Sugar Cane Leaf-A Potential Raw Material For Cheap Grades of Paper and Board (Part II)

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SUMMARY

About 6—7 million tonnes of sugar cane leaves are available per annum as agricultural residue and can be utilized for manufacture of cheap grades of paper and board.

An unbleached yield of 56% could be obtained using 10% NaOH at a temperature of 170°c with a bath ratio of 1:4 and cooking time of 10 minutes.

Sulphate pulping with equivalent conditions gave a bleached pulp with comparatively higher brightness values, other properties remaining almost same.

C.E.H. bleaching of 10% soda pulp with 10 and 12% chlorine have given 42 and 40% yields at 71—72 and 77—78% Elrepho brightness respectively. In case of 9% Na_2O sulphate pulp the yields are 36—37% at 77—79% brightness when bleached with the same sequence as above with 10—10.5% chlorine.

The pulps are strong for preparation of cheap grades of bleached as well as unbleached varieties of paper. Double fold and tear are however medium to low and hence need long fibred pulp bleanding to improve these characteristics.

INTRODUCTION

With the increase in population, education and industrialization in our country, the demand for pulp and paper has also increased. The projected demand for raw materials to meet the requirement of pulp and paper by 1988-89 is about 7.7 million tonnes as against 4.14 million tonnes of 1978-79 [1]. As bamboo alone is not sufficient to meet this demand, many non conventional raw materials are being tried. An attempt on the pulping of sugar cane leaves is also a step in this direction keeping in view its bulk availability[2]. (6.0-7.0 million tonnes per annum) as an agricultural residue.

Although processing of agricultural residues involve a number of problems and limitations, their industrial utilization, if successfully exploited will add to our national economy.

Sugar cane leaves are being destroyed presently in the fields after harvesting and hence their use for manufacture of pulp and paper will not only help partially in overcoming the shortage of cellulosic raw material but also support the farmers financially.

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Agricultural residues like rice or wheat straw are primarily used as fodder and bagasse as a fuel in the sugar industry. Sugar cane leaves have no practical utilization and hence can be a potential source for paper making as a raw material. In an earlier study[2], it was reported that sugar cane leaves yield 41-42% of unbleached and 31-34% of bleached pulps with 67-70% Elrepho brightness and moderate strength by a conventional soda pulping process. Pulping studies were carried out with 10% NaOH for 3 hours at 145°C temperature with a bath ratio of 1 : 10.

Higher unbleached yields of 47-48% could be obtained if the cooking time is reduced to 2 hours and the bath ratio to 1 : 6, but the overall strength is also lowered. Bleaching this pulp with calcium Hypochlorite gives 38-39% yield and 64-65% brightness with comparatively lower strength.

The present study deals with the pulping characteristics of sugar cane leaves at 1:4 bath ratio and elevated temperature (170°) for short duration of 10-30 minutes using both soda and sulphate process of pulping, and the bleachability of the pulps so obtained.

A comparison of proximate chemical analysis made in table 1 indicates that sugar-cane leaves can be considered similar to rice and wheat straw as far as chemical constituents are concerned. The fibre length is very much similar to that of straws and bagasse, but the diameter is comparatively smaller.

EXPERIMENTAL

Discarded dry sugar cane leaves were collected at the time of harvesting, hand chopped to 8-10 cms. length and cooked in an indirectly heated rotary digester of 15 litre capacity. Pulping experiments were carried out at 170°C using 10 and 12% NaOH in soda pulping and 9% of active alkali as Na_2O in sulphate pulping based on O. D. weight for 10,20 and 30 minutes. In all the experiments, the sulphidity was 22% and a bath ratio of 1:4 was maintained and the temperature was raised to 170°C in approximately 90 minutes. The pulp was washed thoroughly on a fine mesh cloth, uncooked materials hand picked and the unbleached yield determined. The pulp was evaluated in a standard laboratory valley beater, 60 gsm. standard sheet were made on the laboratory British sheet making machine, conditioned and tested as per standard ISI procedure (details in Table II).

The pulp obtained was bleached in C. E. H. sequence as per data in Table-III in two sets. In the first set, a constant dose of chlorine was given after determining the approximate requirement for a moderate bleaching, to study the variation in brightness, yield and strength properties.

