Pulp and Papermaking Characteristics of Nodes, Internodes And Culm of Bamboo Dendrocalamus Strictus

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ABSTRACT

The present paper deals with the evaluation of two main portions of bamboo (D. strictus) i e. nodes and internodes and comparison of their pulp and papermaking properties with as such bamhoo culm. The study reveals that nodal and internodal portions of bamboo culm differ in their chemical constituents. Internodal portion of bamboo has higher holecellulose and lower pentosions, extractives. ash and lignin compared to nodal portion The chips of nodal pprtion require more active alkali in pulping to obtain pulp of desired kappa number compared to chips of internodal portion. The pulp yield is lower with more rejects in case of nodal portion. However. in bleaching the chemical requirement and bleachability are some under the identical conditions. The bleached pulp viscosity is lower in case of pulp from nodal portion. The fiber morphological and Bauer McNett classification results show that pulp ftom nodal portion has compartively lower fiber length than internodal portion. The strength properties of bleached pulp of nodal portion are comparatively lower As such bamboo culm show the intermediata trend in all the properties.

Bamboo belongs to family Graminas. Though bamboo steam is woody in nature but similar to other plants of this family it consists of aiternatively nodes and internodes Nodes and internodes differ with each other anatomically. In the process of papermaking physical, morphological and chemical homogenity of wood of wood play an important role. As reported earlier (1) the nodes and internodes (Sambusa arundinacea) behave quite differently in pulp and papermaking characteristics. Dendrocalamus strictus is the main variety of bamboo used by Indian paper industry. This study has been undertaken to evaluate pulp and papermaking characteris of node, internode and culm as such of the varlety of bamboo.

EXPERIMENTAL

SAMPLE :

The samples of sound bamboo (Dendroca'amus strictus) were collected and chipped in the mill chipper. The chips were classified in Williams chips classifier (Table I). The chips of —32+3 portions were taken for the study. The chips were divided into two portions. One portion was kept for study as such bamboo culm and from other portion, nodal and internodal portions were separated manually.

TABLE—I

CHIPS SIZE CLASSIFICATION

Screen size mm	Chips retained %
+32	4 2
—32, +25	26 2
—25, +22	15.9
—22, +19	11.0
—19, +16	11.2
—16, +13	14.4
—13, +6	15 3
—6, +3	1.8

PROXIMATE CHEMICAL ANALYSIS :

The chips were powdered separately in laboratory grinder and the analysis was carried out as per TAPPI STANDARD methods except holocellulose which was determined by sodium chlorite treatment method. The results of proximate chemical analysis are recorded in Table (II).

TABLE—II

PROXIMATE CHEMICAL ANALYSIS

Particulars, (%)	Node	Internode	As Such
Cold water solubility	8.1	6.1	6.6
Hot water solubility	8.6	7.6	7.6
1.0% NaOH solubility	26.1	20.8	22.0
Alcohol-benzene solubility	6.5	6 8	6.9
Holocellulose	63 2	71.5	70.9
Klason lignin	29 5	25.9	27.6
Pentosans	19.4	16.3	17.1
Ash	4.8	4 0	4.6

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PULPING :

The conditions of pulping i. e. chemicals and 'H' factor were optimised to get unbleached pulp kappa No. 27±2 and then subsequntly pulping experiments were carried out, taking 2 Kgs. oven dry chips in 15 ltrs. capacity electrically heated rotary digester, under the optimum conditions. The pulping conditions and results are recorded in Table–III.

TABLE—III
PULPING DATA

Particulars	Node	Internode	As Such
Moisture in chips, %	10.4	11.0	10.0
Active Alkali on OD chips as Na_2O, %	18.5	17.0	17.5
Screened pulp yield, %	41.7	46.5	45.2
Rejects, %	2.3	0.9	1.6
Total pulp yield, %	44 0	47.4	46.8
Kappa No.	28.5	27.4	26.5
Black liquor			
pH	12.0	11.9	11.6
Active Alkali as Na_2O at 200 gpl TS,/gpr.	9.1	8.4	8.4

Pulping conditions		
Bath ratio	—	1:3
Diluent	—	Water
With sulfidity ± 1%	—	19.0
'H' factor	—	1120
Cooking Schedule		
50 to 170°C	—	2 hrs.
At 170°C	—	1 hr.

