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STUDIES ON SODA-SULPHUR PULPING

Part II. Pulping of Coconut-leaf Middle-rib (*Cocos nucifera* Linn) by Soda-Sulphur Process

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By using soda-sulphur process of coconut-leaf mid rib (*Cocos nucifera Linn*), a stronger pulp with higher yield in less cooking time was obtained. The pulp may be used for producing writing and printing paper.

Key words: Soda-sulphur, Coconut-rib, Pulping.

INTRODUCTION

Coconut leaves grow abundantly in the coastal area of Bangladesh. For better-growth of the plants and high yield of coconut, old leaves are frequently cut off. These leaves are mainly used by villagers as fuel, in large quantities.

The microscopic and photomicroscopic study of the elementary fibres of the coconut-leaf mid-rib, the main woody portion of the leave was made by Siddiqueullah [1] and co-workers. The soda and sulphate pulpings of the leave were made by Sirajul Karim [2] and others to obtain writing and printing paper.

The present studies are based on soda-sulphur process. Elemental sulphur was added to cooking liquor of sodium hydroxide.

Studies were also made for its chemical composition by Tappi standard procedures [3-6]. The results are given below :

a)	Alpha cellulose	(%)	39.12
b)	Lignin	(%)	30.75
c)	Pentosan	(%)	20.00
d)	Ash	(%)	5.92

EXPERIMENTAL

1. *Preparation of the raw material.* Matered coconut leaves were collected from Munshiganj area of greater Dhaka district. The middle-rib was separated and cut into small pieces of approximate size 1.0" x 0.5". The chips were sun-dried, and moisture contents determined by oven-drying the samples at 105° at least for 18 hours.

2. *Material in each digestion.* One kilogram of the coconut-leaf mid-rib (oven dry basis) was used for each digestion.

3. (a). *Method of pulping.* The chips in presence of caustic soda (NaOH) and elemental sulphur(s) were digested in a stainless steel rotary digestor.

(b). *Digestion conditions.* The percentage of caustic soda varied from 26 to 30 and that of sulphur from 0 to 2 (using 0.0, 0.5, 1.0, 1.5, 2.0 % respectively) for different digestions. Time varied from 2 to 4 hours and temperature (°C) from 145 to 165°. Material-liquor ratio varied from 1:4 to 1:6. After each digestion the pulp was used for determination of unbleached yield permanganate number [7] and physical properties like breaking length [8], burst factor [9] tear factor [10] and brightness [11] from hand-sheets [12] made according to Tappi standard procedures.

The permanganate number and unbleached yield. The permanganate number and yield of the unbleached pulp were found 14.14 and 44.21 % respectively by using the optimum pulping conditions.

RESULTS AND DISCUSSION

Consumption of chemicals for producing well-digested pulp from the coconut-leaf mid-rib is high due to heavy lignin content.

The unbleached and bleached yields (in present) for both CEH and CEHEH pulps are 44.21, 39.05 and 37.49 respectively, the values are higher than those obtained by others [2]. Also, the addition of 1.0 % elemental sulphur to the cooking liquor accelarated the delignification and shortened the cooking time from 5.0 hours for soda or sulphur process to 3.0 hours for soda-sulphur process. The most widely accepted reaction mechanism for addition of elemental sulphur to the cooking liquor may be represented as follow :

$$6\,NaOH + 4S \rightarrow 4Na_2S + 3H_2O + Na_2S_2O_3$$

$$\text{Again } Na_2S + H_2O \rightleftharpoons NaOH + NaHS$$

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The hydrosulfide, thus formed, acts as a buffer and tends to reduce degrading (injurious) effects of more active sodium hydroxide on cellulose and hemicellulose giving rise to higher pulp yield and stronger pulp in soda-sulphur process. In addition, the hydrosulfide reacts with lignin to produce thiolignin which in turn makes lignin readily soluble in alkali and reduces pulping time.

The permanganate number (14.14) showed that the yields obtained were not at the expense of pulp purity indicating that the optimum pulping conditions were selected with good delignification results.

