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SUITABILITY OF KALLAR GRASS (*LEPTOCHLOA FUSCA*) AS A PULPING MATERIAL

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Studies have been carried out to explore the suitability of kallar grass *(Leptochloa Fusca)* as an alternate and cheap pulping source in comparison with other conventional pulping materials *viz.* bagasse, wheat straw and kahi grass. It has been concluded that kallar grass an agricultural waste grown on saline lands to arrest salinity being low in lignin-is easily digestible material and has breaking length and burst factor comparable to that of kahi grass but lesser tear factor and screened yield. Further it has 25% higher ratio of long fiber and lower ratio of short fiber when compared to kahi grass. It may particularly be a feasible proposition for mills of smaller capacity to prepare writing paper after blending it with certain proportions of long fiber pulp.

Key words: Kallar grass, Pulping material, Fiber dimensions.

Introduction

The three main categories of fibers presently used as raw material in paper making are wood, rags and various type of grasses [1]. The world scenario of pulp and paper production indicates that 75-80 percent of the pulp is based on softwoods, 15-20 percent on hard woods and only 5-10 percent on grasses [2]. Unfortunately, Pakistan is not bestowed with sufficient forest resources. A survey of major paper industries of Pakistan reveals that the shortfall of wood is met, mainly by utilizing non-wood type raw materials such as bagasse, wheat straw and kahi grass. As for bagasse, it is mostly consumed as fuel in sugar mills, whereas wheat straw has valuble alternate outlet as animal fodder. Recently bigger mills are facing problems with the supply of kahi grass in respect of limited area of its growth and insufficient supply to meet their requirements. Under these circumstances it was considered appropriate to carry out search for new and alternate pulping materials having assured supply round the year.

Leptochloa fusca, known commonly in Pakistan as kallar grass is a highly salt tolerant plant which grows well on water logged saline sodic soils and also arrest salinity [3]. It was first reported by Blatter [4] in 1929 from rocky banks of kallar kote lake about 5 km from Thatta (Sind) and then by Chaudhry [5] in 1969 in Shaikhupura and Gujranwala districts. It is a tall grass varying from 1.0 to 1.5 meter in height during favourable growth season i.e. July to September and 0.4 - 0.8 meter during winter [6]. It can be harvested three to four times a year each time yielding 12 to 15 tons of grass per acre.

Detailed investigations were carried out on kallar grass as a pulping material in comparison with bagasse, wheat straw and kahi grass. The main objective of the present study is to establish suitability of kallar grass as an alternate cheap source of pulp of paper making.

Experimental

The samples of kallar grass, bagasse, wheat straw and kahi grass were first ground in a laboratory grinder so as to pass through 80 mesh and were chemically analysed using TAPPI standard methods [7].

The samples for chemical digestion were prepared by chipping them off into suitable lengths of 2-3 inch followed by washing with water to remove adhering dirt * and grit etc. In each digestion, 1 kg of oven dried. material was used in a stainless steel rotary digester. Kallar grass, bagasse, wheat straw and kahi grass were cooked by soda as well as by neutral sulphite processes while maintaining the digestion conditions viz. pressure, temperature, time etc. (Table 2) similar to the one being commonly used by the local industry. In any case the washed, disintegrated and screened pulp was then subjected to refining operation in a laboratory refiner till a beating degree of 45° SR was attained.

Standard paper sheets from these pulps were then made, using Karl Frank GmbH sheet former according to TAPPI standard T-218. The Bursting, Tensile and tearing strengths of the standard sheets were determined according to TAPPI standard T-403, 484 and 414 respectively.

Investigations have also been carried out for the determination of fiber dimensions viz. length and diameter of unbleached pulp of kallar and kahi grasses (digested by soda process) using microscopic count method [8]. In order to obtain dependable results, sufficient data has been collected, analysed for frequency of different sizes and enlisted in Table 5. For enlightening the studies still further, the fiber length distribution curves of both the grasses have been shown in Fig. 1 and 2.

* and grit etc. In each digestion, 1 kg of oven dried.