BLEACHING OF PULP :

The bleaching experiments were carried out for all the pulps using CEHH Sequence. 500 g. O. D. pulp for each set was taken and disintegrated to open the fiber bundles and excess water was removed. In chlorination stage, optimum chlorine was used and filtrate was tested for residual chlorine and pH. In alkali extraction stage NaOH was added to get final pH around 9.5 and the temperature was maintained in hot water bath. Similar to alkali extraction stage Hypo I & II stages were carried out in a hot water bath. Calcium hypochlorite of 24-25 gpl available chlorine was used. The pulp was washed thoroughly after every stage of the bleaching conditions and results are recorded in Table–IV.

TABLE–IV
BLEACHING OF PULP USING CEHR SEQUENCE

Particulars	Node	Internode	As Such
Unbleached Pulp Kappa No.	28.4	27.4	26.5
CHLORINATION			
Cl_2 added, %	7.00	7.00	6.50
Cl_2 consumed, %	6.76	6.78	6.45
Final pH	1.7	1.8	1.7
ALKALI EXTRACTION			
NaOH added, %	1.8	1.8	1.7
Final pH	9.6	9.5	9.2
HYPO I STAGE			
Cl_2 added, %	2.25	2.25	2 50
NaOH added, %	0 6	0.6	0.6
Cl_2 consumed, %	1.96	2.06	2 38
Final pH	8.6	8.6	8.6
HYPO II STAGE			
Cl_2 added, %	1.00	1.00	1.00
Cl_2 consumed, %	0.55	0.64	0.60
Final pH	7.4	7 3	7 6
Total Cl_2 added, %	10.25	10.25	10.00
Total Cl_2 consumed, %	9.37	9.48	9.43
Brightness, (Elrepho), %	79.5	80.2	80.2
Viscosity, Cp (CED)	7.8	10.7	10.6
Post Colour No.	9.7	8.6	7.8

N.B.—1) Chemicals were added on the basis of O. D. unbleached pulp.

2) **Constant conditions :**

	C	E	H_I	H_{II}
Consistency, %	3.0	10.0	10.0	10.0
Temperature, °C	Ambient (28-30)	66	40	40
Retention time, Hr.	0.75	1.0	1.0	1.5

BAUER McNETT CLASSIFICATION AND FIBER MORPHOLOGY :

Bauer Mc Nett classification of fiber of all the three bleached pulps were carried out as per TAPPI STANDARD procedure (T-233). Fiber lengh and diameter of fibers were determined microscopically. The results are recorded in Table-V.–A & B.

TABLE—V-A

BAUER McNETT CLASSIFICATION OF FIBERS

Mesh No.	Mesh Opening, mm	Fiber Retained, % Node	Internode	As Such
+ 16	1.19	32.2	63.9	58.8
—16 + 30	0.595	23.1	10.9	14.3
—30 + 50	0.297	14.2	7.6	8.5
—50 + 200	0.074	7.9	6.5	5 5
—200 + 200	—	22 6	11.1	12.9

TABLE—V-B

FIBER MORPHOLOGY

Particulars	Node	Internode	As Such
Av. Fiber Length, mm	1.23	2.44	2 1
Av. Fiber Diameter, micron	13	17	16

PHYSICAL STRENGTH PROPERTIES :

The bleached pulps were beaten separately in laboratory valley beater to different freeness levels and standard handsheets (60 ± 1 g/m^2) were made on British handsheet making machine. After conditioning the sheets were tested for strength properties. The strength properties data at 30°SR were taken out by interpolation. The results are shown in Fig. 1–3 and Table–VI.

TABLE—VI

PHYSICAL STRENGTH PROPERTIES OF HANDSHEES AT 30°SR

Prticulars	Node	Internode	As Such
Bulk, Cm^3/g	1.56	1.50	1.54
Burst Factor	28	48	45
Tear Factor	60	105	98
Breaking length, KM	4.85	7.36	7.30
Double Folds, No.	42.0	175	160

