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Effects of Pulp Blending on Strength Properties of *Ipomoea carnea* Jacq

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Blending of long fibered pulps with short fibred pulp is one of the important aspects in paper making. The morphological and chemical nature of hard wood and soft wood fibers are different in many respects. Soft wood fibers have poor drainage, lower wet strength and at press rolls tendency of sticking. In order to overcome the problems and improve the quality, blending plays an important role. Pulp blending can be done in 3 distinct ways *e.g.*, chips blending, pulp blending before beating and pulp blending after beating. Before pulp beating improves the physical strength marginally, but pulp blending after separate beating showed excellent physical strength properties. In the present investigation blending of pulp of *Ipomoea carnea* with pulps of bamboo has been studied.

Key Words: Pulp blending, Chiping, Beating, Physical strength.

INTRODUCTION

India is on of the thresholds of high developments for the enhancement of industries and the progress of the country. Paper industry is one of the industry which is expanding rapidly to fulfill the demand of pulp and paper products, but it is expected that the gap between demand and supply will increase in population growth and advancement in civilization. The steady increase with production of paper has raised serious problem of raw materials supply even in technically and culturally advanced countries. Conifers[1] the chief raw material for paper making since long is not available in sufficient quantity due to climatic topographic and various other reason in most of the countries[2]. The other raw materials suitable for paper making are almost exclusively short fibered with an average fiber length. It is well known that several properties of the paper produced from short fibered pulp are of inferior quality[3]. Present study was undertaken with an aim to produce blends of pulps from long fibered pulp to produce paper of acceptable quality.

Peckham and May[4] worked with blends of pine and gum bleached kraft pulps and concluded that the strength of a pulp blend can be predicted very closely if the two pulps are beaten before combining simply by obtaining a weighed average of the strength properties of the two freeness level. Brecht[5] concluded that when the two pulps differ only slightly in their physical properties, the blends follow a linear relationship. Literature survey reveals that a lot of work has been carried out on the pulping characteristics of bamboo, mixed hardwoods and mixed pulping of bamboo and hardwood, bamboo and softwoods for manufacturing different grades of pulping.

In experiments with blends of aspen and western softwood pulps it was found that blends were inhibited consistently higher tearing resistance that could be predicted by assuming linear relationship. Nordeman[6] concluded that the properties of a blend of two pulps can be predicted by weighing the properties of respective blend components in proportion to their functions. The blend was investigated by testing blends of upto 30 % high yield unbleached hardwood pulps with high yield unbleached pine pulps. Short thin walled fibers are currently used for the manufacture of many grades of paper[7]. Higgins[8], Alger[9], Grant[10], Rydholm[11]) and Giertz[12] have pointed out the usefulness of incorporating such fibers in paper making process.

EXPERIMENTAL

The stalks of *Ipomoea carnea* of around one or two years of age and bamboo was collected, cleaned, chipped and screened. Wood dust passing through 60 meshes and retained through 80 meshes was used for proximate analysis. Results of proximate analysis are shown in Table-1.

TABLE-1
PROXIMATE CHEMICAL ANALYSIS OF *Ipomoea carne* Jacq

Particulars	Sample I	Sample II	Sample III	Average	Bamboo
Ash content	6.14	6.20	6.10	6.14	4.10
Cold water solubility	8.43	6.21	7.53	7.39	6.42
Hot water solubility	12.60	12.05	14.10	12.9	5.80
Ether solubility	3.04	3.70	3.14	3.29	1.20
Alcohol benzene solubility	8.46	7.95	7.45	7.99	4.30
1 % NaOH solubility	28.60	28.40	29.40	28.00	26.00
Pentosan content	17.60	16.89	16.90	17.12	17.70
Lignin content	18.08	18.01	18.00	18.03	26.20
Holocellulose content	67.49	66.50	66.90	66.96	67.30
Hemi cellulose content	22.40	22.67	22.89	22.65	22.10
α-Cellulose content	46.45	47.45	47.28	47.00	37.00
Acetyl content	4.32	4.49	4.59	4.46	–
Methoxyl content	4.76	5.25	4.79	4.93	–
Uronic anhydride	3.45	3.45	3.78	3.56	–

The chips passing through 30 mm screen but retained on a 3 mm screen were collected and air dried.

Fiber morphology: For morphological study a small piece of *Ipomoea carnea* were subjected to chemico mechanical maceration to separate the individual cellular elements from each other without damage. It involves the use of hot acetic acid and sodium chlorite solution to remove most of the lignin and other cementing materials without appreciable degradation of the cellulosic tissue[13-17]. The microscopic slides of cellular materials were prepared as per BIS: 5285-1969. The microscopic slides were projected at a magnification of 40 X and fiber lengths were measured, while the fiber width and cell wall thickness were measured by measuring the projected images at a magnification of 160 X. Results are reported in Table-2.

