Papermaking Potential of Blends of Bamboo and Eucalyptus Sulphate Pulps

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To estimate the paper–making potential of pulp blends, a study of the physical properties of handsheets made from blends of unbleached bamboo and eucalyptus sulphate pulps in varying proportions, was made. This has enabled to determine the proportion of bamboo pulp that could be reduced in the furnish without impairing the physical strength properties, which also implies that savings in bamboo raw material can be effected. The procedure consisted of mixed beating of bamboo and eucalyptus sulphate pulps of variying permanganate numbers in the valley beater to a constant beating degree (°SR). Standard handsheets of 60 g/m² made on the British sheet making machine were tested for bulk, breaking length, burst, tear, double folds and porosity. In a separate experiment the effect of refining degree on the strength characteristics of individual bamboo and eucalyptus pulps and a mixed pulp (70% bamboo+30% eucalyptus) both in unbleached and bleached condition were alsa made.

Introduction

Indian pulp and paper industry is poised for tremendous growth and development. In order to meet the estimated demand, the production will need to be 2.64 million tonnes in 1980. For this forestry sector has the responsibility of organizing the raw material supply. This in turn demands for the creation of man made forests. For the best utilization of the plantations, it is utmost necessary to have a thorough understanding of their substitution potentials in the pulp and paper industry. In this context, this paper deals with eucalyptus hybrid as a fibrous raw material of tomorrow in conjunction with bamboo, the existing raw material for pulp and paper today.

The progress in the utilization of short fibred hardwood pulps have been achieved largely through extensive research. Some workers[1,2] believe that hardwood fibres mixed upto 10% in composition increase and improve paper properties and structure. According to Ionsen [3], short fibres and fines of hardwood pulps fill in the pores and improve air porosity and smoothness of paper. Opinions vary regarding the amount of short fibres to be mixed with longer ones. Heis [4], Mai [5] and Kosaya [6] believed that short fibres can be used upto 20% of the composition without any effect on paper properties. Some [7,8,9] even recommend 30-40% hardwood fibres in paper composition. In recent years it is reported that Japan is manufacturing certain grades of writing and printing papers from 100% hardwood furnish. Australia is said to be utilizing eucalyptus pulp for almost every grade of paper. However, the furnish composition depends upon paper quality and the limitations of paper machine[11]. Guha *et al*[12] carried out studies on effects of pulp blending and their general conclusion was that the best results are obtained by separate pulping, and separate beating, and then blending the two pulps. With such widely prevailing ideas, it was felt necessary to study the properties of eucalyptus-bamboo pulp blends, for strength and quality improvements with a view to ascertain the substitution potential of the eucalyptus pulp.

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Experimental

For the first set of experiments where the mixed beating of bamboo and eucalyptus pulp in varying proportions, was carried out, a mill bamboo pulp was used. For mixing eucalyptus pulps, the eucalypus chips prepared from 10 year old *E. hybrid* in the mill chipper and cooked to varying permanganate numbers, under the conditions given in Table I, were used. The refining curves for bamboo and eucalyptus sulphate pulps of varying K. Nos. were determined and are given in figures 1–4. The effect of blending of eucalyptus pulps of varying K. Nos. with the bamboo pulp and mixed beating to a constant beating degree i. e. 30°SR was studied and the results are shown graphically in fiigures 5–10.

