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# Effect of Wet End Additives on Bamboo Pulp

## INTRODUCTION

It is well known that beating of pulp fibres is essential and this process consumes great amount of power and time. Efforts have been done to reduce power consumption, time of beating and to minimise some of the effects which are detrimental for some of the varieties of paper such as low opacity, greater tendency to cud and greater hydro-expansivity of paper developed by beating. This has been done by the use of some additives in stock preparation.

Considerable amount of study has been undertaken by Swason<sup>1</sup> on effect of natural gums on wood pulp. Tookey, Ernst, Lohmar and Wolff<sup>2</sup> have tested some seed galactomannans from *Crotalaria intermedia*, *C. spectabilis*, *Cassia emarginata*, *Trigonella foenum-graecum* and *Melilotus indica* as wet-end additives on wood pulp. The first three were generally equivalent to commercial guar-gum in improving burst, tensile and fold properties of hand-sheets. The later two improved the strength characteristics of hand-sheets, but were not as effective as guar gum. The *Cassia emarginata* mucilage gave the greatest improvement in strength and *Melilotus indica* mucilage gave the least improvement in strength and inferior to guar although it gave the best improvement in fold and the least decrease in tear factor. Jayne, Tongren and Jackson<sup>3</sup> made a critical

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*Investigations on the effect of sixteen natural gums available commercially, two varieties of commercial carboxymethyl cellulose viz., Cellpro LSH and Cellpro LVE, and six samples of seed gums isolated by National Botanical Gardens, Lucknow, on bleached bamboo pulp have been reported in this paper. The percentage increase from 1.0 per cent to 42.0 per cent in breaking length, 15.0 per cent to 50.5 per cent in burst factor and 11.5 per cent to 46.0 per cent in ash content was obtained when 1.0 per cent natural commercial gum was used as wet-end additive on oven-dry pulp. The percentage increase of 16 per cent in breaking length, 15.8 per cent in burst factor and 74.2 per cent in ash content was obtained in case of 1.5 per cent cellpro LVB and increase of 15.7 per cent in breaking length, 19.3 per cent in burst factor and 74.2 per cent in ash content was obtained when 1.5 per cent of cellpro LSH were used as wet-end additive on oven-dry pulp. The increase in breaking length and burst factor were not as high obtained by other natural commercial gums in the case where gums isolated by National Botanical Gardens, Lucknow, was used. However, increase in burst factor and ash contents were quite significant. The percent increase in breaking length was from 1.1 per cent to 21.3 per cent, in burst factor from 0.8 per cent to 4.3 per cent, and in ash content from 13.1 per cent to 45.9 per cent, when natural gums were added on oven-dry pulp.*

survey of literature on use of the beater and head box additives for the improvement of sheet characteristics on wood pulp. Leach<sup>4</sup> has described the reasons for the increase in paper strength when locust bean gum is used as a beater-additive.

Carboxy methyl cellulose (CMC) is also being used as wet-end and beater additive to give the paper-sheet the required properties. Surewics, Wlodimerz and Butkowski<sup>5</sup> have done some work on two CMC preparations viz. Glikocel S and Glikocal N. They were added in unbleached kraft pulp used for bag paper in 1 per cent of their weights based on oven-dry fibres. Their effects were evaluated by determining the strength properties of paper. Except tearing strength, which was slightly lowered the burst, tensile and fold were increased.

No systematic work has been done so far to study the effect of wet-

and additives on bamboo pulp. The reason for this is that wood pulp constitutes the chief raw material for paper making in the world. In India bamboo is the main fibrous raw material and hence this study has been undertaken in Cellulose and Paper Branch, Forest Research Institute, Dehra Dun.