The highest fibre-length (1.60 mm) was given by CEH soda-sulphur pulp and that for CEHEH soda-sulphur pulp was 1.57 mm. These values are higher than the corresponding value (1.54 mm) for CEH sulphate pulp [2] of coconut-rib. The different values for the fibre-length placed in Table 5 indicate that the pulps from the coconut ribs are medium fibre and there was practically no degradation for soda-sulphur pulps.

Table 1. Optimum conditions for soda-sulphur pulping of coconut-leaf mid-rib.

NaOH (%)	Sulphur (%)	Time in hours	Temperature	Material-liquor ratio	Pressure kg/cm^2
28.0	1.0	3.0	155	1:5	5.5

Table 2. Laboratory evaluation [13] of the unbleached soda-sulphur pulp from coconut-leaf mid-rib.

Beating time in	Breaking length in	Tear factor	Burst factor	Freeness[14] in ml.
00	6517	119.97	109.56	897
10	6662	125.51	112.03	886
20	6745	132.30	11.40	877
30	6800	149.58	114.35	866
40	6907	170.77	116.14	857
50	7041	166.68	118.39	846
60	7032	159.12	118.24	835

Table 3. Laboratory evaluation of 3-stage bleached *CEH soda-sulphur pulp of coconut-leaf mid-rib.

Beating time in (min.	Breaking length in (m.)	Tear factor	Burst factor	Freeness in (ml)
00	7651	160.0	117.51	885
10	7666	67.65	118.87	874
20	7798	174.50	120.48	863
30	7864	188.88	121.01	854
40	7941	99.00	122.30	844
50	7994	214.19	123.94	833
60	7965	207.76	122.70	821

*In CEH, C means chlorination at pH 1-2, consistency 3.5 %, room temperature (30°) for 1 hour where 60 % of the total chlorine demand was supplied and the remaining 30 % chlorine was used in H. [sodium hypochlorite treatment] at pH 9-11, room temperature (30°), consistency 3.5 % for 1 hour. The intermediate step E [caustic extraction 2 % on pulp] was done at 75°, 13.5 % consistency for 1 hour.

Table 4. Laboratory evaluation of 5-stage** CEHEH bleached soda-sulphur pulp of coconut-leaf mid-rib.

Beating time in (min.)	Breaking length in (m.)	Tear factor	Burst factor	Freeness in ml
00	6995	181.54	111.54	880
10	7100	187.40	113.18	869
20	7244	195.55	115.48	860
30	7404	209.14	118.01	850
40	7484	217.75	119.30	841
50	7461	235.39	118.94	830
60	7446	229.09	118.70	819

**In CEHEH, C means chlorination at same conditions of C in CEH where 60 % chlorine was supplied, E [caustic extraction] done at usual conditions of E as in CEH. The (first) H means [sodium hypochlorite treatment] where 15 % chlorine was supplied and the remaining 15 % chlorine was supplied during (second) H [sodium hypochlorite treatment] for the second time. Other conditions of C, E, H, E, H were as those of CEH.

Table 5. Bleached yield, brightness, bibre-length and fibre-diameter of bleached pulps of coconut-leaf mid-rib.

Type of Bleached Pulp	Bleached yield (%)	Brightness (%)	Fibre-length (mm)	Fibre- (mm)
CEH	39.05	76.2	1.60	0.016
CEHEH	37.49	78.1	1.57	0.015

The breaking length and the burst factor increased upto 50 minutes beating time in case of unbleached and CEH bleached pulps while for CEHEH these properties increased upto 40 minutes beating time due to gradual increase in fibre area in optical contact. The tear factor 235.39 is highest for present studies and also for chemical (soda and sulphate) pulps obtained from other cellulosic

raw materials like jute [15, 16] jute-stick [17,18,19] bamboo [20,21,22,23] rice-straw [24], ekra [25] dhaincha [26] koroi [27], kadamba [28] and mandar [29].

CONCLUSION

1. The unbleached soda-sulphur pulp is suitable for producing good quality packing and wrapping paper.
2. The CEH and CEHEH soda-sulphur pulps are very suitable for better grade writing and printing paper.

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