

PULPING AND PAPER MAKING EXPERIMENTS
ON DHAINCHA (SESBANIA CANNABINA) .*

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INTRODUCTION;

Dhaincha (*Sesbania cannabina*), an annual plant, is cultivated in the riverine deltas, charlands and alluvial banks of rivers in the districts of Dacca, Faridpur and Mymensingh . It also grows in other areas of North, Central and Eastern part of East Pakistan .

Locally it is known as Kath-Dhaincha and botanically falls in the Leguminosae family . There are three plants akin to each other under the names *Sesbania Aculeata*, *Sesbania Cannabana* and *Sesbania paludosa* . *Sesbania paludosa*, commonly known as Shola or Kath-sola , grows in the marshy lands and is lighter in weight than Dhaincha. *Sesbania aculeata* is a virgate and prickly shrub, whereas Dhaincha, a slender, straight, unarmed plant, grows to a maximum height of 20 feet . Dhaincha plants, flexible when green, become stiff after cutting and drying and are used as fencing material, creeper support and fuel wood. Even by most conservative estimates the annual production of the plant is enough for running a large paper mill on perpetual basis .

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Pulps were produced from the raw material by the kraft, Neutral Sulphite Semi-chemical and Hot soda processes . The plants, being light in weight like Jute sticks , float on the surface and resist chemical impregnation by coldsoda process . Disintegration by mechano-chemical process was also found to^{be} suitable .

MATERIALS.

A consignment of dry Dhaincha plants, collected from Faridpur District, was sent to the Forest Research Institute, Chittagong, by the Forest Industries Development Corporation, Dacca . A further quantity was later collected from Dacca District .

The plants were split and cut to 2 inch lengths . Fibre dimension determined by means of an eye-piece micro-meter after macerating the chips with a 1:3 mixture of 10% solutions of chromic and nitric acids were as follows :

Average fibre length	:	0.793 mm .
Average fibre diameter	:	0.034 mm .
Average lumen diameter	:	0.0175 mm .
Average cell-wall thickness	:	0.0080 mm .

The results of chemical analysis as determined by TAPPI Standard methods are as follows :

Specific gravity	:	0.617
Density	:	38.48 lb/cft.
Cold water solubility	:	11.24%
Hot water solubility	:	12.35%
1% Caustic solubility	:	29.64%

PULPING EXPERIMENTS.

Kraft Pulping.

A stainless steel laboratory-model rotating digester with a capacity of 0.8 cubic foot and heated by indirect steam was used for pulping the Dhaincha chips by the kraft process. The digester charge was 3.68 pounds of chips (moisture-free basis). The cooking conditions are given in table-I.

At the end of the digestions, the steam was shut off and the black liquor drained as quickly as possible. After the internal pressure had been reduced to the atmospheric, the cover was removed and the cooked chips were dumped into a seventy five mesh wire screen box . The cooked chips were then disintegrated in a tank by an electric stirrer . The pulps were washed until the wash water was clear, passed through a screen with 0.015 inch wide slits, put into a cloth bag, and pressed in a hand press . Yield determinations were made from these pulps .

Neutral Sulphite Semi-chemical Pulping.

Neutral Sulphite Semi-chemical pulps were also made in the same rotary digestors as used in kraft pulping . The cooking liquor consisted of sodium sulphite and sodium bicarbonate . The chips were digested with the liquor for one hour during which period the temperature was taken to 170°C and the temperature was maintained at the same level for two more hours. At the end of each cook the liquor was drained and the chips washed for 10 minutes , while they were inside the digester. They were then milled in an 8-inch disk mill to a freeness (Canadian Standard) of 450-500 millilitres . After milling, the pulp was washed in a screen box for 5 minutes, then screened, pressed to damp dryness, weighed and sampled for yield determination . (Table I).

Hot soda Pulping .

In this process, the same procedure was followed as in the case of kraft pulping . Here, only caustic soda was used as cooking chemical . (Table I .).

Paper making experiments.

The pulps were run in a midget Fourdrinier paper machine. The kraft pulp was found to be suitable for making wrapping, writing and printing grade papers. The neutral sulphite pulp could be used for making glassine paper . Glassine paper produced at the Laboratory was found to be comparable in transparency, ink-absorbence and erasibility to imported ones .

RESULTS AND DISCUSSIONS.

Test Methods.

Pulps produced by all the three processes were run in a beater machine to various freeness (Canadian Standard) levels. Handsheets were made from these pulps and tested for strength properties by the TAPPI Standard methods . Glassine paper made in the laboratory was put to use test.

PULPING AND PULP STRENGTH.

Kraft Pulping : For making wrapping, printing and writing grade papers, 15, 19.4 and 25 percent of total ^{cooking} chemicals were used for 3 sulphite digestions . Cooking for 2 hours at maximum temperature of 170°C produced 52.3, 41.5 and 34.6 percent yield respectively . One hour's time was taken to take the temperature to 170°C . The strength properties (Table 2) of the pulps at 250 C.S.F. found out by Statistical methods from the test data were very good. (Table 5 .)

The yield percent varies directly as the total chemicals used . Cook No. 124 K with total chemical of 15% gives the best yield . With increasing percentage of chemicals tear factor and yield go down, as the Burst factor, Breaking length and folding endurance increase . Considering from economic point of view cook No. 124 K may be supposed to give the best results as the yield is considerably higher than in the other two cooks and the chemicals used are the lowest . In general, the tear value is on the lower side , but other strength properties are better than those of Civit and Sundri pulps . Results are much better compared to those of Minjri and Simul pulps . Folding endurance is even better than that of paper birch . (Table 6)

Neutral Sulphite Semi-chemical pulps.

