

STUDIES ON MAKING PAPER PULP FROM RICE STRAW (*ORYZA SATIVA*) BY THE SODA METHOD

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Rice straw, an agricultural waste, contains a substantial amount of alpha-cellulose from where a better quality writing and printing paper may be made by the soda-method through a low consumption of chemicals.

Key words: Rice-straw, Soda, Paper-pulp.

INTRODUCTION

There are different varieties of rice available in different regions of the world. In Bangladesh, two varieties of crops *Aus* and *Aman* are produced during the rainy season. In the dry season, Boro and Irri crops are cultivated in areas where irrigation facilities are available.

Rice straw is mainly used as cattlefeed in this country. The rice-straw is also used by villagers as fuel and roofing materials for their dwellings.

The present studies are based on the rice straw of the *Aman* variety for the production of pulp of the writing and printing quality. Analysis of rice straw was carried out by

TAPPI [1-4] standard methods and the results are given below :

(a) Alpha-cellulose (%)	36.05
(b) Lignin (%)	12.38
(c) Pentosan (%)	27.54
(d) Ash (%)	16.26

Different pulping techniques [5-10] and pulping agents were used on rice straw from time to time. Earlier workers have determined the physical properties of pulp sheets of the unbleached pulps obtained from different digestions but they did not optimise the pulping conditions. Attempts were therefore made to make the studies complete in those respects by the soda process.

Table 1. Effect of caustic soda on pulp-yield and permanganate number of the unbleached pulp sheets from soda pulp of rice straw.

- | | |
|------------------------------------------------------------|------|
| (a) Material taken in g.o.d. basis | 1000 |
| (b) Temperature (°C) | 150 |
| (c) Time in hr. including 50 min. to reach the temperature | 3.0 |
| (d) Material: Liquor | 1:7 |
| (e) Pressure kg/cm ² | 5.0 |

Expt. No.	NaOH (%)	Unbleached yield (%)	Permanganate number	Breaking length in metres	Tear factor	Burst factor	Brightness (%)
1.	6.0	Remained	Undigested	—	—	—	—
2.	8.0	Not good	Digested	—	—	—	—
3.	10.0	48.55	9.02	3003	47.34	46.00	49.5
4.	12.0	47.03	7.77	3203	44.16	50.01	53.8

Table 2. Effect of temperature on pulpyield and permanganate number of the unbleached pulp and physical properties of unbleached pulp sheets from soda pulp of rice straw.

Expt. No.	Temperature (°C)	Unbleached yield (%)	Permanganate number	Breaking length in metres	Tear factor	Burst factor	Brightness (%)	
		(a) Material taken in g.o.d. basis						1000
		(b) % NaOH						10.0
		(c) Time in hr including 50 min. to reach the temperature						3.0
		(d) Material: Liquor						1:7
		(e) Pressure kg/cm ²						5.0 at 150°C
5.	140	50.24	11.38	2810	40.15	43.12	44.4	
6.	150	48.55	9.02	3003	47.34	46.00	49.5	
7.	160	46.62	7.69	3266	42.25	50.09	55.0	

Table 3. Effect of time on pulp yield and permanganate number of the unbleached pulp and physical properties of unbleached pulp sheets from soda pulp of rice straw.

Expt. No.	Time in hr.	Unbleached yield (%)	Permanganate number	Breaking length in metres	Tear factor	Burst factor	Brightness (%)	
		(a) Material taken on g.o.d. basis						1000
		(b) % NaOH						10.0
		(c) Temperature (°C)						150
		(d) Material : Liquor						1:7
		(e) Pressure kg/cm ²						5.0
8.	2.0	Remained	Undigested	—	—	—	—	
9.	3.0	48.55	9.02	3003	47.34	46.00	49.5	
10.	4.0	43.04	6.60	3449	48.00	51.43	58.8	

Table 4. Effect of material-liquor ratio on pulp yield and permanganate number of the unbleached pulp and physical properties of the unbleached pulp-sheets from soda pulp of rice straw.

