Studies on use of hardwoods with bark on pulp and Papermaking

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ABSTRACT

The use of young hardwoods obtained from 'man made forests' has become quite common due to its availability and commercial reasons. This study has been undertaken to evaluate pulp and papermaking characteristcis with and without bark of these hardwoods, viz , Eucalyptus hybrid, Casuarina equisitifolia and Leucaena leucocephala with particular reference to impact of use of bark. This study reveals that Subabul though requires slightly higher alkali during cooking, gives pulp of higher physical properties compared to other two woods, while Casuarina falls in between these two Bark content in Eucalyptus wood is comparatively high and adversely affects the overall pulp and papermaking characteristics including the specks problem. However, keeping in view the commercial availability of these woods, furnish has to be decided depending on overall process and quality of paper to be manufactured

Use of hardwoods has become quite common by integrated paper mill. At the same time plantation through social forestry, farm forestry etc. of some of the fast growing varieties of hardwoods, viz., eucalyptus, casuarina and subabul has also been taken up by different agencies to meet the wood requirements specially of paper industry. Use of these varieties of hardwoods has become quite popular wherever commercial viability exists. It may be also mentioned that as such with use of these hardwoods deforestation particulary by paper industry is also checked to a great extent and with this it helps in maintaining ecological balance. In this process, effective and efficient use of these raw materials has become very important and essential. Keeping these points in view various studies are being conducted by varying the processing conditions to get optimum results.

The bark, which constitute substantial percentage of wood, has also been considered as additional source of raw material and its use has direct impact on over all economics. The earlier studies (1 & 2) indicated though this portion can be used for paper manufacture but it would have adverse effect on chemical consumption, cleanliness, physical properties etc. (3 & 4) Due to these reasons most of the paper mills manufactruing bleachable grades of paper are not using wood with bark,

However, no work has been reported about the use of these woods with bark mainly obtained from these plantation and comparatively very young than forest based woods, This study has been taken up to investigate in detail pulp and papermaking properties of as such wood, debarked wood and only bark of eucalyptus, casuarina and subabul.

Experimental :

1. Samples of about 5 years of age of Eucalyptus hybrid, Casuarina equisitifolia, Leucaena leucocephala were collected from the mills wood yard. Average diameter and bark content were determined and recorded in Table–1.

2. Proximate chemical analysis was done and data are recorded in Table–2.

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3. Logs of wood and bark were chipped and pulping experiments were done separately to get pulp Kappa No. 22±2. The pulping data are recorded in Table–3.

4. Different pulp samples were bleached using CEHH sequence. Since the pulps obtained from the bark (100%) could not attain the desired level of brightness (80%) in spite of addition of heavy doses of chlorine, the data are not taken into consideration. Other bleaching data are recorded in Table–4.

5 Bauer McNett classification of fibres was done and results are recorded in Table–5 A. Fiber morphological data are given in Table–5 B.

6. Bleached pulps were beaten separately in laboratory valley beater and standard handsheets were prepared and tested for physical strength properties The data are recorded in Table–6.

Observations :

1. Average bark content (Table–1) in eucalyptus wood is quite high, i e, 17.7% compared to subabul and casuarina. It may be mentioned that most of the logs of woods are reported to be from 4-7 years old trees.

2. The proximate chemical analysis data show that alcohol benzene solubility of all the woods are comparable indicating extractives present in the wood are of same level. Lignin content is higher while holocellulose is lower in case of eucalyptus compared to other two woods. Analysis data of as such wood and debarked wood are more or less comparable while barks behave differently in all the cases.

