Utilisation of Waste Kendu leaves for Paper and Board Making

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1.0. Introduction

Kendu leaf is an important agricultural product in India. It is the leaf of the tree called Kendu whose botanical name is "Diospyros Tomentosa". In the manufacturing process of "Bidi" large amount of Kendu leaf cuttings are left over as waste. Also some damaged bidi leaves are available as waste. Large bidi manufacturers encounter the problem of disposal of waste. The quantity of these waste leaves in the Eastern region has been estimated to be around 120 tonnes/day. Future of bidi industry, which employs a large number of workers, may be improved if waste leaves are utilised in production of some useful material.

This paper presents an experimental work on the pulping characteristics of Kendu leaves and suitability of Kendu pulp with or without other pulps for paper/board making. Demand for pulp and paper is gradually increasing and supply position of traditional raw materials like bamboo, wood, straw, etc. is not entirely satisfactory. According to our estimate, India will require about 10 million tonnes of cellulosic raw material per year for paper and pulp industry at the end of sixth five-year plan. The known existing source of bamboo, the traditional and major fibrous raw material in India, could be expected to provide, at the most, about 2.5 million tonnes per year to the pulp and paper industry. Hence possibility of utilisation of this waste agricultural material for setting up small paper/board manufacturing units is worth investigating.

2.0 Characteristics of Kendu leaves

The physical and chemical characteristics of Kendu leaves were determined as per TAPPI standard procedures.

2.1 Physical property : Kendu leaves are pale yellow in color and develop brick-red patches on aging.

2.2 Chemical analysis :—

Alcohol-Benzene solubility	—	5.24%
Ether solubility	—	2.07%
Hemi-Cellulose	—	56.5%
Lignin	—	37.8%
Ash	—	2.5%
α-cellulose	—	28.0%

3.0 Experimental procedure

3.1 Deducting and cutting of leaves :—

Before pulping, leaves have been deducted manually and cut to average sizes of 2.5 cm x 3.0 cm.

3.1 Pulping procedure :—

Two different types of pulping investigated :

(a) Higher temperature pulping and
(b) Low temperature pulping

3.1.1. High temperature pulping :—

A laboratory size Hydropulper has been used for mechano-chemical pulping. Hydropulper consists of a m.s. tank of open construction into which raw materials can be charged without plugging. At the bottom portion of the tank there is a circular rotating blade. Impingement plates are fitted at the inside wall of the tank at the same plane with rotor blade. There is a submerged coil type, electrically oil heating arrangement at the outside jacket to heat the stock.

The cooking liquor was charged inside the hydropulper and the heating elements were energized. The liquor was brought to cooking temperature and the deducted torn pieces of Kendu leaves were charged in the hydropulper. The vessel was frequently examined to ensure the regular and continuous circulation of the stock.

The following conditions were maintained during the experiments :

Percentage of caustic soda on OD raw material	— 6%
Consistency during cooking	— 8%
Cooking temperature	— 70°C
Cooking pressure	— atmospheric
Total time	— 80 mts.

Time required to attain maxi-

mum temperature was 20 mts. and digestion at the maximum temperature was for 60 mts.

3.1.2. Low temperature pulping :—

Cut pieces of Kendu leaves were charged into a cylindrical vessel and the cooking liquor was added. The leaves were initially vigorously stirred and kept submerged into the liquor for 2 days at room temperature. Cooking conditions were :

Percentage of caustic soda	— 10%
Total pulping time	— 48 hrs.
Average temperature during pulping	— 29°C

3.1.3 Washing, refining and screening :—

The pulp from both these processes was washed in a table screen till the pH of the washing was neutral. Then the pump was refined in a horizontal disc refiner. It consisted of one stationary and another rotating disc, enclosed in a metal casing with stock feeding arrangement. The refining was done by passing the stock between the groved plates of the disces. The stock entered through a hole in the centre of the disc, passes outwards between the disc and was discharged at the periphery. The clearance between the plates was kept 0.5 mm.

The stock was then washed and screened in a table screen.