Expt. No.	Material liquor ratio	Unbleached yield (%)	Permanganate number	Breaking length in metres	Tear factor	Burst factor	Brightness (%)	
		(a) Material taken on g.o.d. basis						1000
		(b) NaOH (%)						10.0
		(c) Temperature (°C)						150
		(d) Time in hr including 50 min to reach the temperature						3.0
		(e) Pressure kg/cm ²						5.0
11.	1:6	48.80	9.25	2985	47.09	45.95	49.0	
12.	1:7	48.55	9.02	3003	47.34	46.00	49.5	
13.	1:8	48.24	8.91	3037	47.19	46.23	49.9	

Table 5. Optimum conditions for soda pulping of rice straw.

NaOH (%)	Temperature (°C)	Time in hr	Material liquor ratio	Pressure kg/cm ²
10.0	150	3.0	1:7	5.0

Table 6. Yield and brightness of bleached soda pulp of rice straw.

Type of bleached pulp	Bleached yield (%)	Brightness (%)
CEH*	44.15	76.3
CEHEH**	43.00	79.0

*In CEH, C stands for chlorination. At this stage chlorine supplied was 60 % and chlorination was done for 60 minutes at temperature 25-30° and pH 1-2 at consistency 3.5 %; E is caustic extraction for 60 min. at consistency 13.5 %, temperature 75-80° and the extraction was effected by using 2 % NaOH and H for sodium hypochlorite treatment for 60 min. at consistency 3.5 % at 25-30° and pH 9-11. At this stage 30 % chlorine was supplied.

**At this stage 15 % chlorine was supplied and other conditons remained unaffected.

RESULTS AND DISCUSSION

It can be observed from Tables 1-6 that the pulp yields of unbleached soda, CEH soda and CEHEH soda were 48.55, 44.14 % and 43.00 % respectively. The above figures are higher than those obtained for rice-straw pulp by others [9-10]. The different pulp yields and the amount of alpha-cellulose (36.05 %) originally present in rice straw showed that there was no abnormal loss during pulping.

The permanganate number of soda pulp was 9.02 which is lower than that obtained by Talwar [9]. The permanganate number shows that higher pulp yields were obtained due to right selection of optimum pulping conditions which were adequate for good delignification.

The unbleached soda pulp was treated with CEH and CEHEH bleaching systems. The brightness figures were for pulps 76.3 and 79.0 % respectively against magnesium oxide, the latter being higher than those obtained by others [11].

For a laboratory evaluation of their properties unbleached and bleached soda pulps were beaten for 60 min. in a pilot plant Hollander beater. It is observed from Fig. 1, 2 and 3 that unlike jute [11] jute-stick [12] and bamboo [13] the breaking length and burst factors decrea-

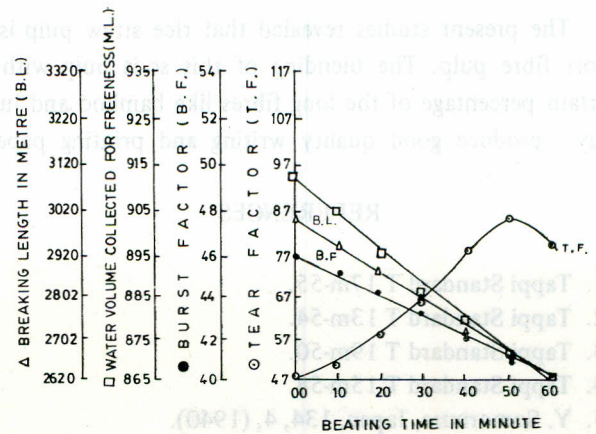


Fig. 1. Beating time in minutes laboratory evaluation of unbleached soda pulp of rice-straw.