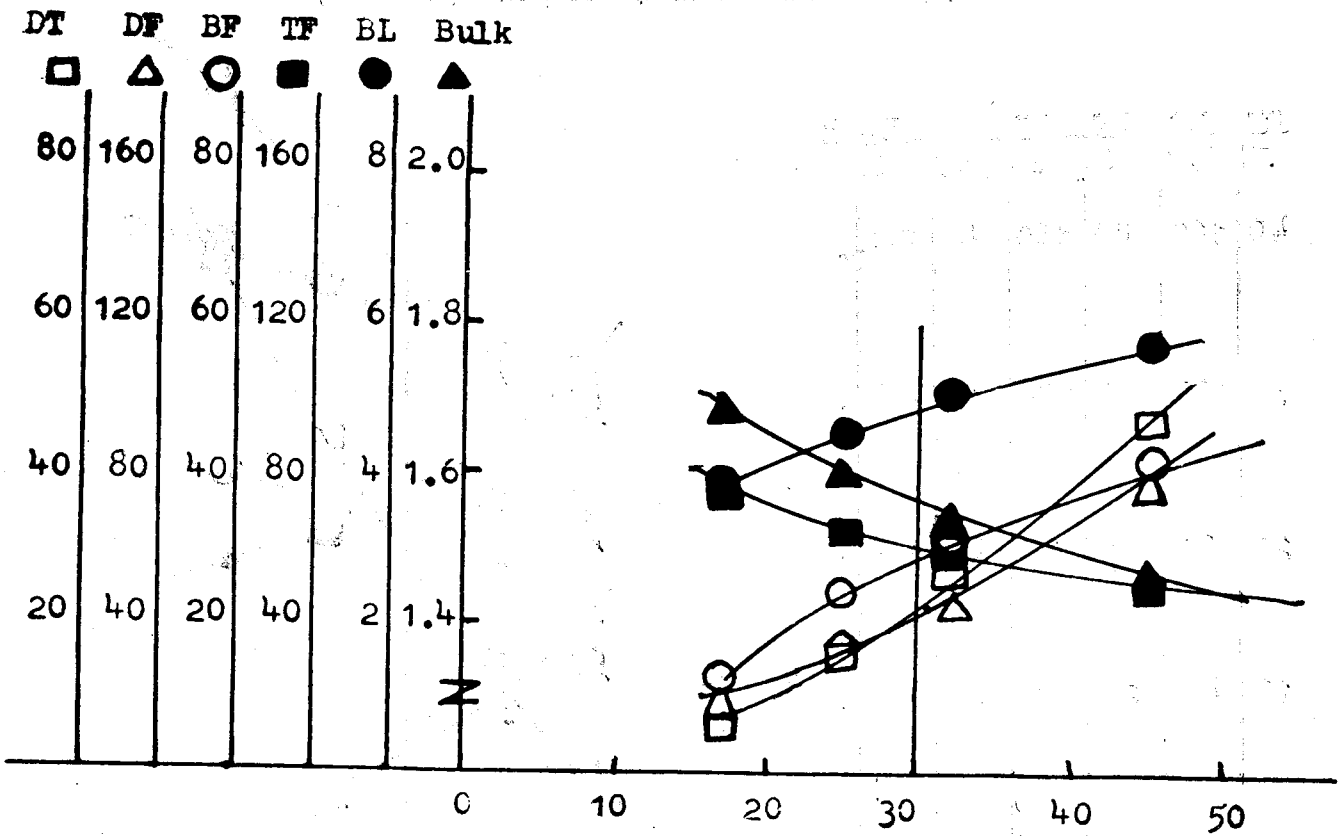

Fig. 1—Slowness Vs Strength properties (Nodes)