3.1.4 Beating and sheet making :—

The washed pulp after refining was charged to a laboratory "Valley" Beater. The beater consists of an elongated tub with a dividing portion, or mid feather, which stops short of both ends of the tub. A beater roll equipped with metal bars set across the width of the roll circulates the stock in the tub and at the same time works the fibres against the bars set in a bed plate under the roll. Amount of action is controlled by raising or lowering the beater roll relative to the bed plate.

The freeness of the pulp has been measured after a definite interval in a freeness tester according to "TAPPI STANDARD". When the desired freeness of the pulp was reached handsheets were made from this pulp in a standard B.S.E. machine. The sheets were dried in a electrically heated drier at 50°C.

3.1.5 Blended Pulp :

Hand sheets were also made by separately cooking, straw, jute stick, hosiery cloth cuttings, etc., and blending these pulps with Kendu pulp in the beater machine.

4.0 Results and Discussion

4.1 Optimum Pulping Conditions :

Results obtained from the experiments indicate that if cooking of Kendu leaves are carried out in a hydropulper at a high temperature, yield of pulp is about 33%, which shows that a considerable amount hemicellulose is lost in such type of cooking. In cold caustic pulping the yield of pulp (56%) was substantially higher than that obtained in high temperature cooking. In cold procedure, yield of pulp is good but caustic consumption is high and also cooking time is exceedingly high. Hence suitable cooking conditions have to be developed so that yield of pulp is not low, chemical consumption is less and the cooking is complete within a reasonable time. By several experiments the optimum condition has been found. By cooking Kendu leaves in a stationary digester, with 6% NaOH at 90°C for 1 hr. and then allowing the stock to remain for another 12 hrs. the yield of the pulp was about 48-49%.

4.2. Characteristics of Paper/ Board.

Characteristic properties of the different samples of paper and board prepared are given in Tables 2 to 8. The paper produced from Kendu pulp alone are very poor in breaking length and double fold, as seen from Tables 2 and 3. By blending Kendu with other pulps, prepared under similar cooking conditions, paper and board samples were obtained, which were comparable in physical properties to commercially available products. This has been indicated in Tables 4, 4A, 5, 5A, 6, 7, 8 and 8A.

TABLE 1

Beating time vs. Freeness of Kendu leaf Pulp

Beating time in minutes	*Freeness (Schopper Riegler Degree) 2 kgs. — 20°C*
0	18°SR
10	26°SR
15	31°SR
20	45°SR

TABLE 2

Properties of Paper samples made from Pulp obtained by mechanochemical pulping of Kendu leaves

Set No.	*Pulp composition*		*Density of paper in gsm*	*Double fold*	*Bursting strength kgs/cm²*	*Breaking load (kgs)*	*Breaking length (m)*	*Remarks*
	Kendu %	*Wheat straw* %						
1	100	Nil	64	0	0.2	1.44	1777	Breaking length is not comparable with standard writing paper. Double fold is poor.
2	80	20	54	0	0.4	2.34	2600	Do
3	70	30	54	0	1.0	4.32	5333	This sample is of good quality & comparable with standard printing paper but double fold is very poor.
4	70	30	54	0	1.0	4.5	5555	In this sample following sizing chemicals were used. Rosin—2% Alum—6% Starch—2%

TABLE 3

Experimental conditions and results of cold caustic pulping of Kendu leaves

Set No.	*Caustic added %*	*Total cooking time in hrs.*	*Yield of refined pulp (% of raw material taken)*	*Consistency during cooking %*	*Beating time in hrs.*	*Beating load (kgs)*	*Consistency during beating*	*Freeness of pulp obtained*	*Density of paper sample gsm*	*Average Breaking load (kgs.)*	*Average Breaking length (m)*	*Double fold*	*Remarks*
1	10	48	56	8.8	2.5	No	2.8	16.5	101	0.48	315	0	Breaking length and folding strength of all the paper sample are below the values of standard papers.
2	10	48.5	58.5	8	3	2	2.2	23.4	61	0.8	800	1	
3	10	48	59	8	5.5	3	2.13	34	86	1.95	1509	2	

TABLE 4

Experimental conditions of cold caustic pulping and beating of Kendu leaves and jute stick

