Studies on Bleaching of Elephant Grass (Miscanthus) Pulp

* Kishore H., * Rawat N., * Panda A., * Roy T.K. & Pant R.

ABSTRACT: *Considering the growing demand of the paper making raw materials in the country, the use of annual plants and grasses are becoming important day to day. A sample of the wildly grown Elephant grass (Miscanthus) was collected from Sweden and evaluated for its paper making characteristics with the intention to suggest it's cultivation in the waste land available in the country near paper mills site provided it is found suitable for producing different grades of papers. Bleachable grade pulp of around 28 kappa number was obtained by cooking this material with 17.8% sodium hydroxide as Na_2O at 160° C for 90 min by keeping raw material to liquor ratio 1 : 5. Unbleached pulp could easily be bleached by CEH bleaching sequence to a brightness level of 84.3% ISO by using CEH and to around 88% ISO by using (D/C) ED. A comparison of the bleaching response with that of Eucalyptus pulp showed that the bleaching response of the Elephant grass pulp was superior than that of the eucalyptus pulp. Elephant grass pulp also showed very good physical strength properties with no adverse effect on the strength on bleaching. Moreover there was improvement in bursting strength and stretch on bleaching.*

INTRODUCTION

Raw material situation

Growing demand of different grades of papers and fast depletion of the natural forest in the country has resulted in acute shortage of forest based raw materials for paper industry. Efforts were made for the plantation of fast growing species like eucalyptus, but the supply of the wood is not sufficient to meet out the growing demand of the paper industry. Because of the short supply of eucalyptus and other fast growing species and bamboo, the agricultural residues have gained importance. Wheat straw and rice straw are being used since long but the bagasse which is the waste obtained after extraction of sugar juice is gaining importance day by day. Wheat straw is not available in plenty because it is a regular cattle feed and rice straw is not a suitable raw material for large and medium paper mills because of the presence of very high silica content in the raw material (6-24%) which poses serious problem in the recovery unit. Bagasse is a suitable raw material for mills with recovery and also for small paper mills without recovery unit. Though it is a good raw material for the production of pulp but it poses a lot of difficulty in handling like storage and depithing. Pulp produced

* Central Pulp & Paper Research Institute
P.O.Box No. 174, SAHARANPUR-247 001 (U.P.)

show poor drainage, opacity and strength properties. Due to its bulky nature, it requires high raw material to liquor ratio in cooking which results in low black liquor solids (6-7%) and presence of high silica (2-4%) in the bagasse, results in the generation of silica rich black liquor. Both of these factors poses problems in the efficient functioning of the recovery system.

To meet out growing demand of paper making raw materials specially for the medium size paper mills with conventional recovery units, there are possibilities for utilizing agro based agricultural plants like kenaf, mesta and jute and various grasses. Though the grasses are being used by small and medium size paper mills, scattered all over the country for making kraft and other superior grades of papers like sarkanda grass is being used widely in the Northern part of the country. Many small paper mills are planning to approach towards the medium size with the recovery unit for the want of pollution abatement and economic viability. Considering the above facts, there is quite a good scope for growing annual plants and grasses in the different parts of the country, specially on the waste land available on the mill site to supplement the availability of the paper making raw materials to some extent.

Recently Central Pulp & Paper Research Institute had collected a wildly grown grass sample from Sweden which is named as Elephant grass (Miscanthus) for the detailed studies of raw material preparation, pulping, bleaching and paper making characteristics of the pulp produced with the intention to plan for growing the same grass on the waste land available in the country provided it is found suitable for good quality papers. The sample received were of 2-3 meters length and about one cm in diameter with the leaves intact.

Detailed studies on the raw material preparation, cooking chemical dosage optimisation, bleaching of the pulp, evaluation of the optical and physical strength properties of the pulps were carried out. The results of the same will be published in a separate report in the near future.

The studies carried out on the bleaching of Elephant grass pulp are described in the paper. As the demand for high brightness paper is increasing day to day and it is difficult to bleach most of the pulps to high brightness level i.e. 88+2% ISO without the use of chlorine dioxide and so the soda chemical pulp produced from elephant grass was bleached by both i.e. conventional CEH and also by D/CED bleaching sequences.

A comparison of the bleaching response of Elephant grass was also done with the bleaching response of the pulp of eucalyptus, a very widely used raw material in the country.

EXPERIMENTAL

Raw material preparation

Leaves were separated from the Elephant grass plant recevied from Sweden. Leaves free stems were chopped manually to get pieces of the size 2-3 cms in length. This chopped material was taken for laboratory studies.

Pulping

Pulping was carried out in a series digester consisting of six bombs each of 2.5 liters. Capacity, rotating in an electrically heated polythylene glycol bath. Raw material was cooking chemical i.e. 17.8% sodium hydroxide as Na_2O and by keeping raw material to liquor ratio, 1 : 5. Washing of the pulp was carried out with cold water. After thorough washing, the pulp was screened in a laboratory serla screen by using mesh of 0.25 mm slot width. Kappa number of the screened pulp was determined as per the standard procedure.

