Comparative Pulping Studies of Poplar Stem and Root

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Poplas Deltoide commonly known as Poplar is a fast growing species and has multiple uses in different industries. Poplar tree is cut at the age of 4 to 6 years of planting and is used variously including the paper industry. Poplar does not re-grow from stump after cutting hence its root is dug out and used for various purposes. In this technical paper comparative-pulping studies of Poplar stem and Poplar root are reported.

INTRODUCTION

Existing forest resources of the country with their low productivity are not able to meet various demands in the form of fodder, fuel, timber and raw material to various industries. More attention is needed to production forestry, which involves raising plantations of fast growing species preferably under intensive forest management (1). In this connection Poplas Deltoide has been found to be as one the promising species under agro forestry system for the plains of Punjab, Haryana and Madhya Pradesh that is grown in single row in the field plantation as well as block plantation by the farmers. Introduction of Poplar in agro forestry practices has benefited the farmers economically and encouraged them to adopt higher investment on oriented scientific research (2). Forest plantations of fast growing species like Casurina, Poplar, Subabool and Eucalyptus are gaining increasing attention from pulp and paper industry as a well thought of strategy in which Poplar as a pulp and paper making fibre resource is well recognized (3-5).

In recent years complete tree utilization involving conversion and use of total tree unmerchantable lops, branches, stumps, root and bole has been studied as a possible additional wood fibre for papermaking. It has been estimated (5) that such practices could increase world wood fibre supply as much as 35%. Pulping of specific component of trees has been investigated by number of workers (6-9).

For carrying out current studies Poplar debarked wood and root were received from Hapur region of western Utter Pradesh. Stem and root of Poplar received for evaluation was 4 to 5 years old for which comparative pulping studies of the two components of Poplar tree were carried out.

RESULTS AND DISCUSSIONS

The Poplar root dug out by the farmers is received by the contractors and is debarked before supplying it to the mills, hence adhering soil and extraneous matter is removed. At the plant level extraneous dirt left in small amount is further removed by utilizing recycled water through spraying nozzle arrangement before and after carrying out the chipping operation in the Drum chipper.

Proximate chemical analysis

Proximate chemical analysis of Poplar stem and its root dust (retained on -40, +60 mesh) was carried out employing Tappi standard methods. The results are tabulated in Table.1. It may be seen that ash, silica, 1 % NaOH solubility, alcohol/benzene solubility. Lignin content are higher in Poplar root than Poplar stem whereas reverse trend was observed in holocellulose and Pentosan content. Comparison of proximate analysis of Poplar stem and its root for ash, silica, 1% NaOH solubility, alcohol/benzene solubility, holo cellulose, lignin and pentosan are compared and projected in Fig.1. From various parameters examined, it is summarised that the pulp quality and pulp yield would be better with Poplar stem rather than with roots.

Kraft cooking of Poplar stem and Poplar root

Poplar stem and Poplar root screened chips (retained on -29.0, +3.0 m.m) were digested with 16.0% and 18.0% respectively under identical cooking conditions (Table.2). Poplar root (partially debarked) containing higher Lignin content required 18.0% alkali to produce pulp of kappa 21-24 whereas Poplar stem needs 16.0% alkali to produce pulp of Kappa in the same range.

Table. 1

Proximate chemical analysis of Poplar stem & Poplar root

Particular	Poplar stem	Poplar root
Ash, %	2.0	3.0
Silica, %	0.4	0.65
Cold water Solubility, %	3.42	3.05
Hot water Solubility, %	6.83	6.11
1 % NaOH Solubility, %	17.93	19.00
Alcohol/Benzene Solubility, %	2.39	3.81
Holo cellulose, %	75.20	68.00
Lignin, %	25.80	28.00
Pentosans, %	14.0	12.50

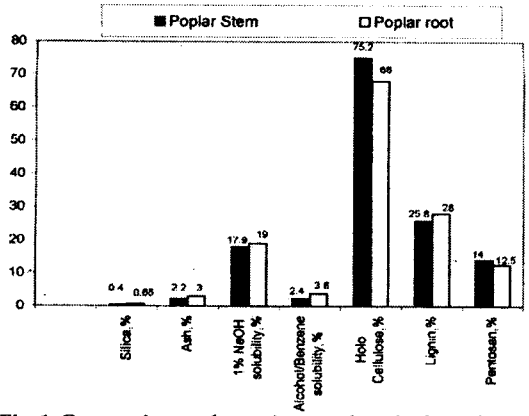

Fig-1 Comparison of proximate chemical analysis of Poplar stem and Poplar root

Unbleached pulp yield of Poplar stem (51.5%) is found to be higher than Poplar root (48.5%).