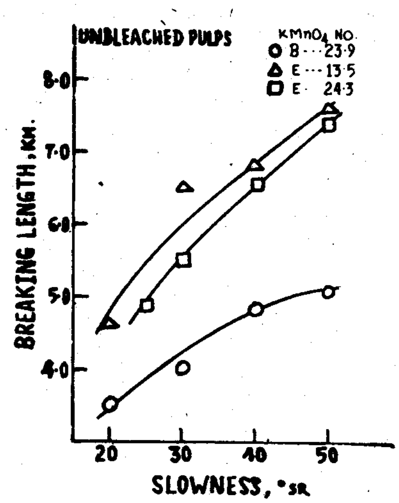

Fig. 1

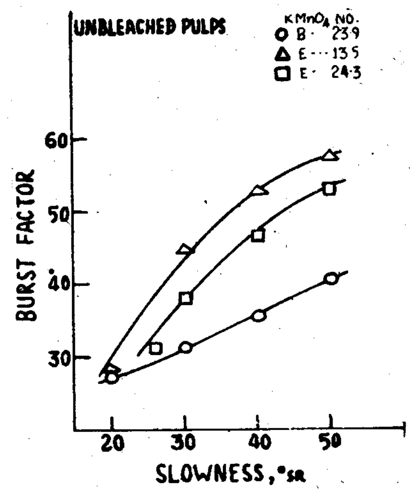

Fig. 2

TABLE I

Pulping Conditions, pulp yield for *E. hybrid* pulps of varying K. Nos.

Cook No.	1	2	3	4
Active Alkali as such ($NaOH+Na_2S$) on chips,%	18	19	20	23
Liq : Chips ratio	3:1	3:1	3:1	3:1
Time to raise to 120°C., min.	60	60	60	60
Time at 120°C., Min.	30	30	30	30
120—165°C., Min.	45	45	45	45
At 165°C., Min.	90	90	90	90
Screened pulp yield, %	48.0	46.8	45.3	45.2
Rejects, %	1.0	0.8	0.8	0.6
$KMnO_4$ No. (40 ml)	24.3	21.2	19.1	13.5

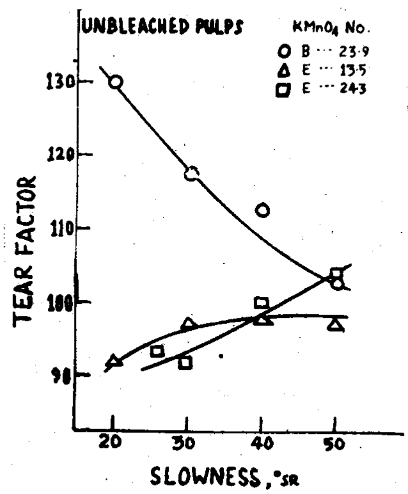

Fig. 3

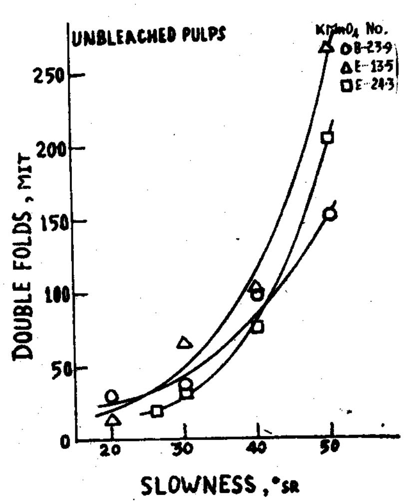

Fig. 4

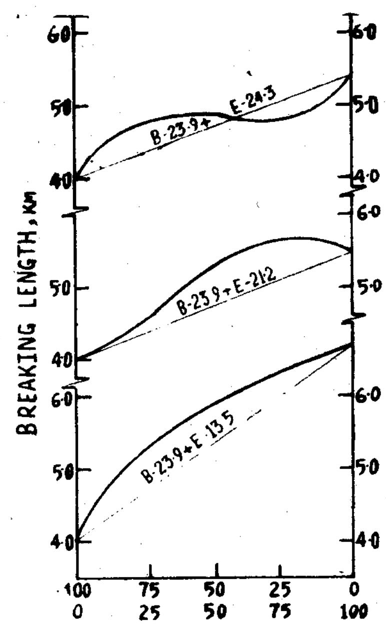

Fig. 5

In another experiment individual pulps of bamboo and eucalyptus and a mixed pulp obtained from mixed cooking (70% bamboo + 30% eucalyptus) were tested for physical strength characteristics, wet web strength, in both the unbleached and bleached condition at varying refining degrees.