TABLE-2
MORPHOLOGICAL CHARACTERISTICES OF
Ipomoea carnea AND BAMBOO

Particulars	Sample I	Sample II	Sample III	Average	Bamboo
Basic density	0.29	0.30	0.30	0.29	0.52
Fiber length	0.68	0.63	0.69	0.66	1.70
Fiber width	33.18	33.0	32.4	32.86	23.60
Lumen width	30.00	28.42	24.5	27.6	9.50
Cell wall thickness	1.40	1.50	1.58	1.47	7.00
Flexibility coefficient	110.6	116.11	132.24	119.65	248.42
Ratio of length to width	0.020	0.019	0.021	0.020	72.03
Ratio of twice cell wall thickness to fiber width	0.084	0.09	0.097	0.089	0.59
Wall fraction	8.4	9	9.7	8.9	59.30
Runkel ratio	0.093	0.105	0.128	0.106	1.47
Ratio of wall thickness	0.046	0.052	0.064	0.053	0.74

Preparation of pulps and blends: Blending of long fiber raw material pulps with short fibered raw material pulps were made in three sets.
Set (i):- Blending of chips in different proportion following by pulping.
Set (ii):- Blending the unbeaten pulps in different proportion before beating.
Set (iii):- Blending of beaten pulp in different proportion before sheet formation.

Pulping of raw materials: The screened chips of *Ipomoea carnea* and bamboo were cooked separately in a rotatory WEVERK make electrically heated digester of 0.02 m^3 capacity. The cooking was done by soda as well as by kraft processes. The cooking condition and results are shown in Tables 3 and 4.

TABLE-3
OPTIMIZATION OF COOKING CONDITION

Particulars	1	2	3	4	5	6	7	8	9
Temperature (ºC)	160	165	170	160	165	170	160	165	170
Cooking condition (%)	17	18	19	17	18	19	17	18	19
Bath ratio (ratio)	1:4	1:4	1:4	1:4	1:4	1:4	1:4	1:4	1:4
Time to Temp. (h)	1.5	1.5	1.5	2.0	2.0	2.0	2.5	2.5	2.5
Unbleached pulp yield (%)	42.4	42.17	39.9	42.6	40.49	39.87	42.87	41.63	38.18
Pulp Kappa No. (num)	23.07	22.05	17.92	24.13	19.24	16.84	25	19.45	15.56
Reject (%)	1.19	1.2	0.07	1.72	1.04	0.07	2.98	0.68	0.05
Free Alkali (g/L)	2.53	4.87	5.16	2.56	4.0	5.56	2.8	4.27	4.99
Viscosity (centipoise)	6.3	6.8	4.6	6.7	5.2	4.7	7.4	5.4	3.3

Pulping of blending chips: The short fibered *Ipomoea carnea* chips were blended with bamboo chips in different proportion *i.e.* 100:00, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 70:30, 80:20, 90:10, 00:100. The above blends were cooked by soda processes under cooking conditions mentioned in Table-4,The pulps obtained from above blends were washed, crumbled and screened. These pulps were beaten in PFI mills up to a freeness level 45º ± SR.

TABLE-4
KRAFT PULPING OF *Ipomoea carnea* AND BAMBOO

Particulars	*Ipomoea carnea*	Bamboo
Active alkali (%)	17	17
Sulphidity (%)	20	20
Time to minimum temp. (min)	90	90
Time to maximum temperature (min)	120	120
Maximum temperature (ºC)	165	165
Liquor to wood ratio (ratio)	4:1	4:1
Unbleached pulp yield (%)	42.17	46.4
Rejects (%)	4.87	3.5
Kappa number (no.)	22	29

Blending of pulps: The *Ipomoea carnea* pulp was blended in different proportion with bamboo pulps separately and mixed pulps were beaten to a freeness level of 45º ± SR. Beaten *Ipomoea carnea* pulps was blended with bamboo in different proportions as mentioned above. Results are shown in Table-5.

TABLE-5
STRENGTH PROPERTIES OF *Ipomoea carnea* AND BAMBOO KRAFT PULPS

Furnish *Ipomoea*:Bamboo		Blending before beating			Blending after beating			Chips blending		
Ipomoea	Bamboo	BI	TI	TNI	BI	TI	TNI	BI	TI	TNI
100	00	3.80	4.01	70.42	3.92	3.71	70.42	3.82	3.72	70.42
90	10	3.92	4.44	70.01	3.84	3.80	69.40	3.74	3.75	68.44
80	20	4.32	4.81	69.98	3.60	4.07	68.60	3.72	3.89	65.79
70	30	4.33	4.88	69.50	3.94	4.21	67.25	3.94	3.92	65.34
60	40	4.37	4.89	69.49	4.10	4.30	65.9	4.02	4.05	64.95
50	50	4.61	4.90	69.32	4.20	4.70	65.7	4.11	4.32	64.66
40	60	4.76	5.00	68.78	4.24	5.03	65.65	4.15	4.83	63.72
30	70	4.84	5.00	68.47	4.31	5.09	64.65	4.17	5.21	63.22
20	80	4.86	5.16	68.4	4.80	5.30	64.32	4.21	5.22	64.3
10	90	5.30	5.42	67.92	5.20	5.45	64.10	4.27	5.38	63.9
00	100	5.34	5.49	62.50	5.35	5.62	64.09	4.34	5.42	63.42

BI = Burst Index; TI = Tear Index; TNI = Tensile Index.