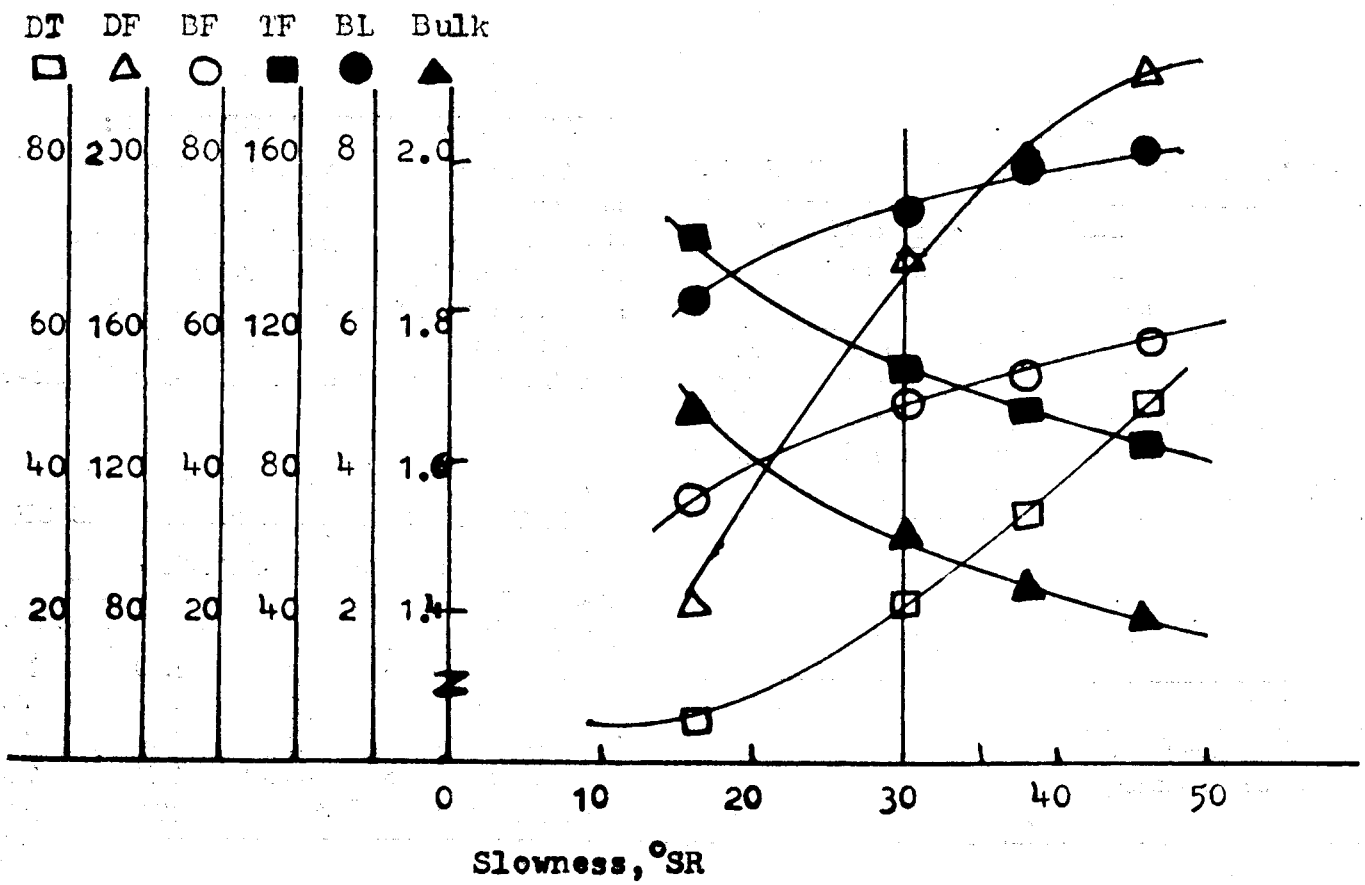

Fig. 2—Slowness Vs Strength Properties (Iuternodes)

