KRAFT PULPING STUDIES OF GAMAR (*Gmelina arborea*, ROXB) OF DIFFERENT AGE GROUPS

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Paper pulps have been prepared from Gamar (*Gmelina arborea*, Roxb.) wood of four age groups by the kraft process. Cooks were made with active alkali and sulfidity ranging from 14.94 percent to 21.05 percent and 14,12 percent to 20,12 percent respectively at 170° C, The best pulp was obtained with 16 years old gamar wood at 14,94 percent active alkali and 14,57 percent sulfidity under optimum condition, Pulp-yield varied from 40,86 percent to 49,35 perecnt at various ages, The physical strength and other properties of Gamar kraft pulp compared favourably with those of other hardwood pulps prepared in the Forest Research Institute, Chittagong,

ক্র্যাফ্‌ট্‌ পদ্ধতিতে চারিটি বিভিন্ন বয়সের গামার কাঠ দ্বারা মণ্ড প্রস্তুত করিয়া পরীক্ষা চালানো হয়। শতকরা ১৪·৯৪ হইতে ২১·০৫ মানের সক্রিয় ক্ষার এবং শতকরা ১৪·১২ হইতে ২০·১২ মানের সালফিডিটি দ্বারা কাগজ মণ্ড প্রস্তুত করা হইয়াছে। ইহাতে শতকরা ১৪·৯৪ সক্রিয় ক্ষার এবং শতকরা ১৪·৫৭ সালফিডিটিতে সর্বাপেক্ষা অনুকূল অবস্থায় ১৬ বৎসর বয়স্ক গাছ হইতে উত্তম মানের মণ্ড পাওয়া গিয়াছে। বিভিন্ন বয়সের গাছ হইতে শতকরা ৪০·৮৬ হইতে ৪৯·৩৫ ভাগ মণ্ড উৎপাদিত হয়। ভৌত এবং অন্যান্য গুণাগুণের দিক হইতে ক্র্যাফ্‌ট্‌ পদ্ধতিতে প্রস্তুত গামারের মণ্ড অন্যান্য বৃহৎ পত্র-বিশিষ্ট গাছের কাঠ হইতে চট্টগ্রাম বন গবেষণাগারে প্রস্তুত মণ্ডের সহিত সন্তোষজনকভাবে তুলনীয়।

INTRODUCTION

Gamar (*Gmelina arborea*, Roxb.) is one of the fast growing hardwood species of the tropical forests of Bangladesh. It grows abundantly in Chittagong, Chittagong Hill Tracts and Cox's Bazar areas. Since long, Gamar, for its dimensional stability, easy working qualities and durability has been getting preference to other indigenous timber for making furniture.

Recently, Karnaphuli Paper Mills at Chandraghona have shown interest in making paper pulp from Gamar wood. Due to the shortage of bamboo resulting from gregarious flowering, the mills have been using miscellaneous hardwoods for the preparation of kraft pulp. The present investigation aims at the possibility of making paper pulp from 8, 12, 16 and 20 years old Gamar.

MATERIALS AND METHODS

Gamar trees are straight boled. The wood is pale yellow, greyish white, reddish white or yellowish brown in colour. The heart-wood of the tree is not distinct. Its density varies from 22 to 38 lbs per cft. The main sources of the wood are the forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar and Sylhet in Bangladesh (Troup 1921).

Samples in log form of different ages (8, 12, 16 & 20 years) of Gamar were received from the plantation in the Karnafully Paper Mills campus. Four boles, one for each age group, were received with bark on. The boles were approximately seven feet in length and 36, 40, 48 and 52 inches in average diameter respectively. They were chipped at $\frac{1}{2}$ in × $\frac{3}{4}$ in separately in the laboratory wood chipper machine and the over and under sized chips were screened out manually. Chips were exposed to air to obtain uniform moisture content in the range of 15 to 22 percent.

Fibre Analysis

Specimens were taken separately from the chips of different age groups for microscopic studies. These were separately macerated in a 1:3 mixture of chromic acid and nitric acid. Slides were prepared according to the method of TAPPI standard (Anon, 1960). The fibre length, lumen diameter and cellwall thickness were measured. Data presented in Table 1 are the averages of one hundred readings.

Pulping experiments

Digestions were made in a .8 cubic foot stainless steel laboratory model rotating digestor heated by indirect steam. The digestor was charged with 4 lbs chips (on oven dry basis). A series of digestions with 16 years old wood chips were made with active alkali varying from 14.94 percent to 21.05 percent. The optimum condition of cooking chemicals was determined by doing necessary digestions with 16 years old wood and this condition was then applied to wood of other age groups.

The liquor to wood ratio was maintained at 4:1. After cooking for three hours at 170°C the pulps were dumped from the digestor on screen box, washed with hot and cold water and screened through a 0.012 inch wide slot flat screen. The pulp yields were then determined. The pulps were run into the Valley Beater machine and the sample stocks were

Table 1. Fibre analysis of Gamar wood of different age groups

Age (yrs)	Minimum fibre-length (mm)	Maximum fibre-length (mm)	Average fibre-length (mm)	Average lumen diameter (mm)	Average cell-wall thickness (mm)	Average flexibility co-effi-cient	Average relative fibre-length	Average Runkel ratio
8	0,5278	1,3650	0,9584	0,0173	0,0054	0,6170	34,2000	0,6350
12	0,6552	1,4190	1,1770	0,0183	0,0049	0,6430	42,0300	0,5560
16	0,8008	1,4560	1,1885	0,0183	0,0050	0,6420	42,4450	0,5550
20	0,8372	1,4920	1,2017	0,0169	0,0053	0,6072	42,9280	0,6235

collected from the beater at different intervals of time for determining the freeness, Hand sheets were prepared according to TAPPI standard (Anon, 1960). The hand sheets were conditioned for 24 hours in a humidity controlled room maintained at a temparature and humidity of 73±3 5°F and 50±2 percent respectively. The physical strength properties of the pulps were then determined. The pulping condition and the strength properties of the pulps are given in Tables 2 and 3 respectively.