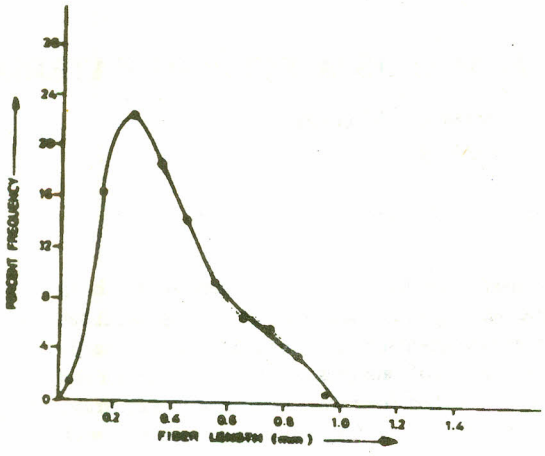

Fig. 1. Fiber length distribution curve of kallar grass

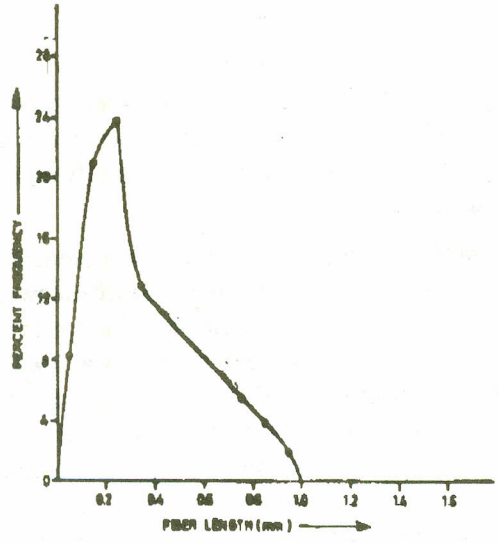

Fig. 2. Fiber length distribution curve of kahi grass.

Results and Discussions

A comparative study has been made on the pulping suitability of kallar grass with the three raw materials namely bagasse, wheat straw and kahi grass, which are mainly used by the local industry.

The chemical analysis of kallar grass (Table 1) reveals that although cellulose is the least of all 30% of original raw material-but lignin is also minimum hinting that it would require lesser amount of digesting agents and mild conditions. This observation is also in confirmity with the fact that grasses generally have a fairly low content of easily accessible lignin which make them a readily digestible material [9]. As for ash, naturally it should be higher since it is grown in saline lands.

Table 2 depicts the results of two cooking processes viz. Soda and Neutral sulphite and conditions namely temperature, pressure, time, solid-liquor ratio etc. which are commonly used by the local industries. It also presents the Kappa Number - a measure of residual lignin of digested unbleached pulps-and these are within the normal range of 12-20 [10].

An examination of Table 3 confirms the already established fact that the percentage yield of crude and screened

TABLE 1. CHEMICAL ANALYSIS OF RAW MATERIALS.

Raw material	α-Cellulose %	Klason lignin %	Alcohol/ benzene soluble %	Pentosans %	Ash %
Kallar grass *(Leptochloa fusca)*	30.7	14.0	9.8	26.3	6.8
Bagasse *(Saccharum officianarum*	34.9	21.1	1.0	23.0	1.6
Wheat straw *(Triticum vulgare)*	38.0	14.5	8.8	18.4	7.4
Kahi grass *(Saccharum spontanium)*	35.5	16.9	9.0	24.6	4.79

TABLE 2. DETAILS OF COOKING PROCESSES

Sr. No.	Raw material	*Process	Cooking liquor composition NaOH %	Na_2CO_3 %	Na_2SO_3 %	Cooking temp. °C	Time for max. temp. attainment (min.)	Cooking time hr.	Pressure kg/cm²	Liq-fiber ratio	Kappa No.
1	Kallar grass	S	9.0	—	—	150	40	3.0	6.25	5:1	16.50
2	-do-	N	—	2.3	12.0	160	35	2.75	7.0	4:1	13.90
3	Wheat straw	S	9.5	—	—	170	30	3.25	7.5	4:1	13.50
4	-do-	N	—	5.5	16.8	160	45	3.0	7.0	3:1	14.00
5	Bagasse	S	10.0	—	—	165	35	3.0	6.5	4:1	13.50
6	-do-	N	—	3.0	14.0	150	30	3.25	6.5	4:1	17.00
7	Kahi grass	S	9.5	—	—	170	50	3.0	7.5	6:1	15.50
8	-do-	N	—	2.5	12.5	170	60	3.25	7.5	5:1	16.00

*S = Soda process N = Neutral sulphite process

TABLE 3. EFFECT OF PULPING PROCESS ON THE PULP YIELD.

Agrowastes pulping process	Kallar grass		Bagasse		Wheat straw		Kahi grass	
	S	N	S	N	S	N	S	N
Crude yield (%)	41.2	44.0	56.4	59.6	45.1	47.0	62.6	65.0
Screened yield(%)	35.0	37.3	54.2	57.3	43.0	45.0	50.3	53.2
Rejects (%)	6.2	6.6	2.2	2.3	2.1	2.0	12.3	11.7
Ratio screened yield Rejects	5.64	5.65	24.63	24.91	24.80	22.5	4.09	4.54

TABLE 4. CHEMICAL ANALYSIS OF SCREENED PULPS OF KALLAR AND KAHI GRASSES.

Screened pulp	Ash content %	Alcohol benzene solubles %	Klason lignin %	Cellulose %	Pentosan %
Kallar grass	4.82	4.73	1.38	75.91	16.30
Kahi grass	4.16	3.89	0.97	77.59	15.86

TABLE 5. LABORATORY EVALUATION OF UNBLEACHED PULPS.