3. It can be observed from Table–3 that active alkali requirement to get a fixed Kappa Number is lower in case of casuarina wood with and without bark

TABLE—1

Diameter and Bark Content of Raw Materials

Sl. No.	Raw Material	Avg. Diameter Cms.	Avg. Bark Content, %	Basic Density, g/cm³
1	Eucalyptus	12.4	17.7	0.45
2	Casuarina	5.1	8.3	0.54
3	Subabul	8.1	11.6	0.51

TABLE—2

Proximate Chemical Analysis

Particulars, %	EUCALYPTUS			CASUARINA			SUBABUL		
	With bark	De–bark	Only bark	With bark	De–bark	Only bark	With bark	De–bark	Only bark
Alcohol–benzene solubility	1.77	1.43	1.6	1.36	1.26	2 1	2.2	2.63	2 69
Lignin	30.3	29.8	...	21.7	22.7	...	25.2	27.1	29 6
Holocellulose	65.7	70 5	65 6	71.3	73.9	57.8	71.6	72.6	62.8
Ash	1.2	0.71	2 87	0.87	0.63	2.04	1.2	0.94	5.62

compared to other two woods. At the same time debarked woods require lower alkali compared to such wood. It is not possible to attain the desired level of Kappa Number (22+2) for bark pulp even at very high doses of active alkali. At normal alkali dose and pulping conditions barks have given very high pulp Kappa Number.

4. The bleaching behaviour (Table-4) of pulps obtained from as such woods and debarked woods remain the same in terms of total chlorine demand and final pulp brightness. At the same time all these pulps followed the same trend in bleaching as reported for hardwood pulps. It may be noted that bleached pulp of as such eucalyptus wood has higher specks compared to debarked wood, while in case of casuarina and subabul pulps of both types of woods, i.e. with and without bark specks are comparable. This indicates that pulp of eucalyptus with bark has tendency to give more specks compared to other two woods. The bleached pulp viscosity of eucalyptus is also low compared to other two woods.

TABLE–3

PULPING DATA

Particulars, %	EUCALYPTUS			CASUARINA			SUBABUL		
	With bark	W/out bark	Only bark	With bark	W/out bark	Only bark	With bark	W/out bark	Only bark
Chemicals as Na_2O, % on OD chips basis	18.0	16.5	18.0	16.0	15.5	18.0	18.0	17.0	18.0
Unbleached screened pulp yield, %	43.1	48.4	36.9	48.4	50.6	35.5	49.6	51.7	33.0
Rejects, %	0.8	0.6	1.2	1.2	1.2	0.8	1.3	0.6	1.0
Kappa Number	23.4	21.4	44 8	20.9	19.9	46.1	22.9	20 9	66.5
Residual active alkali as Na_2O, % (20% T.S.)	8.4	5.6	2.9	4.0	9.6	2.2	7.7	12.0	2.5
Unbleached pulp Viscosity, cP. (CED)	17.7	21.4	...	20.9	20.5	...	20.7	19.9	...

Constant Pulping Conditions :

1) Bath ratio (Chips : Liquor) — 1:3

2) **Cooking Schedule :**

70 to 120°C., Min. 45
At 120°C., " 45
120 to 165°C., " 90
At 165°C., " 75
'H' Factor 1005

5) Bauer McNett classification data show that subabul pulp has higher retention of fibers at 35 mesh compared to other two woods (Table No. 5A) which is further confirmed by average fiber length which is higher in case of subabul (1.03mm) compared to other woods.

6) Physical strength properties data (Table-6) indicate that pulp of subabul has higher strength index compared to casuarina and eucalyptus. Pulps of debarked woods have higher properties compared to as such wood with bark.