Set No.	*Raw Material*	*Caustic added (%)*	*Consistency during pulping*	*Pulping time in hrs.*	*Yield of refined pulp %*	*Pulp composition*		*Beating time for mixed pulp in hrs.*	*Beating load in kgs*	*Consistency during beating I*	*Freeness of pulp*
						Kendu	*Jute stick*				
1	a. Kendu	10	8	48	58.7	50	50	4	3	2	25.3
	b. Jute stick	10	8	48	80						
	a. Kendu	10	8	72	55	50	50	4	6	1.5	41.3
	b. Jute stick	10	8	72	76						

TABLE 4A

Test results of paper made from Kendu leaf and jute stick

Set No.	*Density of paper gsm*	*Breaking load in kgs.*	*Breaking length (m)*	*Double fold*	*Remarks*
1	101.5	4.3	2811	2	Double fold of all these papers are extremely poor.
2	69.2	2.7	2558	3	

TABLE 5

Experimental conditions during cold caustic pulping of Kendu leaves and rice straw and beating of mixed pulp.

Set No.	*Raw material*	*Caustic added %*	*Consistency during pulping %*	*Pulping time in hrs.*	*Yield af refined pulp %*	*Pulp composition in beater*		*Beating time in hrs.*	*Beating load in kgs.*	*Consistency during beating %*	*Freeness of pulp °SR*
						Kendu %	*Jute stick %*				
1	a. Kendu	10	3.6	96	52	50	50	2	3	2	51°SR
	b. Rice straw	10	5	96	72						
2	a. Kendu	10	5.5	72	55	50	50	4	6	1.54	63.5°SR
	b. Rice straw	10	6.3	72	73						

TABLE 5A

Results of Testing of Paper and Paper Board from the mixed pulp.

Set No.	*Sample*	*Density of paper gsm*	*Breaking load in kgs.*	*Breaking length in (m)*	*Double fold*
1	Paper	117	5.1	2906	12
	Paper Board	462	15.4	2222	—
	Paper	67	3.6	3582	26
	Paper Board	248	10.2	2716	—

TABLE 6

Results of Testing of paper and paper board from mixed pulp of Kendu and waste paper.

Set No.	*Sample*	*Pulp composition*		*Freeness of pulp*	*Density of paper gsm*	*Breaking load in kgs*	*Breaking length (m)*	*Double fold*	*Remarks*
		Kendu	*Waste paper*	*°SR*					
1	Paper	50	50	36°SR	76.8	4	3472	18	
2	Paper Board	50	50	36°SR	260	12.8	3280	—	

TABLE 7

Results of Testing of paper samples made from mixed pulp

Set No.	*Pulp composition*		*Freeness of pulp*	*Density of paper gsm*	*Average Breaking load, kgs.*	*Average Breaking length (m)*	*Double fold*	*Remarks*
	Kendu	*Hosiery waste*						
1	50	50	51	59	4.2	4752	36	This sample is comparable with standard writing or printing paper which has 3000-3500 Breaking length and 40-50 folding strength.

TABLE 8

Experimental conditions during hot caustic cooking of Rice straw and Kendu leaf and beating of mixed pulp

Set No.	*Raw material*	*Caustic added %*	*Temperature during cooking, °C*	*Temperature cooking %*	*Cooking time in hrs.*	*Yield of refined pulp*	*Pulp composition in Beater*		*Beating time in hrs.*	*Beating load in kgs.*	*Consistency during beating*	*Freeness of pulp °SR*
							Kendu %	*Rice straw %*				
1	Kendu	6	90	7.2	1*	48.5	50	50	3.5	3	2.24	72
	Rice straw	6	90	5	1*	60.5						

* N.B. After one hr. of heating the stocks were allowed to stand for 12 hrs. in cold condition.

TABLE 8A

Results of Paper and Paper Board made from mixed pulp of Kendu leaves and rice straw

Set No.	*Sample*	*Freeness of pulp °SR*	*Density of paper gsm*	*Average Breaking load kgs.*	*Average Breaking length (m)*	*Double fold*	*Remarks*
1	Paper	72	82	8.5	6991	52	(a)
2	Paper Board	72	457	43	6272	—	(b)

(a) Properties of this paper is comparable with standard wrapping paper which has 6000-8000 metre breaking length and 40-60 folding strength.

(b) Quality of this Board is as good as standard board which has 4000-5000 m breaking length.

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