## EXPERIMENTAL AND DISCUSSION:

(A) **Commercial natural gums:** Bleached sulphate flash dried bamboo pulp was used for the experiments. The pulp was soaked in water for a period of 12 hours before beating. The soaked pulp was beaten in Hollander beater at 3% consistency to a freeness of 270 ml. (C.S.F.). Initial freeness of pulp was 650 ml. (C.S.F.). After beating 2.5% rosin soap, 10 pre cent soap stone and 8% alum were added. The freeness after addition of chemicals was

Sl. Trade Name and No. of Additive	Supplied by	Percentages of additive added		Freeness of the stock (C.S.F.)	Breaking length metres	Percentage in- crease in break- ing length	Burst factor	Percent increase in burst factor	Tear factor	Ash content	Percent increase in ash content.
		4	5								
1	2	3	4	5	6	7	8	9	10	11	12
1.			Chemicals mentioned	250	1880		9.3	—	43.7	6.1	—
2.	Gum Guar HK	Vivekanand Mills Bombay-10.	0.5	175	2000	6.37	11.4	22.6	52.9	7.7	26.2
			1.0	170	2420	28.7	13.7	47.3	54.0	8.3	36.1
			1.5	160	2670	42.0	14.0	50.5	58.0	8.5	39.4
3.	Diacol CP/5	Indian Gum Ind. Ltd. Bombay.	0.5	190	2190	16.5	12.5	34.4	51.4	7.0	14.8
			1.0	175	2450	30.4	13.0	39.8	—	7.5	22.9
			1.5	170	2470	31.4	13.0	39.8	51.6	7.0	14.8
4.	Hybound HGW	Advance Chem. & Pharm. Works Ahmedabad.	0.5	180	2010	6.9	12.0	29.0	58.6	6.8	11.5
			1.0	170	2420	28.7	13.0	39.7	60.4	7.4	21.3
			1.5	160	—	—	12.6	35.5	—	7.8	27.9
5.	Diacol CGSP	Indian Gum. Ind. Ltd.	0.5	160	2260	20.2	12.4	33.3	—	6.5	6.6
			1.0	150	2400	27.6	13.4	44.1	54.3	6.8	11.5
			1.5	150	2450	30.4	13.9	49.5	54.6	6.8	11.5
6.	Higum PH	Hindustan Gum & Chem. Ltd. Bhi- wani.	0.5	180	2200	17.0	12.6	35.5	47.0	7.6	24.6
			1.0	175	2350	25.0	12.9	38.7	48.6	8.9	46.0
			1.5	170	2400	27.6	13.2	41.9	50.7	8.0	31.2
7.	Higum PC	-do -	0.5	175	2200	17.0	12.2	31.2	48.6	7.0	14.8
			1.0	170	2340	24.4	12.5	34.4	52.8	7.8	27.9
			1.5	170	2400	27.6	13.4	44.1	53.7	8.1	32.8