In this process, the normal procedure of draining off the liquor at a certain stage could not be followed as impregnations could not be effected easily and the chips tended to burn when the liquor was drained off . So , both in this process and in the Hot soda process procedures had to be followed as in the case of kraft pulping .

Two cooks were made with 15 and 21 percent of chemicals . Cook No. 171 NS with 21 percent chemicals gives better strength properties while the yield is also not too bad . (Table 3). The results are almost comparable to those obtained by kraft process. Superior grade glassine papers could be made from these pulps .

Hot soda Pulps : Two cooks were made in this process with 15 and 18 percent chemicals respectively. There were more screening with 15 percent chemicals. As a result the yield was poorer. The strength properties also considerably improved with 18 percent chemicals.(Table 4). Burst and folding value are very good, tear and breaking length are comparable to those obtained by other two processes .

TABLE: 1.- KRAFT, NEUTRAL SULPHITE SEMICHEMICAL AND HOT SODA PULPING OF DHAINCHA:

Dig. No.	Chemicals				L/W. Ratio	Max. temp. °C	Time to temp. min.	Time at temp. min.	Free-ness ML.	Yield %
	NaOH %	Na ₂ S %	NaHCO ₃ %	Na ₂ SO ₃ %						

KRAFT PULPING.

124 K	12	3	-	-	7:1	170	60	120	460	52.3
125 K	15.4	4	-	-	7:1	170	60	120	380	41.5
126 K	20	5	-	-	7:1	170	60	120	350	34.6

NEUTRAL SULPHITE SEMICHEMICAL PULPING.

171 NS	-	-	21	5.25	7:1	170	60	120	450	49
172 NS	-	-	15	3.75	7:1	170	60	120	510	55

HOT SODA PULPING.

168 HS	15	-	-	-	7:1	170	60	120	600	49.8
169 HS	18	-	-	-	7:1	170	60	120	470	50.6

TABLE : 2.- PROPERTIES * OF DHAINCHA KRAFT PULPS .

Dig. No.	Beat- ing time min.	Free- ness (C.S.) C.C.	Burst factor	Tear factor	Folding end (M.I.T.) Double folds	Breaking length metre .	Density. G/C.C.
124 K	0	460	37.90	65.72	830	7110	0.68
	11	430	41.38	65.61	1220	7370	.69
	17	240	58.94	60.62	1870	9660	.77
125 K	0	380	58.74	68.83	1630	10880	.65
	11	310	63.86	61.20	2160	10010	.71
	22	220	67.84	50.87	2410	10120	.75
126 K	0	350	55.19	70.57	2150	9730	.74
	6	310	69.99	59.80	2830	10740	.83
	11	270	72.44	56.28	2980	10960	.79
	18	250	69.38	50.44	2960	10670	.88

* Tested by TAPPI Standards .

TABLE : 3. PROPERTIES * OF DHAINCHA NEUTRAL SULPHITE SEMICHEMICAL PULPS.

Dig No.	Beating time min.	Free-ness ml.	Burst factor	Tear factor	Folding end. (Double)	Breaking length m.	Density G/C.c.
171 NS	10	450	61.13	55.65	1490	9250	.74
	19	350	65.93	44.63	1530	12060	.79
	28	230	71.62	40.89	2370	10530	.85
172 NS	9	510	49.97	51.68	520	9230	.61
	13	450	54.72	48.66	620	9360	.62
	20	330	66.91	47.32	710	9950	.67
	26	250	59.72	38.55	850	10090	.68

TABLE: 4. PROPERTIES * OF DHAINCHA HOT SODA PULPS.

168 HS	0	600	57.27	65.18	1190	7530	.67
	14	360	55.44	58.20	1350	8710	.68
	20	270	56.74	54.85	1250	9220	.75
	30	220	64.72	56.43	1450	9610	.75
169 HS	0	470	39.30	73.47	870	7700	.67
	3	430	48.24	70.07	1500	8580	.69
	20	250	65.75	62.55	3010	10140	.81

* Tested by TAPPI Standard methods.

TABLE : 5- STRENGTH PROPERTIES OF DHAINCHA PULP AT 250 CANADIAN STANDARD FREENESS VALUE. *

Cook No.	Burst factor	Tear factor	Breaking length(Meter)	Folding End. M.I.T. (Double)	Yield %
168 HS	58.20	53.50	9400	1430	49.8
169 HS	65.75	62.55	10140	3010	50.6
124 K	58.00	62.00	9550	1840	52.3
125 K	67.50	55.00	10100	2330	41.5
126 NS	69.38	50.44	10670	2960	34.6
171 NS	71.00	41.30	10600	2300	49.0
172 NS	59.72	38.55	10090	850	55.0

TABLE: 6- A COMPARATIVE STUDY OF THE STRENGTH PROPERTIES OF DHAINCHA KRAFT PULP WITH THOSE OF SOME HARDWOOD SPECIES.*

Species	Total chemical	Yield %	Strength properties at 250 C.S.F.				
			Gm/cc	Tear factor	Burst factor	Breaking length	Folding end.
Civit	15.10	45.75	1.94	90.0	59.6	8830	1440
Sundri	16.00	44.40	0.64	123.0	66.0	9280	800
Paper birch.	18.00	51.80	.85	64.3	73.5	11800	660
Minjri	20.00	43.40	.56	84.1	40.1	7000	240
Simul	15.00	46.70	.63	100.0	50.7	7720	1270
Dhaincha.	15.00	52.3	0.76	62.0	58.0	9550	1840

* Statistically determined.