Evaluation of Heteropogon contortus as an alternate source for Pulp & Paper making

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ABSTRACT

Scarcity of raw material continue to be a paramount problem and associated with an unbearable cost burden as well Afforestation programmes which are vital are still very meagre and industry is required to look for agro residue and locally available grasses which have good fibre potential Contrary to this the search for new and prospective sources of fibrous raw materials for making pulp, suitable for printing and writing grade paper is never ending, *Heteropogon contortus* evaluated for its pulp and paper making properties. Data on chemical constituents, fibre dimensions, unbleached, bleached yield and physical strength properties of pulp sheets were obtained. The unbleached pulp yields under soda pulping process were 47.6 to 48.2% and 22 to 27.2 Kappa No without enzyme and with enzyme Kappa No is 20.6 to 26.0. Laboratory handmade pulp sheets with adequate strength properties were obtained from soda pulp prepared from this plant material.

Key words: *Heteropogon contortus*, Kappa number, Pulping, Bleaching, Strength properties

Introduction

Pulp and paper industry is on the threshold of material resource crunch. The conventional raw materials like softwood, hardwood and bamboo used for pulp, paper and cellulose based industries are depleting day by day and it is predicted that by the turn of the century, there will be a global shortage of these raw materials. During the last three decades though many of the forest based fast growing annual and perennial plants have been identified cultivated and their suitability for pulp and paper making have been studied [1-13]. Search for new fiber crops has been underway and is continuing. There is a necessity to evaluate new fiber crops which may be available on sustainable basis.

It Scientific classification are Kingdom: Plantae, Division: Magnoliophyta, Class: Liliopsida, Order: Poales, Family: Poaceae, Genus: Heteropogon, Species: H. Contortus

Common name Black or bunch spear grass (Australia), tangle head (United States), pili grass (Hawaii), assegai grass (Zimbabwe). *Heteropogon contortus* is a tropical, perennial tussock grass with a native distribution encompassing Southern Africa, southern Asia, Northern Australia and Oceania. The species has also become a naturalised weed in tropical and subtropical regions in the Americas and East Asia. The plant grows to 1.5 m in height and is favoured in most environments by frequent burning. The plants develop characteristic dark seeds with a single long awn at one end and a sharp spike at the other. The awn becomes twisted when dry and striaghtens when moistened, and in combination with the spike is capable of drilling the seed into the soil.

Habit of *Heteropogon contortus are* Perennial; caespitose. Basal innovations intravaginal. Culms erect; 30150 cm long; 1.53 mm diam. Culm-internodes solid. Culm-nodes black. Lateral branches fastigiate.

Leaves cauline. Leaf-sheaths keeled. Ligule a fringe of hairs; 1 mm long. Collar glabrous, or pilose. Leaf-blades 330 cm long; 28 mm wide. Leaf-blade surface ribbed. Leaf-blade apex abruptly acute.

Infloresence of *Heteropogon contortus* Inflorescence composed of racemes. Peduncle antrorsely scabrous above Racemes 1; single; erect; unilateral; 310 cm long. Rhachis fragile at the nodes; glabrous on margins. Rhachis internodes linear. Rhachis internode tip oblique. Spikelets appressed; in pairs. Fertile spikelets sessile; 1 in the cluster. Companion sterile spikelets pedicelled; 1 in the cluster. Pedicels oblong; semiterete; 0.2 times length of fertile spikelet, and flower Anthers 3; 2.5 mm long. Stigmas is 2.

Distribution of *Hetropogon contortus* in Europe: central, southwestern, and southeastern. Africa: north, Macaronesia, west tropical, west-central tropical, northeast tropical, east tropical, southern tropical, south, middle Atlantic ocean, and western Indian ocean. Asia-temperate: western Asia, Arabia, China, and eastern Asia. Asia-tropical: India, Indo-China, Malesia, and north Indian ocean. Australasia: Australia. Pacific: southwestern, south-central, northwestern, and north-central. North America: southwest USA, south-central USA, and Mexico. South America: Mesoamericana, Caribbean, northern South America, western South America, Brazil, and southern South America.