1	2	3	4	5	6	7	8	9	10	11	12
8. Diacol 8005/C	Indian Gum. Ind. Ltd.	0.5	180	2020	7.4	11.4	22.6	50.6	6.9	13.1	
		1.0	170	2270	20.8	12.3	32.2	53.5	7.2	18.0	
		1.5	160	2300	22.4	12.6	35.5	54.3	8.1	32.8	
9. Diacol CS/50	- do -	0.5	185	2000	6.4	11.1	19.3	50.0	8.1	32.8	
		1.0	180	2030	8.0	12.0	29.0	53.3	8.6	41.0	
		1.5	170	2200	17.0	12.5	34.4	57.2	8.6	41.0	
10. Diacol CST	Indian Gum. Ind. Ltd.	0.5	190	1900	1.0	10.1	8.6	51.2	7.1	16.4	
		1.0	180	2000	6.4	11.8	26.8	55.0	8.0	31.2	
		1.5	175	2100	11.7	12.0	29.0	57.2	8.0	31.2	
11. Gum Guar HP	Vivekanand Mills, Bombay-10.	0.5	190	1900	1.0	10.9	17.2	46.1	7.0	14.8	
		1.0	170	2000	6.4	11.0	18.3	47.3	7.2	18.0	
		1.5	160	2100	11.7	11.0	18.3	48.6	7.7	26.2	
12. Higum PM		0.5	190	2000	6.4	11.0	18.3	47.0	8.6	41.0	
	Chem. Ltd. Bhi-wani.	1.0	185	2020	7.4	11.7	25.8	47.4	8.7	42.6	
		1.5	180	2090	11.4	12.2	31.3	48.3	8.4	37.7	
13. Diacol CSP/505	Indian Gum. Ind. Ltd.	0.5	190	1990	5.8	11.5	23.6	55.5	8.7	42.6	
		1.0	180	2000	6.4	11.9	27.9	56.1	8.7	42.6	
		1.5	175	2050	9.0	12.8	37.6	58.2	—	—	
14. Gum Guar BK	Vivekanand Mills, Bombay-10.	0.5	185	1960	4.3	11.0	18.3	50.0	6.9	13.1	
		1.0	175	2010	6.9	11.8	26.8	50.9	7.2	18.0	
		1.5	170	2040	8.5	11.8	26.8	53.0	7.6	24.6	
15. Gum Guar BW	- do -	0.5	195	1900	1.0	10.7	15.0	47.1	8.1	32.8	
		1.0	180	1920	2.0	11.0	18.3	47.6	8.9	46.0	
		1.5	170	2000	6.4	12.0	29.0	—	8.5	39.4	
16. Tamarind Seed	Das & Company	0.5	170	1950	3.7	11.2	20.4	57.5	7.3	19.7	
	Bombay-1.	1.0	160	2060	9.6	12.5	34.4	57.3	8.2	34.4	
		1.5	140	—	—	10.9	17.2	59.1	8.5	39.4	

TABLE II

Sl. Trade Name No. of the Additive	Supplied by	Percentages of additive added	Freeness of the stock (C.S.F.)	Breaking length	Percentage in- crease in break- ing length	Burst factor	Percent increase in burst factor	Tear factor	Ash content	Percent increase in ash content.
		%	ml.	metres	—	%	%	—	%	%
1.	Chemicals as mentioned	210	3130	—	—	22.8	—	85.7	3.1	—
2.	Cellpro LVB	0.5	180	5540	6.7	25.0	9.6	33.0	4.6	48.4
3.	-do-	1.0	160	3500	12.2	25.0	9.6	89.0	4.7	51.6
4.	-do-	1.5	130	3630	16.0	26.4	15.8	91.1	5.4	74.2
	M/s. R. B. Mas- tural and Sons, Ahmedabad.									
5.	Cellpro LSH	0.5	180	3400	8.6	26.4	15.8	88.8	4.6	48.5
6.	-do-	1.0	140	3600	15.0	26.4	15.8	95.6	5.4	74.2
7.	-do-	1.5	120	3620	15.7	27.2	19.3	98.4	5.4	74.2

250 ml. (C.S.F.). Sample was drawn from beaten pulp and standard sheets of about 60 g.s.m. were made on standard British sheet making machine. The sheets were pressed and dried using rings and plates in air. The air-dried sheets were conditioned at 65% Relative humidity and 21°C. temperature and tested for strength properties. The ash content of the sheet was also determined. The results are recorded in Serial No. 1 of Table I.

From remaining pulp samples were drawn and wet-end additives in the proportion of 0.5 per cent, 1.0 per cent and 1.5 per cent were added. After addition of additives pulp was disintegrated for 10 minutes in all the cases. The freeness of the pulps after addition of additives was checked and standard sheets of 60 gsm. were made. The sheets were pressed and dried using rings and plates. The air dry sheets were conditioned at 65% R.H. and 21°C. temperature. The conditioned sheets were tested for strength properties. Ash contents of the sheets were also determined. The trade name of the additive, name of supplier, freeness of the pulp after addition of additive, strength properties of handsheets and ash contents of the handsheets are recorded in Table-I along with the per cent increase in breaking length, burst factor and ash content

From the results it can be seen that in general there is a tendency of freeness a drop as the percentage of additive was increased from 0.5% to 1.5%. The strength properties in general increases with addition of additives. The retention of filler increases which can be seen by increase in ash content. This indicates that for given ash content there would be more increase in the strength properties of handsheets.