Bleaching

Screened Pulp was bleached by conventional CEH bleaching sequence and also by D/CED sequence by using different dosage of bleaching chemical in the final stage of bleaching. Bleaching at different stages was carried out under the following conditions.

Conditions for different stages of bleaching

	Chlorination/ D/C Stage	Alkali Extraction Stage	Hypo Stage	Chlorine dioxide Stage
Cy., %	3	8	8	8
Temp., °C	30	60	40	70
Time, Min.	40	60	120	180

Black liquor analysis was carried out according to TAPPI Method T-625-ts-64.

Pulp evaluation

Beating of the unbleached and bleached pulps were carried out in PFI mill under standard conditions as per ISO 5264. Testing of sheet strength and optical properties were carried out as per ISO & SCAN standards given in manual of Laboratory Research Method (1).

RESULTS & DISCUSSION

Table-1 indicates the results of the proximate analysis of different agro based raw materials like bagasse, rice straw and wheat straw alongwith that of Elephant grass (miscanthus). Cellulose, hemicelluloses and lignin contents in the elephant grass was found almost comparable to that of bagasse and wheat straw but the ash content and hence the silica in case of Elephant grass was found least compared to other agro based materials. Lower silica content in Elephant grass is an added advantage for recovery of black liquor.

Table-1.

Physical Data & Proximate analysis of Elephant grass

Proximate analysis	Elephant grass (Misconthus)	Bagasse	Rice straw	Wheat straw
Ash %	1.5	2-3	7-24	5-8
Cellulose %	44	35-40	32-36	40-45
Hemicellulose %	24	28-32	20-25	25-30
Lignin %	17	18-22	12-15	14-16

Table-2 indicates the results of CEH and D/CEH bleaching of the Elephant grass (Miscanthus). Unbleached pulp of kappa number 28 showed unbleached pulp initial brightness 33% ISO. Pulp was bleached by CEH as well as by D/CED sequence. Chlorine dosages were decided on the basis of the kappa number of the unbleached pulp. In D/C stage, 10% of the chlorine is replaced by chlorine dioxide. After alkali extraction of the chlorinated pulp, the brightness was found 45.2% and 42.8% ISO respectively for CE and D/CE stage. In case of CEH bleaching the pulp

Table-2.

Bleaching of Elephant grass (Misconthus) Pulp with & without using Chlorine dioxide

Unbleched pulp Kappa No. = 28
Unbleched pulp Brightness = 33% ISO

Bleaching Sequence	CEH	D/CED
1. Chlorination Stage		
a. Total Chlorine applied%	5.6	5.6
b. Chlorine dioxide as available chlorine, applied/consumed	Nil	0.56/0.56
c. Chlorine as available chlorine applied/ consumed	5.6/5.26	5.04/5.00
2. Alkali Extraction Stage		
a. Sodium Hydroxide applied%	2.0	2.0
b. pH start/ end	11.8/11.0	11.3/11.1
c. Brightness % ISO	45.2	42.8
3. Hypo Stage		
a. Calcium Hypochlorite applied/ consumed %	1.0/1, 1.50/1.47, 2.0/1.67	--
b. NaOH% added as Buffer to make pH > 9	0.25, 0.30, 0.50	--
4. Chlorine dioxide Stage		
a. Chlorine dioxide applied/ consumed		1.0/1.0, 2.0/2.0, 2.5/2.42, 3.0/2.7
b. Brightness % ISO	74.1, 81.4, 84.4	68.3, 78.3, 82.5, 87.6

Table-3.

Comparison of bleaching response of Elephant grass (Misconthus) pulp with the eucalyptus pulp

	Elephant Grass Pulp		Eucalyptus Pulp	
Unbleched pulp Kappa No.	= 28		22	
Unbleched pulp Brightness, % ISO	= 33		26.8	
Bleaching Sequence	**CEH**	**D/CED**	**CEH**	**D/CEDD**
1. Chlorination Stage				
a. Total Chlorine applied%	5.6	5.6	5.0	5.0
b. Chlorine dioxide as available chlorine, applied/consumed	Nil	0.56/0.56	Nil	1.0/1.0
c. Chlorine as available chlorine applied/ consumed	5.6/5.26	5.04/5.00	5.0/4.79	4.0/3.58
2. Alkali Extraction Stage				
a. Sodium Hydroxide applied%	2.0	2.0	1.5	2.0
b. pH start/ end	11.8/11.0	11.3/11.1	11.5/10.8	11.1/11.0
c. Brightness % ISO	45.2	42.8	--	53
3. Hypo Stage				
a. Calcium Hypochloriteapplied/ consumed %	2.0/1.67		2/1.26	
b. NaOH% added as Buffer to make pH > 9	0.50		0.50	
4. Chlorine dioxide Stage 1				
a. Chlorine dioxide applied/ consumed		3.0/2.7		2.5/2.5
b. Brightness % ISO		3.8/4.0		4.5/5.0
5. Chlorine dioxide Stage 2				
a. Chlorine dioxide applied/ consumed				1/1
b. pH				4.5/4.6
c. Brightness % ISO	84.3	87.6	75.2	87.8

Table-4.