Bleaching of Poplar stem and Poplar root pulp

Poplar stem and Poplar root unbleached pulps were bleached under C-Ep-H-D sequence as per mill bleaching conditions for achieving target brightness 87±1 % P.V (Table.3). The cleanliness of the pulp made from Poplar stem and Poplar root was quite good. Poplar stem bleached pulp yield (45.7%) was observed to be higher than Poplar root pulp (42.5%). Similar was the trend noticed with bleached pulp viscosity. Above results viz, pulp brightness, viscosity and bleached pulp

Table. 2

Kraft Cooking of Poplar stem & Poplar root.

Particulars	Poplar stem	Poplar root	
		Cook No.1	Cook No.2
Chips taken, on O.D. chips, kgs	2.0	2.0	2.0
Alkali used, % as Na_2O	16.0	16.0	18.0
Sulphidity, %	18.4	18.4	18.4
Bath ratio.	1:3.5	1:3.5	1:3.5
Cooking Cycle:			
i) Ambient temperature to 135°C. mints	120	120	120
ii) 135 to 165°C. mints	60	60	60
iii) At 165°C. mints	60	60	60
iv) Total cooking time, hours	4.0	4.0	4.0
Kappa No. of the pulp	23.6	30.6	20.3
K. No. of the pulp.	15.1	18.0	14.0
Unbleached pulp yield, % (on O.D. chips)	51.5	47.0	48.5
Rejects. %(on O.D. chips)	0.6	4.5	0.7
Black Liquor Analysis			
i) °Tw At 60°C	20.0	20.0	23.0
ii) R.A.A, g/l as Na_2O	15.5	14.0	18.6

yield of Poplar stem and Poplar root are projected in Fig.2 with respect to their pulp Kappa.

Fibre Dimensional studies

Fibre dimensional studies of Poplar stem and root bleached pulps carried out under a Projectina Projection microscope shows that Poplar stem bleached pulp has higher slenderness ratio than Poplar root pulp which results in higher physical strength properties of poplar stem bleached pulp.

Fibre Classification of bleached pulp

Fibre classification of Poplar stem and Poplar root bleached pulp was carried out in a Bauer Mcnett classifier and the results are reported in table.5. Fibres retained on 40 mesh was higher in Poplar stem than Poplar root bleached pulp but fines passing through 140 mesh showed reverse trend which also supports higher strength properties of Poplar stem bleached pulp. Comparison of fibre classification results are projected in Fig.3

Physical strength properties of bleached pulps

Both the bleached pulps of Poplar stem and root were beaten to 30° S.R freeness in a P.F.I. Mill and evaluated for physical strength properties (Table-6). It may be seen that Poplar stem bleached pulp has higher strength properties than Poplar root. Comparison of strength properties of Poplar stem and root are highlighted in Fig.4

Table. 3 Bleaching of Poplar stem & Poplar root pulp under C-Ep-H-D Sequence

Particular	Poplar stem Kappa No. 23.6	Poplar root Kappa No. 20.3
Chlorination Stage.		
i) Chlorine applied, %	3.50	3..0
ii) Chlorine consumed, %	3.46	2.94
iii) End pH.	1.5	1.9
Alkali Extraction Stage.		
i) Caustic applied, %	1.5	1.2
ii) Hypo chlorite applied, %	0.4	0.4
iii) End pH,	10.7	10.0
Calcium Hypo chlorite Stage.		
i) Hypo chlorite applied, %	2.5	2.0
ii) Hypo chlorite consumed, %	2.39	1.91
ii) Sulphamic Acid, %	0.1	0.1
iv) Buffer added, %	0.8	0.5
v) End pH	8.0	8.1
Chlorine dioxide Stage.		
i) Chlorine dioxide applied, %	0.5	0.5
ii) Chlorine dioxide consumed, %	0.42	
ii) End pH	5.7	5.3
Final Results.		
i) Total chlorine applied, %	6.0	5.0
ii) Total chlorine consumed, %	5.25	4.85
iii) Pulp Brightness, % P.V	87.0	87.5
iv) Bleached pulp yield. % (on O.D. chips)	45.70	42.5
v) PulpViscosity (0.5%C.E.D),Cps	8.5	7.8

Constant bleaching conditions

	C	Ep	H	D
Consistency %	3.0	10.0	10.0	10.0
Temp. °C	Ambient	65±1	40±1	70±1
Time, mnts	60	60	120	120