The procedure for the wet web strength briefly consisted of employing a test strip of 3 cm x 10 cm

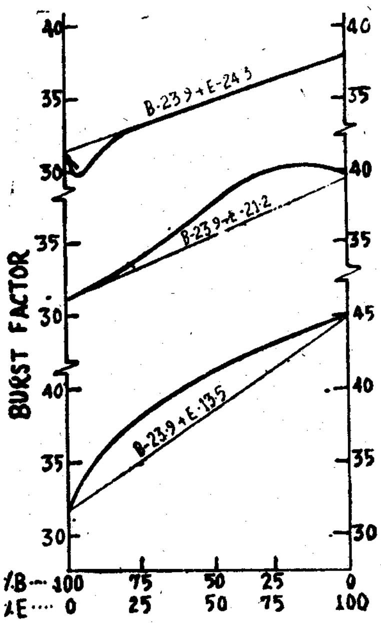

Fig. 6

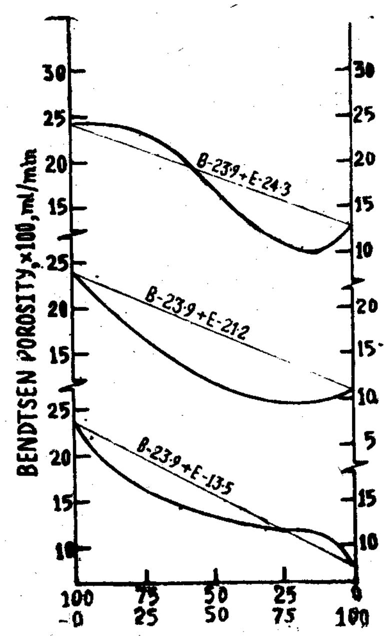

Fig. 7

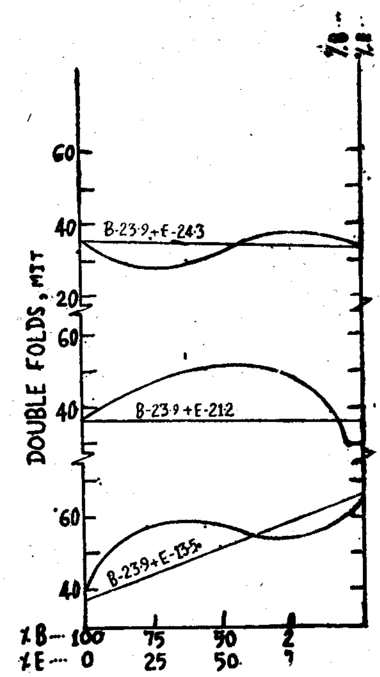

Fig. 8

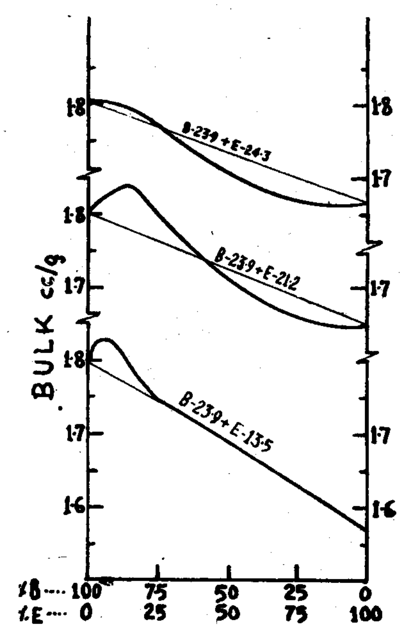

Fig. 9

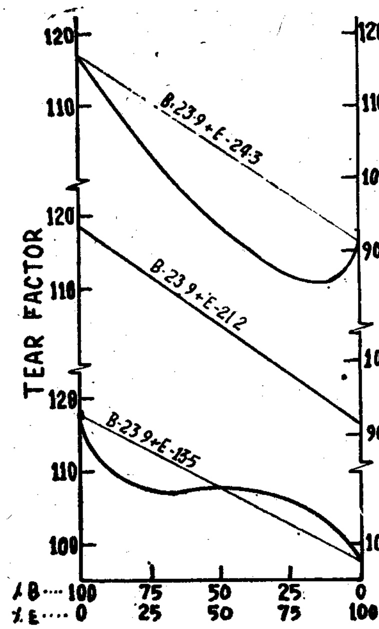

Fig. 10

obtained from a 60 g/m² sheet and prepared on the British sheet making machine. The strip was couched with the help of blotters to adjust the weight of the strip to 1 ±0.03 grams (20% consistency). The strip was tested for the wet web strength on a locally fabricated apparatus prepared essentially on Brecht and Geniger principle. The apparatus consisted of two metallic trollies-one stationary and another mobile with negligible friction. The whole arrangement was fixed to a physical balance. The test strip was placed on the trollies so that the sample was half way on each trolley. Then standard weight was kept on each trolley and the load applied on another pan of physical balance until the strip breaks. Without placing the strip, the experiment was repeated to get the blank reading. The difference gave the breaklng load.

The wet web strength was then determined by the formula :

$$\text{W.W.S. metres} = \frac{Pl}{100\,q}$$

P=breaking load, g.
l =breaking width i.e. 30 cm.
q=O.D. wt. of the strip, g.

The pulping tests were carried out in an stationary digester of 20 litre capacity, provided with indirect heating and liquor circulation. The resulting pulps were evaluated for strength development in a laboratory valley beater and handsheets were made and tested for physical properties according to standard Tappi methods-

Results & discussion:

The physical strength characteris- of the individual pulps are given in figures 1-4. With increase in the slowness(°SR) of the pulp, the improvement in the burst factor and breaking length for eucalyptus pulps is significant. Further there is a sudden rise in the double folds (MIT) for eucalyptus pulps as beating progresses which is less significant in case of bamboo pulp. Changes in resistance to tear on beating show that whereas the bamboo pulp exhibited a steady decrease, the eucalyptus pulps displayed upward trend either continuously or after an initial increase a costant trend. Properties like breaking length and burst factor were definitely higher for eucalyptus pulps when compared to bamboo pulp.