Physical strength properties of unbleached & bleached Elephant grass (Miscanthus) pulp

Elephant Grass Pulp	PFI rev	Freeness CSF	D.Time sec	Apparent Density g/cm³	Burst Index Kpam²/g	Tensile Index Nm/g	Stretch %	Fold Kohler Molin log	Tear Index mNm²/g	Porosity Bendestien ml/min
	0	680	4.46	0.61	1.80	39.0	1.3	1.00	7.30	>3000
Unbleached	500	520	4.86	0.65	3.50	59.0	2.1	1.85	8.15	2150
	1000	420	5.39	0.75	4.10	71.8	2.4	2.09	8.05	1220
	2000	250	7.72	0.77	4.75	81.0	2.9	2.31	7.10	140
	0	655	4.30	0.73	2.05	43.0	1.7	1.00	7.15	2970
CEH-Bleached	500	490	5.32	0.73	3.50	66.5	2.6	1.83	7.40	770
	1000	400	7.77	0.76	4.20	74.0	3.0	2.12	7.20	230
	2000	195	12.34	0.67	5.80	82.5	4.1	2.56	6.45	30
	0	660	4.45	0.66	1.95	38.5	1.8	1.00	7.80	2870
D/CED-Bleached	500	495	5.29	0.84	3.80	65.5	2.7	1.65	8.20	830
	1000	380	6.48	0.78	4.70	66.5	3.3	1.95	7.70	200
	2000	225	10.5	0.83	5.40	77.0	5.5	2.09	6.95	40