In the second set, the pulp with maximum yield and strength with 10 minutes pulping using

TABLE-I PROXIMATE CHEMICAL ANALYSIS OF DIFFERENT RAW MATERIALS

S. No.	Particulars	Unit	Sugarcane[2] leaves	Rice[3] Straw	Wheat[4] Straw	Bagasse[5]	Bamboo[6]
1.	Cold water Solubility	%	7.04	9.50	—	3.80	3.29
2.	Hot ,, ,,	%	15.00	12.60	9.50	6.30	6.12
3.	1% NaOH Solubility	%	40.00	45.20	40.20	18.70	21.35
4.	Alcohol Benzene Solubility	%	3.47	4.60	2.90	2.70	3.13
5.	Pentosans	%	25.80	22.70	23.00	15.80	15.06
6.	Lignin	%	17.23*	12.80	21.00	19.20	27.85
7.	Hollo cellulose	%	69.53*	55.60	—	69.90	—
8.	C & B cellulose	%	—	—	44.29	—	59.71
9.	Alpha cellulose	%	33.60	32.10	32.00	—	—
10.	Ash	%	10.50	16.10	6.00	1.90	2.35
11.	Fibre length	mm	1.16**	1.36	1.5***	1.35	3.4
12.	Fibre diameter	mm	0.0062	0,009	0 013***	—	0.014

* Ash corrected values

** Weighted average fibre length.

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TABLE II—SODA AND SULPHATE PULPING

S. No.	Particulars	Unit	10% NaoH			12% NaOH			9%Na_2O		
1.	Cooking time,	min	10	20	30	10	20	30	10	20	30
2.	Unbleached unscreened yield	%	56.3	53.7	50 8	48.3	46.3	45.4	49.5	47.9	46.0
3.	Kappa Number		37.6	33 7	30.7	26.6	25.3	24 4	34.2	24.4	23.0
4.	Initial Freeness	°SR	10	12	12	15	14	15	14	14	13
5.	Final Freeness	°SR	41	41	40	41	42	40	40	41	39
6.	Bulk	cm³/9	2.0	2.13	2.01	1.91	2.01	2.03	1.9	1.91	1.93
7.	Breaking length	meter	5650	4610	4640	49:0	4940	4440	5470	5240	4910
8.	Burst factor		24	21	22	23	27	22	25	27	22
9.	Tear Factor		47	43	38	39	39	42	39	36	40
10.	Double Fold	Nos	39	33	31	16	17	17	23	17	11
11.	Ash	%	6.5	10.2	11.8	8.2	10.0	11.4	9.6	9.7	9.0

9-10% chemicals was bleached with varying doses of chlorine in order to obtain a brightness level of 78 – 79% Elrepho (Table IV). The hand sheets from bleached pulp were also made and tested similar to the unbeachcd pulp sheets.

DISCUSSION

Against the earlier study of long cooking hours with low temperature and high dilution, in this study, by raising the temperature to 170°C and decreasing the dilution to 1 : 4, the rate of pulping is enhanced considerably and it has been possible to obtain a pulp with an unbleached (unscreened) yield of 56% (Table-II). With a kappa number of 37.6 and moderate strength properties, the results indicate that with an increase in chemical percentage and cooking period, kappa number decreases and the yield also goes down considerably. This indicates an optimum, pulping condition of 10 minutes cooking time with 10% NaoH, which is sufficient enough for making unbleached varieties of paper.

Cooking periods of less than 10 minutes may also be adequate as preliminary experiments indicate that just raising the temperature to 170°C within 90 minutes and releasing it immediately, a pulp of satisfactory quality was obtained, though it contained slightly higher percentage of shieves etc.

Sulphate pulping with active alkali as Na_2O equivalent to 12% NaOH, gives indications of better strength and yield with lower kappa number. The sulphate pulp was slightly darker in shade and contained less shieves.

In the case of soda pulping, the % ash shows a slight increase with more drastic pulping conditions. This aspect is being further investigated. In sulphate pulping however, ash % shows a constant value.

10 minutes pulping with 10% NaOH gives a bleached yield of 42% with C.E.H. sequence using about 10% chlorine (total) at a brightness of 70·71% (Elrepho) and good strength properties with respect to breaking length and burst factor. The tear and double folds are moderate (Table-III).

The brightness of bleached pulps can be further increased to 78·80% (Elrepho) by increasing the chlorine % to 11-12 (Table-IV), but with appreciable reduction in the bleached pulp yield.

It is an interesting observation that except in the case of 10% NaoH pulping where the kappa number decreases with increasing cooking time, there is no appreciable difference in the kappa number with increasing cooking time in the other cases. The brightness values are also more or less constant for the pulps cooked with higher cooking time but same chemical dose. However as shown in Table-IV, an increase in chlorine consumption of 20—10% gives pulps with brightness of 78—80% (Elrepho) for soda and sulphate processes respectively. This increase in brightness has of course an appreciable effect on the strength properties in all respects except tear.