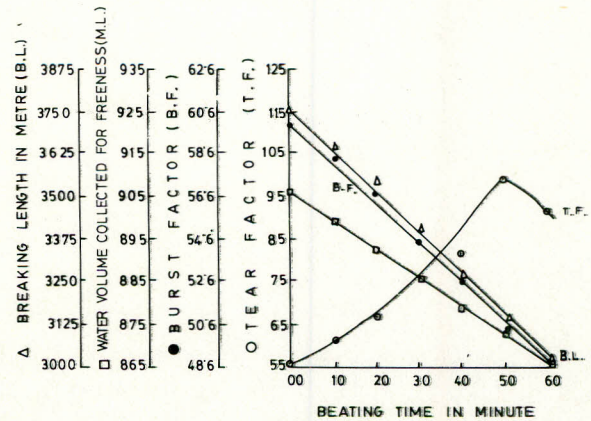


Fig. 2. Beating time in minutes laboratory evaluation of CEH bleached soda pulp of rice straw.

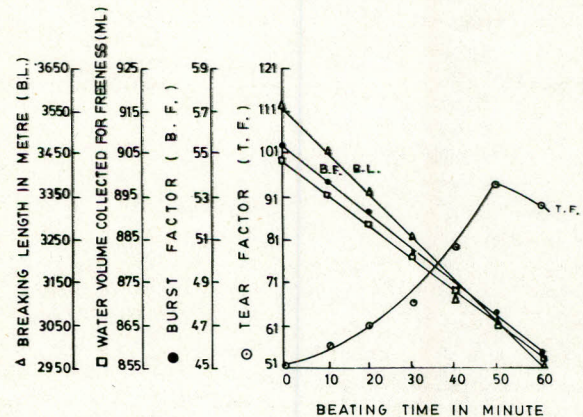


Fig. 3. Beating time in minutes laboratory evaluation of CEHEH bleached soda pulp of rice straw.

sed from 0 to 60 min. probably due to gradual decrease in the area of fibres in optical contact and the results are comparable with Islam's findings [10], but the tear factor in all cases of rice straw pulps increased from 0 to 50 min. and then decreased.

The present studies revealed that rice straw pulp is a short fibre pulp. The blending of this soda pulp with a certain percentage of the long fibres like bamboo and jute may produce good quality writing and printing paper.

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Fig. 1. Heating time in minutes laboratory evaluation of unbleached soda pulp of rice straw.

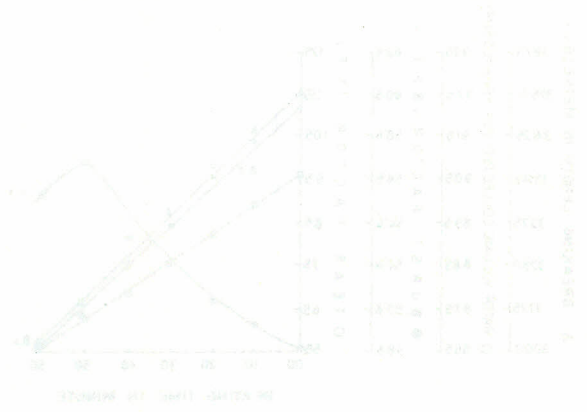


Fig. 2. Heating time in minutes laboratory evaluation of CFB bleached soda pulp of rice straw.



CEFB*	CEFBH**
78.3	44.1
79.0	43.8

* In CFB C stands for chlorination. In the stage chlorination stage for 60 min and the treatment was done for 60 minutes at temperature 25-30° and pH 7-11. A caustic solution of 1.5% concentration was used for 60 min at consistency 1.5-2% temperature 25-30° and the chlorination was effected by using 1% NaOCl and H₂O₂ for sodium hypochlorite treatment for 60 min at consistency 1.5-2% at 25-30° and pH 9-11. At the stage 30% chlorine was supplied.

** At this stage 11% chlorine was supplied and chlorination time treated unaffected.

RESULTS AND DISCUSSION

It can be observed from Table 1-3 that the pulp yields of unbleached soda CFB pulp and CFBH pulp were 48.22, 44.12 and 43.82% respectively. The above figures are higher than those reported for rice straw pulp by other [8-10]. The different pulp yields and the amount of chlorination (CEFB) strongly present in the straw showed that there was an important role during pulping.

The permeability number of soda pulp was 49.2 after a series of experiments. It was found that the permeability number of soda pulp was 49.2 after a series of experiments. It was found that the permeability number of soda pulp was 49.2 after a series of experiments.