The effect of blending of eucalyptus pulps of varying K. Nos. with the bamboo pulp, in varying and mixed beating to 30° SR are shown graphically in figures 5–10. The properties of the blends show that either the relationships are linear, or the values only slightly greater or lower than anticipated. For breaking length, burst factor and double folds an indication of synergistic effect was observed when the content cf euclyptus pulp of K. No. 21 was increased. The effect of blending of increasing quantities of eucalptus pulp was to reduce the air permeability of the handsheets substantially. From the curves given in figures 5–10, it could be interpreted that it is advantageous to blend an eucalptus pulp of low K. No. with the bamboo pulp and for practical considerations like the pulp yield obtained, amount of chemicals used during cooking, a pulp of 20 and less K. No. would be preferable.

In order to study the properties of the blend of bamboo and eucalyptus pulps (unbleached and bleached) at varying refining degree (°SR), individual pulps of bamboo, eucalyptus and a mixed pulp, were obtained under the conditions given in Table II. In order to make the eucalyptus chips easily pulpable with bamboo, the eucalyptus chips of little less size were used in comparison to bamboo chips, as will be seen from the chips classification data given in Table II.

The effect of refining of bamboo, unbleached sulphate pulp, eucalyptus unbleached sulphate pulp and mixed pulp, on bulk, breaking length, burst factor and tear factor are depicted graphically in figures 11 and 12. At any slowness level (°SR) the bulk of the handsheets for the eucalyptus pulp is low, compared to bamboo pulp. It is obvious, from this, that properties like breaking length and burst factor which are dependent on fibre bonding will be higher for the eucalyptus pulp, and this has actually been found. Normally with increase in the density of the sheets, it is expected that the resistance to tear is decreased. This was found to be the case with bamboo pulp, whereas the eucalyptus pulp showed an upward trend and the tear factor of the mixed pulp was practically unaffected with increased beating. This is an added advantage of mixing eucalyptus pulp.

In order to examine the effect of bleaching on the strength properties of bleached pulps, bamboo pulp, eucalyptus pulp and pulp from the mixed cook were subjected to bleaching by the CEHH sequence. The bleaching data is given in Table III. The data show that the total bleach requirement for eucalyptus pulp is much less in comparison to bamboo pulp to attain 80% brightness.