(B) **Commercial carbonyl methyl cellulose:** Bleached bamboo sulphate pulp was beaten in Valley beater employing Tappi standards to a freeness of 250 ml. (C.S.F.) 2% Rosin soap, 5 per cent soap

TABLE III

Sl. Trade Name and No. mark of	Supplied by	Percentages of additive	Chemicals as mentioned	Freeness of the stock (C.S.F.)	Breaking length	Percentage increase in breaking length	Burst factor	Percent increase in burst factor	Tear factor	Ash content	Percent increase in ash content
—	—	%	ml.	metres	%	—	%	—	%	—	%
1.				1880	—	9.3	—	—	43.7	6.1	—
Sample A National Botanical Garden, Lucknow.											
2. S. Crandiflora		0.5	220	1930	2.7	12.3	3.0	53.9	53.9	7.7	26.2
C. tetragonoloba		1.0	200	2060	9.6	12.5	3.2	54.5	54.5	7.9	29.5
		1.5	200	2170	15.4	13.6	4.3	61.2	61.2	8.1	32.8
Sample B -do-											
3. S. aculeata		0.5	230	2120	12.8	11.7	2.4	59.7	59.7	8.0	31.2
C. tetragonoloba		1.0	220	2200	17.0	12.2	2.9	60.7	60.7	8.9	45.9
		1.5	220	—	—	12.8	3.5	51.0	51.0	8.9	45.9
Sample C -do-											
4. S. aculeata		0.5	185	1950	3.7	11.3	2.0	51.9	51.9	7.1	16.4
		1.0	175	2950	4.3	11.1	1.8	46.3	46.3	7.4	21.3
		1.5	170	2280	21.3	12.2	2.9	44.6	44.6	7.0	14.8
Sample D -do-											
5. A. procera		0.5	160	1880	—	10.5	1.2	50.0	50.0	7.5	23.0
C. tetragonoloba		1.0	160	1900	1.1	11.0	1.7	55.9	55.9	7.8	27.9
		1.5	155	1950	3.7	11.3	2.0	58.1	58.1	8.3	36.1
Sample E -do-											
6. Buohania spp.		0.5	180	1940	3.2	10.1	0.8	56.7	56.7	7.8	27.9
C. tetragonoloba		1.0	150	1900	1.1	10.2	0.88	52.9	52.9	8.9	45.9
		1.5	150	—	—	10.7	1.3	47.9	47.9	8.2	36.4
Sample F -do-											
7. C. tetragonoloba		0.5	180	1900	1.1	11.0	1.7	54.9	54.9	6.9	13.1
Bentha variety		1.0	160	1920	2.2	11.5	1.9	61.5	61.5	7.2	18.0
		1.5	150	2080	10.6	12.3	3.0	63.4	63.4	8.1	32.8

stone and 5% alum were added. The pulp was divided in 7 lots. In first case standard sheets of about 60 gsm. were made. In remaining 6 lots two types of carboxy methyl cellulose viz. cellpie LVB and Cellpro LSH were added. The percentages of both the additives used were 0.5 per cent, 1.0 per cent and 1.5 per cent. After addition of additives pulps were disintegrated for 10 minutes to ensure thorough mixing, and freeness of the pulp was determined. Standard sheets of about 60 gsm. were made and pressed. The pressed sheets were dried in air using rings and plates. The air-dry sheets were conditioned at 65% R.H. and 21°C. temperature and tested for strength properties. Ash content of the sheets were also determined. Percentage of additive added, freeness after addition of additive, strength properties of standard sheets and ash content of sheets are recorded in Table II along with the per cent increase in breaking length, burst factor and ash content.