Sr. No.	Raw material	Process	Burst factor	Tear factor	Breaking length (m)
1	Kallar grass	S	24.5	26.2	4200
2	-do-	N	19.5	22.0	5500
3	Bagasse	S	45.2	55.0	6800
4	-do-	N	35.0	42.0	7300
5	Wheat straw	S	33.0	41.0	4460
6	-do-	N	28.1	35.6	5870
7	Kahi grass	S	25.0	56.0	3450
8	-do-	N	18.9	49.0	4210

pulp in all the cases is higher by Neutral sulphite process 'N' as compared to Soda process 'S' [11]. When the figures obtained by using both the processes with different raw materials are compared, it comes to surface that, as expected in the light of analytical results, percentage yield of crude and screened in case of kallar grass is the least; nevertheless rejects are lesser than kahi grass. Further, incidently the screened yield per unit mass of rejects indicated by the ratio screened yield to rejects; in case of kallar and kahi grass by either of the processes are very close to one another. The same is the case for bagasse and wheat straw with quite higher value and thus these two may be considered another category from this point of view. The chemical analysis of screened pulp of kallar and kahi grasses (Table 4) shows that their chemical analysis is quite comparable with slightly lower content of ∝–cellulose and marked by generally higher content of non cellulosic materials in kallar grass. Further higher percentage of lignin in kallar grass may have an adverse effect on its interfiber bonding properties [8].

A comparison of the evaluation factors of unbleached pulp of different raw materials in Table 5 obtained by soda and sulphite processes indicates that the burst and tear factors in latter case are lesser which is in agreement with the general observations [2]. The tear and burst factors which are a measure of interfiber bonding and individual fiber strength [12], are found to be comparatively lower in the case of kallar grass as compared to other raw materials. However, the breaking length of kallar grass is higher than that of kahi grass and quite close to that of wheat straw.

The mean fiber length and diameter (mm) of bagasse and wheat straw as referred in the literature [2] are 1.7, 0.020 and 1.5, 0.013 respectively. An examination of the data concerning the fiber dimensions (Table 6) reveals that the mean fiber length and diameter (mm) of kallar and kahi grasses are of the order of 0.3908, 0.00735 and 0.3540, 0.01026 respectively. These values are of little significance if attempted to interprete as such. In order to draw pertinent conclusion, the fiber length data has been further categorized into long, medium and short fibers [13] and their percent frequencies have also been calculated. It may be recalled that fibre length is one of the factors which imparts strength to the finished paper sheet [12]. It comes to the surface from Table-6 that the mean length of long as well as short fiber is slightly higher and of the medium slightly lower in kahi as compared to kallar grass. However percent frequency of short fiber in kahi grass is exceptionally on the higher side. Although the mean length of long fiber in case of kahi is slightly higher which results in its greater tearing strength (Table 5) yet the ratio of long fiber in kahi to kallar for the same number of medium and short fibers in either case comes out to be 1:1.23.

TABLE 6. FIBER DIMENSIONS OF KALLAR AND KAHI GRASS.

	*Long fiber (L.F.) (0.5-1.0mm)		Medium fiber (M.F.) (0.1-0.5mm)		Short fiber (S.F.) (0.0-0.1mm)		Relation of L.F. to (M.F.+S.F.)	Ratio of L.F. in Kahi and Kallar grass for the same No.of(M.F+S.F)	Diameter 10 — 25μ		2 —10μ		Mean length (l) (mm)	Mean dia. (d) (mm)	Slenderness ratio l/d
	**% Freq.	Mean Length (mm)	% Freq.	Mean Length (mm)	% Freq.	Mean Length (mm)			% Freq.	Mean dia (μ)	% Freq.	Mean dia (μ)			
Kallar grass	26.86	0.672	71.64	0.292	1.49	0.080	1:2.72	1 : 1.23	9.7	14.70	90.3	6.56	0.3908	0.00735	53.17
Kahi grass	22.93	0.718	68.81	0.287	8.25	0.094	1:3.36		35.7	13.86	64.3	8.26	0.3540	0.01026	34.50

The fiber length distribution curves (Fig. 1 and 2), based on percentage of length groups in respect of kallar and kahi are quite revealing one. It is obvious from these curves that the distribution is almost normal in both the cases.

Conclusion

It may be inferred from the preceeding discussion that kallar grass being low in lignin is as easily digestible material. Further it has fiber dimentions and strength properties viz. breaking length and burst factor comparable to that of kahi grass but lesser tear factor and screened yield. Nevertheless, it has about 25% higher ratio of long fiber and lower ratio of short fiber as compared to kahi grass. Thus these investigations and their results lead to the conclusion that kallar grass may be used for the manufacture of writing paper in mills of smaller capacity after blending it with certain proportions of long fiber pulp.

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