The wet web strength of the handsheets was found to be higher for eucalyptus pulp in comparison to bamboo pulp, and the mixed pulp gave a value in between that of bamboo and eucalypts pulp. The results are shown in fig. 13 and 14. A comparison of the strength properties at 40°SR for unbleached and bleached pulp (Table IV) show

TABLE II

Chip size classification and pulping data for Bamboo and Eucalyptus chips

Size classification of chips, screen opening. mm. % retained on.	Bamboo	Eucalyptus	70% Bamboo + 30% Eucalyptus
—32+25	34.7	15.2	27.6
—25+22	16.0	10.4	14.5
—22+19	15.8	14.1	15.5
—19+16	17.9	20.3	18.7
—16+13	8.3	15.6	10.6
—13+ 6	7.3	24.4	13.1

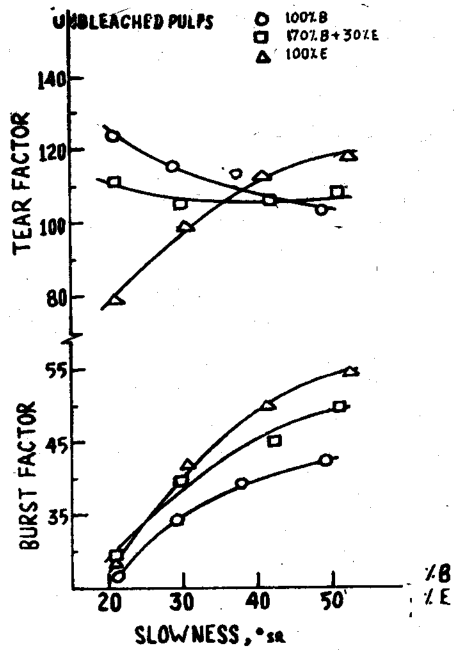

Fig. 11

Kraft Pulping Data

Experiment No.	1	2	3
Material	100% Bamboo	100% Eucalyptus	70% Bamboo + 30% Eucalyptus
Chips O. D. wt., Kg	2.5	2.5	2.5
Active Alkali as such ($NaOH+Na_2S$) on chips, %	19	19	19
Liquor : Chip ratio	3:1	3:1	3:1
Time to raise to 120°C., min.	60	60	60
Time at 120°C. min.	30	30	30
120–165°C., min.	45	45	45
Time at 165°C., min.	60	90	90
Screened pulp yield, %	50.7	45.8	48.0
Rejects, %	5.8	1.1	3.8
$KMnO_4$ No. (40 ml) of screened pulp	23.0	19.0	20.9