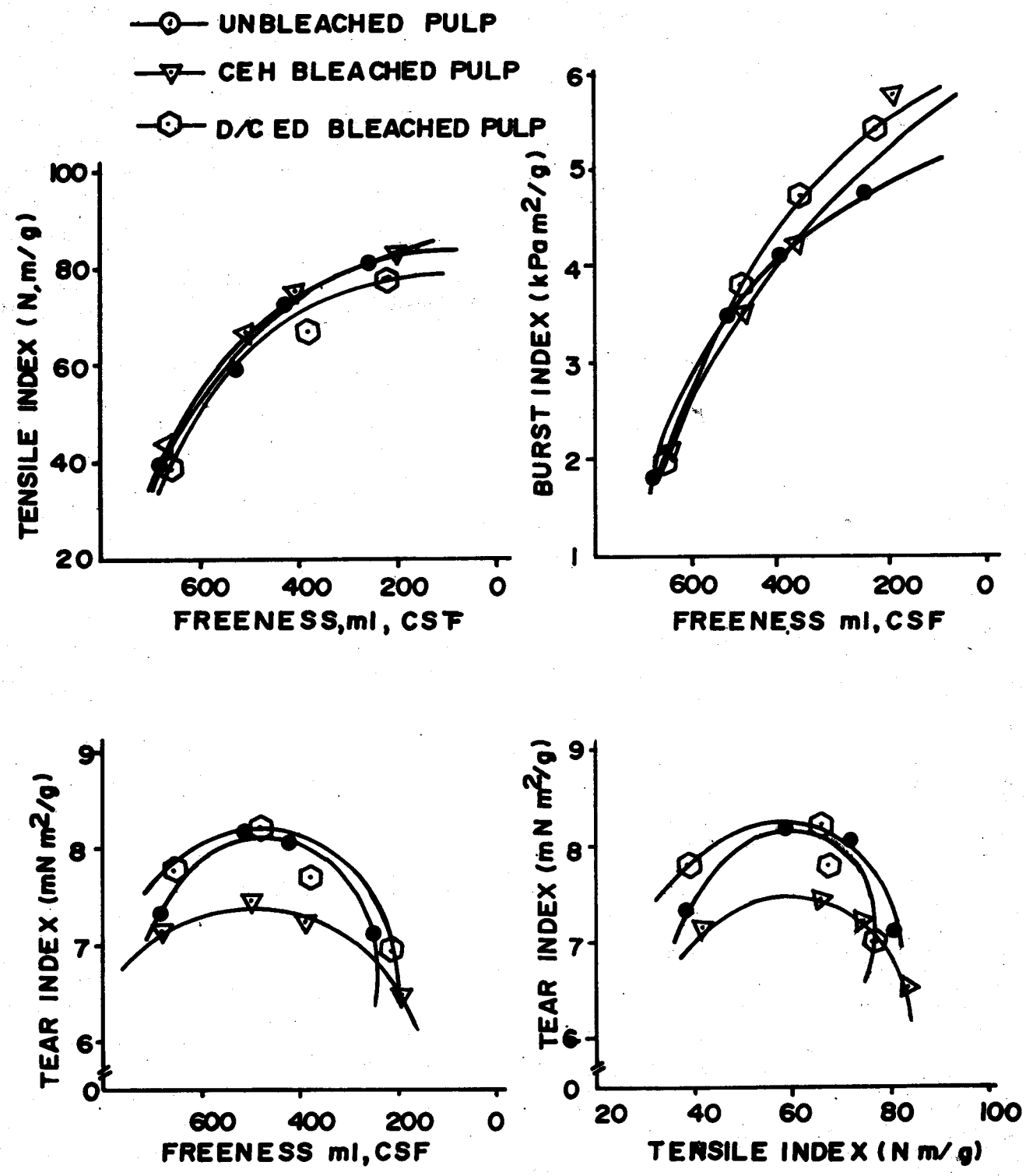

FIG.1, PHYSICAL STRENGTH PROPERTIES OF UNBLEACHED & BLEACHED PULPS OF ELEPHANT GRASS (MISCANTHU S).

could easily be bleached to 74.1% ISO brightness level just by using 1% calcium hypochlorite as available chlorine in the final stage of bleaching. By increasing hypo dosage to 2%, the brightness achieved was 84.3% ISO. Higher dosage of hypochlorite was not tried due to the degradation of the pulp. In case of D/ CED bleaching, using 1 % chlorine dioxide as available chlorine the brightness achieved was 68.3% ISO only. Increasing chlorine dioxide dosage to 2% and 3% the respective brightness achieved was 78.3% and around 88% ISO.

Table-3 indicates the comparison of the bleaching response of the Elephant grass pulp with the Eucalyptus pulp. In case of CEH bleaching, the bleaching response of Elephant grass was found very good as compared to that of Eucalyptus pulp. Elephant grass pulp of kappa number 28 could be bleached to 84.3% ISO brightness level while the Eucalyptus pulp of kappa number 22 to the brightness level of 75.2% ISO. In case of D/CED bleaching the same Elephant grass pulp could be bleached to around 88% ISO brightness level by (D/C)ED while the Eucalyptus pulp by (D/C)EDD i.e. in four stages of bleaching.

Table-4 and Fig.-1 indicate the physical strength properties of the unbleached and bleached pulps of Elephant grass. The physical properties of the unbleached pulp were found very good and suitable for many grade of papers. Bleaching of the pulp either by CEH or by D/CED had not affected the properties adversely and moreover there was some improvement in the bursting strength and stretch.

CONCLUSIONS

1. Elephant grass (Miscanthus) wildly grown in Sweden. It's cellulosic and lignin content are comparable to that of the other agro based raw materials like bagasse and wheat straw. It has one positive aspect i.e. its low ash content compared to that of the others.
2. Low ash content indicates low silica content which is an added advantage for the recovery of the black liquor.
3. Bleachable grade pulp of around 28 kappa number could be obtained by cooking Elephant grass at 160°C for 90 min and by using 17.8% sodium hydroxide as Na_2O.
4. Elephant grass pulp showed good bleaching response both by CEH as well as by D/ CED bleaching sequences. In CEH bleaching, the pulp could be bleached to 84.3% ISO brightness level and in D/CED bleaching, to a brightness level of 88% ISO.
5. CEH bleaching response of the Elephant grass pulp was found much better than that of Eucalyptus pulp. In case of Eucalyptus pulp of kappa number 22 the maximum brightness achieved was 75.2% ISO while the Elephant grass pulp of 28 kappa number could be bleached to 84.3 % ISO brightness level.
6. D/CED bleaching response of Elephant grass pulp was also found better than the Eucalyptus pulp. Pulp of the Elephant grass could be bleached to around 88% ISO brightness level in three stage of bleaching while the Eucalyptus pulp could be bleached to the same brightness level in four stages.
7. Physical strength properties of the unbleached Elephant grass pulp were found very good. There was no adverse effect on bleaching either by CEH or D/CED. Moreover there was an improvement in the bursting strength and stretch on bleaching the pulp.
8. Above findings reveal that the Elephant grass is a suitable raw material for producing many grades of papers.

ACKNOWLEDGEMENT

Authors acknowledge the services rendered by Shri K.S. Moorthy, Dr. Y.V. Sood and other supporting staff of Central Pulp and Paper Research Institute.

REFERENCE

1. Field working document No. 27 IND/73/012. "Manual of Laboratory Research Methods on Papermaking Raw Materials research".