Another interestiug feature is that aftet bleaching, there is an appreciable increase in the strength properties (breaking length and burst factor) but the tear factor and double fold are reduced.

The above analysis or the strength properties

TABLE—III CONDITIONS BLEACHING OF PULP (SET I)

	Unit	Chlorination	Alkali Extraction	Hypochlorite
1. Chlorine on O.D. Pulp	%	5.0	—	5.0
2. Alkali on O.D. Pulp	%	—	2.0	—
3 Consistancy	%	3.0	10.0	10.0
4. Retention	min	30	120	240
5. Final pH	—	2 0	11.0	8.5
6. Temp.	°c	28	50	28

RESULTS OF BLEACHED PULP

S.No.	Particulars	Unit	10% NaOH			12% NaOH			9% Na_2O		
1.	Cooking time	min	10	20	30	10	20	30	10	20	30
2.	Bleached yields	%	42	37.9	35.5	37.3	36.3	35.8	36.8	36.7	35.0
3.	Brightness (Elrepho)	%	70.5	71.0	71.0	73.0	74.1	74.5	76.2	76.8	77.1
4.	Initial Freeness	°SR	19	17	20	20	21	21	19	19	21
5.	Final Freeness	°SR	38	38	40	39	40	41	40	40	40
6.	Bulk	cm^3/g	1.67	1.73	1.77	1.69	1.71	1.88	1.52	1.59	1.64
7.	Breaking Length	metres	62.10	5020	5330	7020	6320	6800	6680	6370	6450
8.	Burst Factor		34	21	29	28	29	29	32	29	29
9.	Tear Factor		39	27	30	32	34	36	30	37	33
10.	Double Fold	Nos	25	18	19	19	17	21	17	12	16
11.	Ash	%	5.6	7.3	7.2	7.1	8.2	9.4	3.9	4.8	7.6

TABLE-IV BLEACHING OF PULP (SET II)

CONDITIONS

All conditions similar to those of Set I except that sulphate soda pulps and with 10 mnte. cooking were bleached with 12% and 11% chlorine equally distributed at chlorination and hypochlorite stage.

S.No.	Particulars	Unit	10% NaOH Pulp	9% Na_2O Sulphate Pulp
1.	Bleached Yields	%	39.7	36.2
2.	Brightness (Elrepho)	%	77.8	80.2
3.	Initial Freeness	°SR	20	21
4.	Final Freeness	°SR	40	40
5.	Bulk	$cm^3/9$	1.59	1.40
6.	Breaking length	metres	5660	5420
7.	Burst Factor	—	29	24
8.	Tear Factor	—	35	28
9.	Double Fold	Nos	12	19
10.	Ash	—	4 6	3.8

of unbleached and bleached pulps give sufficient indication that unbleached kraft grade II and ordinary grades of writing and printing papers conforming to I.S. 1397-1967 and 1848-1971 specifications can be manufactured from sugar cane leaves.

If a high tear and fold is desired, bleaching of sugar cane pulp with a small percentage of long fibred pulps will serve the purpose. By increasing the proportion of long fibred pulps in the blends, even medium grades of paper can be made.

COLLECTION, TRANSPORATION AND STORAGE

Generally, sugar cane fields are concetrated in the vicinity of sugar industries and hence the leaves can be collected through centralized agencies along with sugar cane which the farmers bring. However, the leaves are bulky and need mechanical baling for eeonomical transporation. Ideally it is preferable to have paper mills based on this raw material in areas where it is available in plenty to avoid high transporation cost. Moreover the availbility of sugar cane leaves being seasonal, their storage can be made similar to that of wheat or rice straw.

CONCLUSION

This study gives sufficient indication that sugar cane leaves, so far of no practical utility, can prove to be potential source of raw material for making common varieties of unbleached and bleached papers. The cost of manufacture of this paper is expected to be lower than that of papers from conventional raw materials in view of its low requirement of cooking chemicals and reduced cooking time.

The capital investment cost for the required equipment would be relatively lower. However, the transporation and storage cost of sugar cane leaves would be higher due to their high bulk (2-2.5 tonnes/truck load of manually baled leaves' as against 7-8 tonnes of bamboos/truck load.)

Still the authors feel that the overall economics of the manufacture of paper from sugar cane leaves will be favourable in view of the availability of this raw material which is so far untapped.

An important feature of this study is that the flexibility in the processing is so wide that by adjustment of the cooking and bleaching conditions pulp of our requirement with respect to its strength and brightness can be easily obtained.

A more realistic cost estimate can only be obtained after the manufacture of paper from this material is commercialized.

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