Table 2. Kraft pulping conditions of Gamar wood of different age groups

Cook No	Active alkali (percent)	Sulfidity (perecnt)	Chemical consump-tion (percent)	Yield (percent)	$KMnO_4$ No	Age of wood (yrs)	Remarks
135K	16,54	17,19	87,00	46,80	12,85	16	
136K	21,05	14,12	70,65	40,86	8,91	16	
138K	16,74	20,21	90,96	44,76	12,31	16	
140K	14,94	14,57	94 50	46,24	16.52	16	Optimum condition
141K	15,00	14,61	84,60	49,35	17,78	20	
142K	14,90	14,80	97,00	44,00	12,11	12	
143K	14,99	14,86	98,10	42.67	11,68	8	

Table 3. Physical strength properties of Gamar kraft pulp

Cook No.	Density (gm/cc)	Tear factor	Burst factor	Breaking length (meter)	Folding endurance (double fold)	Beating time (min)
At 450 Canadian Standard freeness						
135K	0,59	82,3	48,3	7100	4580	25
136K	0,62	71,5	35 5	5100	1980	25
138K	0,70	89,0	57:0	73C0	1363	31
140K	0,66	120,0	58,8	7300	2412	30
141K	0,45	84,0	62,0	9450	1568	31
142K	0,67	89,0	54,0	7100	466	26
143K	0,65	103,0	69,0	8100	2105	34
At 250 Canadian Standard freeness						
135K	0,68	78,2	67,5	8400	9900	32
136K	0,69	58,5	52,0	7100	5300	41
138K	0,73	78,8	65,5	9230	2522	59
140K	0,73	121,0	68,0	8600	8806	51
141K	0,63	85,0	79,0	10900	2950	57
142K	0,77	77,0	69,8	9310	1983	65
143K	0,79	83,0	79,0	9600	2506	64

RESULTS AND DISCUSSIONS

Microscopic studies were made on Gamar wood. Runkel ratios of the wood of different age groups were found to be less than unity indicating its suitability for making good quality paper. Gamar wood of 12 years old had the highest flexibility co-efficient indicating better tensile strength. The higher relative fibre length of this group ensured better tearing resistance of the paper. The optimum condition was obtained from Cook No. 140K at active alkali 14 94 percent and sulfidity of 14.57 percent. Under this optimum condition, wood of 20, 12 and 8 years old were also pulped. From Tables 2 and 3 it was observed that the pulp obtained from 16 years old Gamar wood under optimum condition was better than the other three pulps obtained

Table 4. Comparison of strength properties of Gamar wood pulp and other hardwood pulps prepared in the Forest Research Institute, Chittagong

Species	Active alkali (percent)	Sulfidity (percent)	Yield (percent)	$KMnO_4$ No.	C. S. F. (ml)	Beating time (min)	Burst factor	Tear factor	Breaking length (meter)	Pulp density (gm/cc)
Civit (*Swintonia floribunda*)	14.95	15,10	52,50	13,53	450	23	36,00	84,00	5760	0,43
					250	43	64,00	95,00	8390	0,60
Malakana (*Albizzia Moluccana*)	16,06	17,24	49,38	9,02	450	20	88,80	85.00	10400	0,74
					250	47	103,00	72,30	12700	0,81
Simul (*Salmalia malabarica*)	15,00	20,20	46,70	22,50	450	20	40,83	103,00	6410	0,40
					250	32	50,66	100.00	7710	0,63
Minjiri (*Cassia siamea*)	20,00	20,00	43,40	22,43	450	20	24,43	79,50	4500	0,21
					250	40	40,05	84,10	7000	0,18
Rubber wood (*Hevea brasiliensis*)	17,50	20,00	45,10	22,88	450	25	57,10	92,00	7620	0,60
					250	42	75,00	90.50	9280	0,64
Gamar (*Gmelina arborea*)	14,94	14,57	46,24	16,52	450	30	58,8	120,00	7300	0,66
					250	51	68,0	121,00	8600	0,73

from wood of 20, 12 and 8 years old. From Table 2 it was observed that Cook No, 141K had the higher permanganate numbers (17,78) and the Cooks 142K and 143K had the higher chemical consumption (98,10 percent) than the Cook 140K, The yield values of all the cooks were approximately the same, Table 3 indicates that the physical strength properties of the pulp of Cook No, 140K had higher values than those of Cook Nos, 135K, 136K and 138K. Only the folding endurance of Cook No. 135K was higher than that of Cook No, 140K, But on considering the overall physical strength and yield value the Cook 140K was considered the optimum,

The optimum pulping condition of 16 years old wood and the physical strength properties of the resultant pulp have been compared to the pulps prepared in the Forest Research Institute, Chittagong from other hard and semi hardwood species of Bangladesh. The comparative results have been shown in Table 4 It is clear from the Table 4 that the physical strength and other properties of Gamar wood pulp compare favourably with those of other pulps,

CONCLUSIONS

Gamar wood of different age groups can be pulped by the kraft process using optimum condition of chemicals containing active alkali 14.94 percent and sulfidity 14.57 percent.

The pulp yield varies from 49 35 percent to 40.86 percent at various ages,

The physical strength and other properties of 16 years old Gamar wood pulp compare favourably with those of other indigenous hardwood pulps prepared in Forest Research Institute, Chittagong,

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