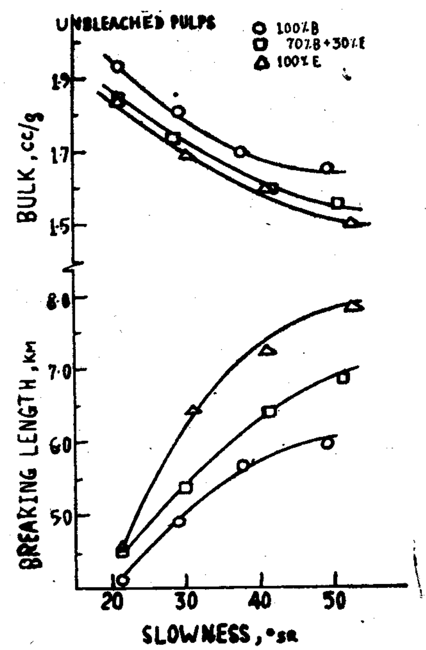

Fig. 12

Table III

Bleaching Data for Bamboo, Eucalyptus and Mixed Pulp

	100% Bamboo Pulp	100% Eucalyptus Pulp	70 % Bamboo + 30 % Eucalyptus Pulp
Ist Stage Chlorination			
K. Nos.	23.0	19.0	20.9
Cl_2 added on pulp, %	9	5	6
Cl_2 consumed, %	8.93	4.92	5.93
IInd Stage Alkali Extraction			
NaOH added on pulp, %	2.50	2.00	2.50
Final pH	9.7	10.4	10.1
IIIrd Stage Hypo I			
Av. Cl_2 added on pulp, %	2.50	0.80	2.25
Av. Cl_2 consumed, %	2.34	0.70	2.06
Final pH	6.6	6.5	6.7
IVth Stage Hypo II			
Av. Cl_2 added on pulp, %	1.0	0.4	1.0
Av. Cl_2 consumed, %	0.73	0.30	0.82
Final pH	6.8	6.9	6.8
Total Cl_2 added, %	12.5	6.2	9.25
Total Cl_2 consumed, %	12.0	5.92	8.8
Shrinkage during bleaching, %	8.1	5.4	7.0
Bld. pulp yield on O.D. chips basis, %	46.8	43.6	44.7
Brightness, % (Elrepho)	78.7	83.0	81.8
CED Viscosity, cP	17.3	9.7	13.7

Constant Conditions

	Consistency, %	Temperature, °C	Time, Min.
Chlorination	3	32	60
Alkali Extraction,	5	55	60
Hypo I	5	45	60
Hypo II	5	45	90

0.07% Sulphamic acid on pulp was added in both the hypochlorite stages (Hypo I and II).

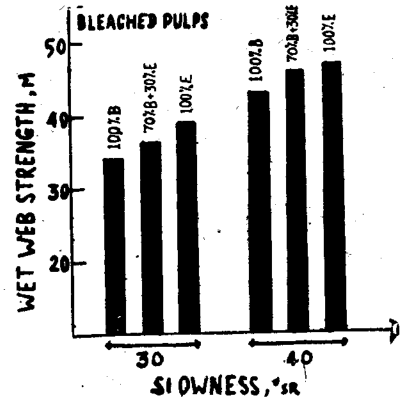

Fig. 13

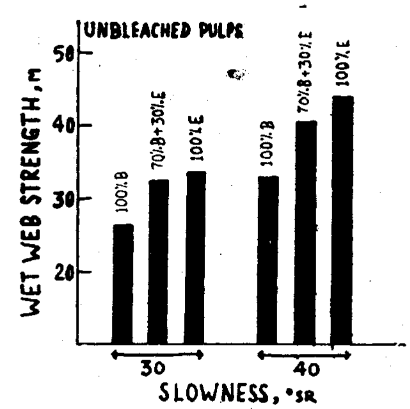

Fig. 14

that except for the tear factor, breaking length, burst factor and double folds were higher for the bleached pulps in comparison to unbleached pulps.

Conclusions:

1) The wet web strength of the eucalyptus pulps (unbleached and bleached) was higher when compared to bamboo pulp and the mixed pulp (70% bamboo +30% eucalyptus) also gave a wet web strength higher than 100% bamboo pulps.

2) Substantial amounts of bamboo pulp could be substi-

Table IV

Strength Properties of Unbld. Pulps at 40°SR

Property	100% Bamboo Pulp		100% Euc. Pulp		70% Bamboo + 30% Euc. Pulp	
	Unbld.	Bld.	Unbld.	Bld.	Unbld.	Bld.
Bulk, Cm^3/gm.	1.70	1.53	1.60	1.51	1.60	1.48
Breaking length, km	5.70	6.86	7.25	7.48	6.39	7.04
Burst factor	39.3	45.2	49.7	55.4	44.8	49.7
Tear factor	113.0	75.4	112.5	100.5	106.0	90.7
Double folds (MIT)	132	241	65	118	202	211
Wet web strength, m.	32.9	43.1	44.1	46.4	40.5	45.9

tuted for eucalyptus pulp, and this substitution will improve some of the paper properties *viz.* breaking length, burst factor, formation etc. and is thus an advantage, besides conserving the resources of bamboo.

3) Most of the properties *viz.*bulk, breaking length, and burst factor of pulp blends exhibited linear relationships with respect to composition.

4) Since important physical characteristics of the blends, could be predicted with reasonably good accuracy by the application of linear relationships, the paper properties of the blends, could be easily varied to meet the specific requirements.

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