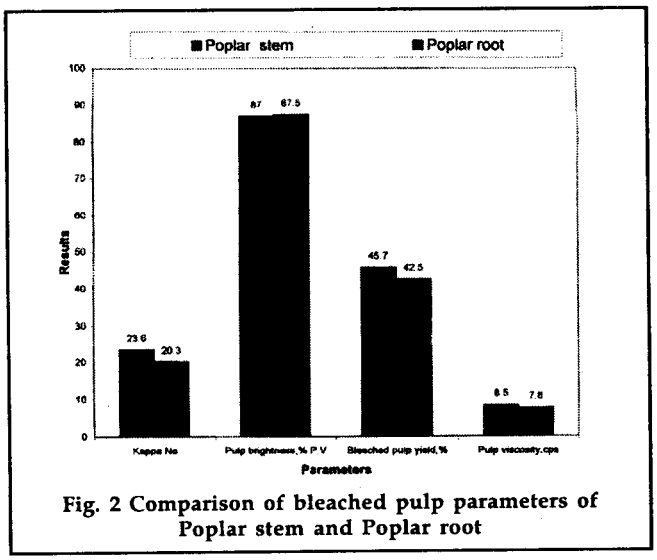

Fig. 2 Comparison of bleached pulp parameters of Poplar stem and Poplar root

CONCLUSION

Poplar stem has higher Holo cellulose and lower Lignin content than Poplar root. Alkali requirement of partially debarked Poplar root is higher than Poplar root to produce pulp Kappa in the same range. Poplar stem gives higher bleached pulp yield and better strength properties than Poplar root bleached pulp. Although strength properties of Poplar stem bleached pulp are better than Poplar root but both raw materials are quite suitable for pulp and papermaking.

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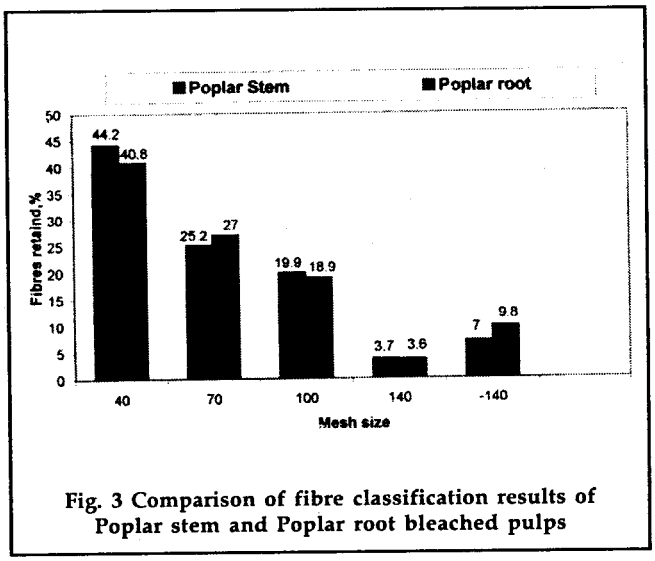

Fig. 3 Comparison of fibre classification results of Poplar stem and Poplar root bleached pulps

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Table. 4
Fibre dimensions of Poplar stem & Poplar root bleached pulps.

Particular	Poplar stem	Poplar root
fibre Length. (m.m)		
Min.	0.9	1.1
Max.	2.4	2.2
Avg.	1.6	1.57
Fibre Diameter (m.m.)		
Min.	0.015	0.01
Max.	0.035	0.04
Avg.	0.023	0.029
Slenderness ratio.		
L/D	69.5:1	54:1

Table. 5
Fibre classification of Poplar stem & poplar root bleached pulps.

Mesh size, mm.	Poplar stem	Poplar root
	Fibre retention %	
+40	44.20	40.78
- 40 + 70	25.19	26.95
- 70 + 100	19.90	18.87
- 100 + 140	3.70	3.60
-140	7.01	9.80
Total	100.00	100.00

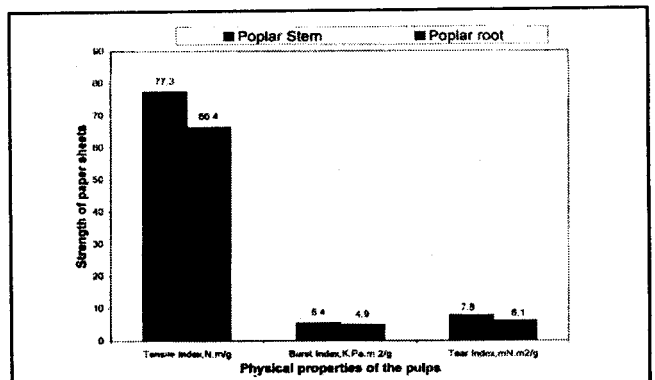

Fig. 4 Comparison of physical strength properties of Poplar stem and Popular root bleached pulps

Table. 6

Physical Strength Properties of Bleached pulp Poplar stem & poplar root.

Particulars	Poplar stem	Poplar root
Final Freeness °SR of pulp.	31.0	31.0
Beating revolution in P.F.I. mill rpm.	6700	4500
Bulk c.c./gram	1.39	1.35
Tensile Index, Nm/g	77.33	66.43
Burst Index, $KPa.m^2/g$.	5.39	4.94
Tear Index, m Nm^2/g.	7.84	6.14

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