Pulp evaluation: The standard hand sheets of 60 g/m^2 from above admixtures were made on British sheet forming machine. The sheet were pressed and dried as per TAPPI standard methods, T-205im-80.These sheets were conditioned at 25 ± 2 ºC and relative humidity 65 ± 2 % and evaluated for various physical strength properties. Results are reported in Table-6.

RESULTS AND DISCUSSION

With the help of proximate chemical analysis one can have an idea about the test samples of wood that belong to hard wood, soft wood or non woody plants. After the proximate analysis the wood being tested for various parameter such as ash content, alcohol, benzene solubility and many other parameter. Results are shown in Table-1.

TABLE-6
PHYSICAL PROPERTIES OF *Ipomoea carnea* PULP BLEACHED WITH BAMBOO

Furnish		Brightness (%)	Post colour number	Breaking length	Porosity
Ipomoea	Bamboo				
100	0	84.00	7.42	7.86	0
90	10	84.10	7.44	7.65	0
80	20	83.45	7.46	7.42	4
70	30	83.76	7.69	7.08	9
60	40	83.70	7.92	6.99	16
50	50	83.35	8.24	6.84	25
40	60	82.90	8.28	6.14	25
30	70	82.75	8.53	6.02	50
20	80	82.70	9.07	7.24	55
10	90	82.55	9.33	7.21	63
0	100	81.05	9.65	6.96	100

Table-2 shows the morphological characteristics of *Ipomoea carnea* and bamboo. The *Ipomoea carnea* fibers are tapering at one end and slightly less tapering at the other end. The cell wall thickness is very low thus giving a low wall fraction and runkel ratio gives stronger paper. The fiber width and lumen diameter of *Ipomoea carnea* resembles with soft wood like pinus kesiya.The thin walled and wide lumen fibers of *Ipomoea carnea* collapse easily to double walled ribbon structure on delignification and exhibit plastic deformation, thus offering more surface contact and fiber bonding. This gives good physical strength and less porosity. As a result of the inability of the fibers to collapse when dried after beating papers made from thick walled fibers have high bulk, stiffness and compressibility and in general higher opacity and resiliency than thin walled fibers.

Table-3 shows the cooking condition of *Ipomoea carnea* and bamboo. It shows the optimum condition for pulping of *Ipomoea carnea* and bamboo. Table-4 shows results of preliminary experiments carried out at varied cooking chemical, time and temperature. Optimum condition as per the experimental results indicate that for *Ipomoea* the suitable condition were found to percentage of active alkali 17 %, time 1.5 h, temperature 165 ºC, kappa number 21,viscosity 6.3 centipoise.

Table-5 shows the results of physical strength properties of *Ipomoea carnea* and bamboo kraft pulps. Furnish of *Ipomoea carnea* and bamboo was mixed in a varied proportion. blending after beating and before beating was done, chips blending were also done. In this burst index, tear index and tensile index of *Ipomoea carnea* pulp are3 3.82 mNm^2/g, 3.72 mNm^2/g and 70.42 Nm/g, respectively. The burst index, tear index and tensile index of bamboo pulps are 5.34 $kPam^2/g$, 5.99 mN^2/g and 62.50 Nm/g, respectively. When both the pulps are blended after beating, the burst index and tear index increases and tensile index decreases with increase in bamboo proportions in blends before beating is due to variation in morphological characteristics of *Ipomoea carnea*.The beating time of *Ipomoea carnea* at freeness

45ºSR was 22 min. This gives under and over beating of one or other pulp affecting the strength properties adversely.

The strength properties of pulp obtained from chips blend beaten to a freeness of 45ºSR show lower burst index tear index and tensile index. The deterioration in strength properties is due to same treatment of both raw materials though they require different treatment because of different composition. The strength properties deteriorate during beating due to variation in morphological characteristics of *Ipomoea carnea* and bamboo. Hence the strength properties of separately cooked pulp blends beaten together shows an improvement over strength properties of pulp obtained from chips blending. Excellent strength properties are obtained when pulps are blended after beating separately.

The sheets were pressed and dried as per TAPPI standard methods T-205cm80. These sheets were conditioned at 25 ± 2 ºC and relative humidity 65 ± 2 % and then the sheets were evaluated for various physical strength properties and the results are reported in Table-6.

Conclusion

It can be concluded from on the experimental observation that blending of long fibered pulps with short fibered pulps after beating the pulps gives better strength properties when compared with other pulps. Percentage of long fibered materials in the blends can be predicted based on the paper properties of desired final product. Separate cooking and beating the pulps together shows an improvement over cooking of mixed chips.

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