypo	0.38	180	9.0-9.5	0.4	85.0	35.5	8.76	0.55
		Total	10.66	450		3.12				
	(b) Sterculia Urens (TAA 16%)	a) Chlorination	9.45	30	2-3		—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	1.92	180	9.5-10	0.72	—	—	—	—
		d) II-Hypo	0.30	180	9.0-9.5	0.4	82.0	32.6	11.7	0.4
		Total	11.67	450		3.12				
13.	Termenalia Belerica (TAA 20%)	a) Chlorination	9.0	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	1.47	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	0.80	180	9.0-9.5	0.4	84.0	36.9	7.3	0.68
		Total	11.27	450		3.2				
14.	Termenalia Tomontosa (TAA 20%)	a) Chlorination	10.8	30	2-3	—	—	—	—	—
		b) Extraction	—	60	11	2.0	—	—	—	—
		c) I-Hypo	2.2	180	9.5-10	0.8	—	—	—	—
		d) II-Hypo	0.2	180	9.0-9.5	0.5	78.0	30.7	8.2	0.64
		Total	13.2	450		3.3				

REMARKS :

(1) In Column 2, % TAA indicated in brackets shows the alkali used in cooking as given in Table No. 3.

(2) During bleaching tests, temperature in chlorination and hypo stages was maintained at room temp. (around 28°-30°C), and in extraction stage with NaOH, temperature was kept around 70°-75°C.

(3) (a) In serial test No. 12(a) (i) and (ii) and also 4 (a & b), chlorination was done at the rate of 60-65% and 25-30% respectively to study the effect of bleaching with such variations.

(b) In all other bleaching tests, chlorination was made at the rate of 60-65% of total chlorine demand.

ix) Standard hand sheets of unbleached and bleached pulps from each test were made as per Tappi standard and their strength properties were determined after conditioning at 65% humidity and at 20°C. These values have been given in Table No. 5 below.

In case with Acacia Sundra (Test cook No. 1), Phyllanthus Emblica (Test cook No. 11), strength properties could not be determined due to their pulping properties found unsuitable for bleachable grade pulp.

DISCUSSIONS & CONCLUSIONS

(i) Tapsi or Sterculia Urens wood gave fairly strong and bright pulp. It required quite a low alkali (16% Na_2O T.A.A.) to produce an easy bleachable pulp with only 13% total chlorine. Its pulp, both unbleached and bleached could well be compared with bamboo pulp in strength properties and yield.

Slenderness ratio of Tappi fibre (174) approached to that of bamboo fibre (190).

These tests show that Sterculia Urens is a very good hardwood, even better than Salai (Boswellia Serrata)[4]. Being a light wood, loading of digesters may suffer as compared to that with bamboo and Boswellia Serrata. resulting in reduced yield from batch digesters.

(ii) Garuga Pinnata (Gargu) was equally a good hard wood suitable for producing bleachable grade papers. Its alkali demand was low (with 16% T.A.A. as Na_2O, pulp produced was of P. No. 17.3 and easily bleachable with satisfactory yield (unbleached 42.2% and bleached yield 39.2%). Strength properties of both bleached and unbleached sheets were quite satisfactory approaching to those of bamboo.

Slenderness ratio of its fibre was of medium range, but higher than that of Boswellia Serrata. Since bulk density of its chips is very near to that of bamboo, its loading in batch digester would not effect production.