From the results it can be seen that the freeness drop is sharp when percentage of additive is increased from 0.5 to 1.5 per cent. The strength properties, in general, increases with the addition of carboxy methyl cellulose. The retention of filler too increases which can be seen by increase in ash content of the sheets. On comparing Cellpro LVB and Cellpro LSH it can be seen that Cellpro LSH gives better results.

(c) Seed gums isolated by National Botanical Gardens, Lucknow :

Bleached sulphate flash dried bamboo pulp was soaked in water for 12 hours. The soaked pulp was beaten in Hollander beater at 3.5 per cent consistency to freeness of 270 ml. (C.S.F.). 2.5 per cent rosin soap, 10 per cent soap stone and 8 per cent alum were added. The freeness after addition of chemicals was 250 ml. (C.S.F.). The sample was drawn

from beaten pulp and standard sheets of about 60 gsm. were made on standard-sheet making machine. The sheets were pressed and dried using rings and plates in air. The air dry sheets were conditioned at 65% R.H. and 21°C. temperature and were tested for strength properties. The ash content of the sheets was also determined. The results are recorded in Table-III.

From remaining pulp, samples were drawn and additives in the proportion of 0.5 per cent, 1.0 per cent and 1.5 per cent were used. After addition of additive pulp was disintegrated for 10 minutes in all the cases. Freeness of pulp after addition of additives was checked and standard sheets of 60 gsm. were made. The sheets were pressed and dried using rings and plates. The air dry sheets were conditioned at 65% R.H. and 21°C. temperature and tested for their strength properties. The results are recorded in Table-III.

From the results recorded in Table-III, it can be seen that additives from *A. procera* and *C. tetragonoloba*, *Buckanamia* Sp. and *C. tetragonoloba* and *Banthra* variety do not significantly increase the strength properties. Additives from *B. grandiflora* and *C. tetragonoloba*, *S. aculeata* and *C. tetragonoloba*, and *S. aculeata* gives considerable improvement and additive isolated from *S. aculeata* and *C. tetragonoloba* gives the best results.

CONCLUSION :

1. Table-I reveals that effect of commercial additives differs from additive to additive. Gum guar, H. K., gave maximum increase in strength properties with appreciable increase in ash content. Diacol CP/5, HyBoundHGW and Diacol CGSP give almost same increase in strength properties but the ash content of sheet is lower as compared to sheets prepared using Gum guar H.K.

2. Diacol CS/50, Diacol CST, Gum guar, HP, Hygum PM, Diacol CSP/505, Gum guar BK, Gum guar BW and tamarind seed gum are comparatively less effective as far as increase in strength properties are concerned. However, increase in filler retention is in the same order as other additives.

3. Table II, reveals that drop in freeness when carboxyl methyl cellulose is added is drastic. The increase in strength of handsheets is more when cellpro LSH is used. Although strength properties increases as the percentage of additive is increased from 0.5 per cent to 1.5 per cent but it will be advisable to use 1.0 per cent additive on oven-dry pulp due to economical reasons.

4. Table-III reveals that of the natural gums derived from various species by National Botanical Gardens, Lucknow additive isolated from *S. aculeata* and *C. tetragonoloba* gives the best results. In case of all the gums increase in breaking length and burst factor was not as high as obtained from other commercial gums. Increase in burst factor and ash content was, however, quite significant.

REFERENCES :

1. Swansons J. W. **Tappi**, 33, No. 9, 451-465 (1950).
2. Tookey H.L., Ernst A.J., Lohmar, K.L. and Wolff I.A., **Tappi**, 44, No. 12, 910-912 (1961).
3. Jayne, J.W., Tongren, J.C. and Jackson, O.T., **Tappi**, 33, No. 1, 32-35, (1950).
4. Leach, H.J., **Tappi**, 37, No. 8, 343-349 (1964).
5. Surewicz, Wlodgimerz and Rut Kewski, **Przeglad Papier**, 17, No. 2, 35-40 (Feb. 1961).