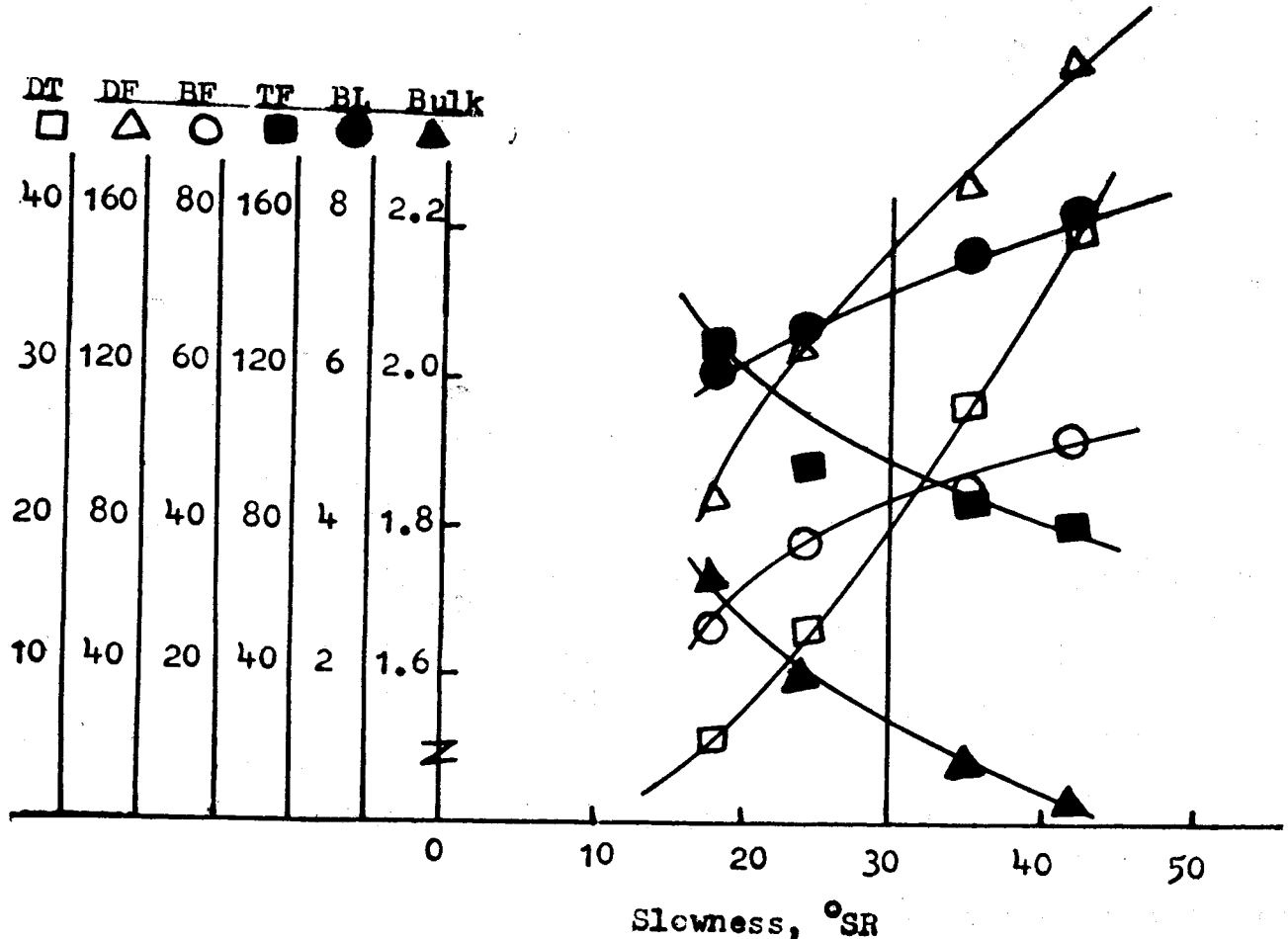

Fig. 3—Slowness Vs Strength Properties (As such bamboo)

OBSERVATIONS & DISCUSSION :

1) Nodal portion in the culm was found (on weight basis) around 18–20%.

2) It can be observed from table (II) that almost all solubilities, lignin, pentosans and ash were higher in case of nodal portion compared to internodal portion but holocellulose was lower.

3) Nodal portion required more active alkali (Table-III compared to internodal portion to obtain desired kappa No. The pulp yield was lower and rejects percentage was higher. As such bamboo culm followed the intermediate trend.

4) Pulps from all the three samples required nearly the same bleaching chemicals to attain the desired brightness (79±1% Elrepho) (Table-IV), but the bleached pulp viscosity in case of nodal portion pulp was lowest.

5) Bauer Mc Nett classification and fiber morphology results (Table–V/A & B) show the nodal portion pulp as fibers of lower lengeh compared to internodal portion.

6) Comparative data of strength properties at 30°SR (Table-VI) show that nodal portion pulp was having all the properties lower compared to internodal portions as indicated by pulp viscosity and fiber classification data. Pulp from such culm follows the intermediate trend.

CONCLUSION

The nodal and internodal portions of bamboo culm behave quite differently in their chemical, morphological as well as pulp and papermaking properties. The nodal portion, which constitute about 20% on weight basis of the culm, has lower holocellulose content but all the solubilities, pentosans, lignin and ash are higher compared to internodal portion. They require high active alkali compared to internodal portion at the same time higher percetage of rejects was obtained in pulping. The chemicals requirement in bleaching for pulps are nearly the same but the bleached pulp viscosity of nodal portions is quite low, pulps of nodal portion has lower fiber length and lower strength properties compared to internodal portion. The as such bamboo culm follows the intermediate trend.

Though, both the portions behave differently but but it is not possible to seperate them under the existing conditions of working. However, some improvements can be done by obtaining proper chips size during chipping. By maintaining lower chips size the problems like cleanliness, rejects, etc. can be solved to a certain extent.

REFERENCE

1. Maheshwari, S. etal, Ippta, Vol. XIII, No. 1, P 67 (1976).