TABLE NO. 5

STRENGTH PROPERTIES OF HARDWOODS' PULP

Serial Test Cook No.	Name of the wood	Quality of pulp	Substance gms/m²	Caliper m.m.	Burst Factor	Tear factor	Breaking length (Meters)	No. of double folds
1	2	3	4	5	6	7	8	
1.	Acacia Sundra	—	—	—	—	—	—	—
2.	(a) Anogissus Latifolia (TAA 18%)	a) Unbld.	62.0	0.1	35.4	77.4	4946	60
	(b) Anogissus Latifolia (TAA 20%)	a) Unbld.	65.0	0.11	30.0	80.0	4923	61
		b) Bld.	61.0	0.11	25.4	68.8	3924	20
3.	(a) Chloroxylon Swetenia (TAA 18%)	a) Unbld.	61.0	0.11	42.6	98.4	5246	62
		b) Bld.	62.5	0.095	41.6	76.8	5973	52
	(b) Chloroxylon Swetenia (TAA 16%)	a) Unbld.	62.0	0.1	48.4	77.4	5699	80
		b) Bld.	61.0	0.09	37.7	78.6	5246	33
4.	Cleistanthus Collinus (TAA 20%)	a) Unbld.	60.0	0.12	15.0	66.6	3602	12
		b) Bld. (60% chlorination)	61.5	0.1	14.6	58.5	3205	8
		c) Bld. (25% chlorination)	62.0	0.09	13.7	37.5	3434	10
5.	Dalbergia Paniculata (TAA 20%)	a) Unbld.	60.0	—	15.7	49.1	3070	5.5
		—	—	—	—	—	—	—
6.	Eucalyptus	a) Unbld.	—	—	16.5	68.6	3758	5
		b) Bld.	—	—	14.5	65.4	3150	1
7.	(a) Garuga Pinnata (TAA 18%)	a) Unbld.	62.0	0.08	50.0	77.4	7311	536
		b) Bld.	61.0	0.075	37.7	49.1	5409	147
	(b) Garuga Pinnata (TAA 16%)	a) Unbld.	62.0	0.085	48.7	64.5	6774	493
		b) Bld.	61.0	0.08	34.4	52.4	5901	49
8.	(a) Gmelina Arborea (TAA 18%)	a) Unbld.	62.0	0.095	22.5	70.9	5161	45
		b) Bld.	61.0	0.095	24.5	59.0	4371	28
	(b) Gmelina Arborea (TAA 16%)	Unbld.	60.0	0.095	26.6	73.3	5777	88
9.	Lagerstromia Parviflora (TAA 20%)	Unbld.	65.0	0.13	15.4	55.4	3384	10
10.	Lannea Grandis.	a) Unbld.	61.0	0.085	55.7	65.5	7103	550
		b) Bld.	62.5	0.08	30.4	25.6	5440	32
11.	Phyllanthus Emblica	—	—	—	—	—	—	—
12.	(a) Sterculia Urens (TAA 18%)	a) Unbld.	62.0	0.09	35.5	80.6	5376	121
		b) Bld.	—	—	—	—	—	—
	i) 60% chlorination		62.0	0.1	25.8	32.3	4408	8
	ii) 25% chlorination		62.0	0.085	40.3	64.5	4193	87
	(b) Sterculia Urens (TAA 16%)	a) Unbld.	60.0	0.09	41.6	83.3	6111	299
		b) Bld.	61.5	0.085	40.6	97.5	5474	174
13.	Termenalia Balerica (TAA 20%)	a) Unbld.	61.0	0.12	24.5	72.1	4371	35
		b) Bld.	64.0	0.11	26.5	50.6	4166	25
14.	Termenalia Tomontosa (TAA 20%)	a) Unbld.	60.0	0.11	21.6	60.0	3666	15
		b) Bld.	60.0	0.092	30.0	60.0	4000	32

(iii) Lannea Grandis (Dumpidi) and Gmelina Arborea (Gummadi Teku) were also found to produce satisfactory quality of both bleached and unbleached pulps of fairly good strength properties.

Alkali demand of Gmelina Arborea was slightly higher, since it took 18% T.A.A. as Na_2O to yield a pulp of P. No. 17.4, but with 16% T.A.A. as Na_2O, P. No. went up to 21.6, with fall in viscosity of brown pulp from 15.7 cp. to 10.4 cp. Lannea Grandis required 16% T.A.A. as Na_2O to produce a pulp of P. No. 20.3 and unbleached yield of 47.5%. Viscosity of this pulp was better (21.1 cp) than that of Gmelina Arborea. Bulk density of chips of both these woods were approaching to that of bamboo and slenderness ratio of their fibre was in medium range of 64-73.

As evident from enclosed test reports, both these woods may be freely accepted along with Tapsi for producing bleached and unbleached grade of paper, blended with bamboo pulp.

(iv) Anogissus Latifolia (Tirman), Chloroxylon Swetenia (Bilugu), Dalbergia Paniculata (Sopera, Cidar), Phyllanthus Emblica (Amla) and Terminalia Balerica (Tanni or Bahera) were found to give pulp of medium strength properties. As will be evident from test reports, their alkali demand to produce pulp of permanganate number around 20, was 20% Na_2O and above. Chloroxylon Swetenia (Bilugu) required 16% and 19% T.A.A. as Na_2O to produce pulp of P. No. 19 and 16.5 respectively and its pulp yield was also good Its strength properties were of medium range. However, as a fibre filler, both for bleached and unbleached grade of papers, Bilugu may be accepted for blending with normal bamboo pulp.

(v) Among the hard woods, Acacia Sundra (Catechou), Lagerstromia Parviflora[1] (Chinnagi, Lendia), Diospyros Malanoxylon (Tendu), Madhuca Latifolia (Mowha, Ippa), Cleistanthus Collinnus (Nalla Costa) and terminalia tomontosa (Nalla Maddi), the first four hardwoods i.e. Acacia Sundra, Lagerstromia Parviflora, Diospyros Malanoxylon and Madhuca Latifolia, were found absolutely unfit for making bleachable grade pulps for paper making, for reasons mentioned against each in preceding test tables.

Cleistanthus Collinus (Nalla Kodsa) is a dark coloured and hard-to-chip wood. Its alkali demand was also found very high, beyond 20% to give bleachable grade pulp and besides this, its bleached unbleached yield were also very poor. Due to these difficulties, this wood could not be bleached blended with normal bamboo pulp. Unless it is carefully cooked with high alkali around 22% Na_2O (T.A.A.), it will be most uneconomical to process and its pulp will be very weak under such conditions[3].

Terminalia Tomontosa[2] (Nalla Maddi) was found hard in chipping and difficult to cook to bleachable grade pulp even with 20% T.A.A. as Na_2O. Its yield strength properties were also very low. It is neither safe in processing with bleachable grade bamboo pulp, nor economical in pulping.

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