TABLE—4
Bleaching Data

Particulars	EUCALYPTUS		CASUARINA		SUBABUL	
	With bark	Without bark	With bark	Without bark	With bark	Without bark
Kappa Number	23.4	21.4	20.9	19.9	22.9	20.9
Chlorination :						
Chlorine added, %	4.0	3.6	3.5	3.4	4.0	3.6
Chlorine consumed, %	4.0	3.6	3.3	3.4	3.95	3.6
Final pH	2.4	2.0	2.2	2.1	2.2	2.5
Alkali Extraction :						
NaOH added, %	1.5	1.5	1.5	1.5	1.5	1.5
Final pH	9.2	8,9	9.1	9.0	9.0	8.9
Hypo Stage I						
Chlorine added, %	1.50	1.6	1.5	1.4	1.75	1.5
Sulfamic acid, % on Cl_2 basis	2.0	2.0	2.0	2.0	2.0	2.0
Chlorine consumed, %	1.53	1.52	1.45	1.37	1.69	1.45
Final pH	6.7	6.7	6.9	6.8	7.0	6 8
Hypo Stage II						
Chlorine added, %	0.75	0.5	0.5	0.5	0.5	0.5
Chlorine consumed, %	0.61	0.45	0.43	0.45	0.45	0.43
Final pH	7.3	7.3	7.4	7.1	7.1	7.1
Total Chlorine added, %	6.25	5.7	5.5	5.3	6.25	5.6
Total Chlorine consumed,%	6.04	5.57	5.3	5.2	6.0	5 48
Shrinkage, %	9.5	8.5	6.5	5.7	9 3	7 0
Brightness, %	79.5	82.6	81 8	81.6	79.7	81 4
Viscosity, cP. (CED)	6.4	6.4	12.7	16.1	10.3	9.1
Specks count, ppm	41	23	21	24	24	19

Constant Conditions :	Chlorination	Alkali Extraction	Hypo I	Hypo II
Consistency, %	3.0	5.0	10.0	10 0
Temperature, °C.	Room Temp.	55	45	Room Temp.
Time, Min.	30	60	165	165

Table – 5 A

Bauer McNett Classification of Pulps (Bleached)

Particulars	EUCALYPTUS		CASUARINA		SUBABUL	
	With bark	Without bark	With bark	Without bark	With bark	Without bark
+ 35 mesh	9	10	21	41	26	44
— 35 + 50 ,,	45	47	35	26	24	22
— 50 + 100 ,,	28	27	22	16	17	14
— 100 ,,	18	16	22	17	33	20

Table – 5 B

Fiber Morphology (bleached Pulps)

Particulars	EUCALYPTUS		CASUARINA		SUBABUL	
	With bark	Without bark	With bark	Without bark	With bark	Without bark
Average Fiber length, mm	0.60	0.72	0.80	0.85	0.97	1 03
Average Fiber diameter, Microns	13	13	14	16	21	20
Average Lumen width, Microns	8	7	8	9	13	11
Average Cellwall thickness, Microns	3	3	3	3.5	4	4.5

Table – 6

Strength Properties of Bleached Pulps at 30 °SR

Particulars	EUCALYPTUS		CASUARINA		SUBABUL	
	With Bark	Without Bark	With Bark	Without Bark	With Bark	Without Bark
Beating time, Min.	8.0	9.5	9.5	16.0	18.5	19.0
Bulk cm^3/g	1.73	1.67	1.68	1.56	1.54	1.47
Breaking length, km	4.34	4.87	4 90	6.38	6.38	6 87
Stretch, %	3.6	3.3	3.0	3.0	3 8	3.7
Tear factor	71	90	91	107	103	109
Burst factor	30.4	36.3	35.7	45.6	51.4	54 2
Double folds MIT	14	22	29	57	103	163
Strength index*	1350	1640	1685	2045	2200	2360

*Strength index = (Log D. F. × B. F. × T. F. $\frac{1}{3}$) × 100

Conclusions :

Bark content in eucalyptus is much higher compared to other two woods and this is the reason why the quality of paper made of eucalyptus with bark is adversely affected maximum compared to other two woods. The requirement of chemicals for bark is considerably high and hence, in order to obtain desired pulp kappa number debarked woods require lesser chemicals in all the cases compared to woods with bark. Pulp yields are lower in case of as such wood compared to debarked woods. Based on the data of pulp viscosity, as such wood pulp of eucalyptus seems to be weaker compared to debarked wood, which is not the case in other two woods.

Bleaching behaviour of all the pulps are more or less same in terms of chemical requirements and pulp brightness. Bleached pulp of as such eucalyptus is more specky which is in confirmation of observations of mills. As such no definite conclusion would be drawn on the basis of laboratory data on specks when bark is used in other two woods.

Average fibre length of subabul is higher compared to other two woods. Properties of subabul pulps are much higher compared to eucalyptus while casuarina falls in between and hence furnish is to be adjusted accordingly depending on the quality of pulp required.

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