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MATERIAL AND METHODS

Raw Material

Heteropogon contortus collected from the field is cut to 1.0 -1.5 inch size in straw cutter. The raw material was prepared and dried to a moisture level of 10-12%. and then used for experimental work on oven dry (O.D) basis, after determining the bulk density.

Pulping:

Soda pulping of *Heteropogon contortus* was carried out in an electrically heated stainless steel autoclave digester with polyethylene glycol bath, thermostatically controlled system, keeping bath ratio 1:4. The digestions were carried at varying chemical concentration for 3 hrs including time to raise the temperature to $165^0 \pm 2^0$C. The pulp after digestion was thoroughly washed with water. The unbleached pulp yield, kappa numbers, etc were determined. The black liquor after each digestion was collected for determination of total solids and residual active alkali. Unbleached pulp treated with enzyme, The results are given in Table- 1

Table -2 Physical strength properties of unbleached Soda pulps of *Heteropogon Contortus.*

STRENGTH PROPERTIES OF UN- BLEACHED PULP			
	14%	**15%**	**16%**
B. Wt	60.5	60.0	60.2
Breaking Length	3655	3400	3270
Tear Factor	72.0	67.9	67.0
Burst Factor	16.2	16.05	16.1
Bulk	2.02	1.98	2.00
Ash %	3.1	3.1	3.2
^{O}SR	28	28	28

The strength properties of *Heteropogon contortus* unbleached pulp with and without enzyme were evaluated and the results are recorded in Table- 2

Bleaching:

The unbleached pulps of *Heteropogon contortus* with and without enzyme was bleached by C-E_p-H-H sequence. The strength & optical properties of bleached pulp were evaluated. The results are recorded in Table-3

Paper sheet formation and testing: The unbleached & bleached pulps were beaten in a laboratory valley beater to 28 & 30 ^{O}SR. Sheets of 60± 1gm^2 were prepared from the pulps in a British standard laboratory hand sheet making machine followed by pressing and drying.

The pulp sheets were conditioned at 65 % relative humidity at 27^0C for 2 hrs and then tested for various physical properties by Tappi method: T-220 om-88.

Table-3 Condition & Bleaching sequence (C-E_p-H-H) of *Heteropogon contortus* pulp

		Chlorination					
		With Enzyme			Without Enzyme		
		14%	**15%**	**16%**	**14%**	**15%**	**16%**
OD pulp	Gm	100	100	100	100	100	100
Cl_2 Added	%	5.1	5.1	5.1	5.1	5.1	5.1
pH (initial)	-	2.44	2.43	2.42	2.41	2.38	2.39
Retention Time	Min	45	45	45	45	45	45
pH (final)	-	2.28	2.27	2.27	2.26	2.26	2.28
R-Cl_2	Gpl	Nil	Nil	Nil	Nil	Nil	Nil
Cl_2 Consumed	%	5.1	5.1	5.1	5.1	5.1	5.1
Alkali Extraction							
Temp	^{0}C	60	60	60	60	60	60
Alkali Added	%	2.8	2.8	2.8	2.8	2.8	2.8
H_2O_2	Kg/T	8	8	8	8	8	8
pH (initial)	-	10.99	11.00	10.98	10.96	10.98	10.94
Retention Time	Hrs	2	2	2	2	2	2
pH (final)	-	9.89	9.90	9.92	9.96	9.94	9.92
Kappa No	-	3.4	3.2	3.0	3.8	3.4	3.2
H-I Stage							
Temperature	^{0}C	40	40	40	40	40	40
Hypo Added	%	2.0	2.0	2.0	2.0	2.0	2.0
pH (initial)	-	8.22	8.20	8.21	8.23	8.18	8.16
Retention Time	Hrs	2	2	2	2	2	2
pH (final)	-	7.89	7.88	7.86	7.84	7.84	7.82
R-Cl_2	Gpl	Nil	Nil	Nil	Nil	Nil	Nil
Cl_2 Consumed	%	2.0	2.0	2.0	2.0	2.0	2.0
H-II Stage							
Temperature	^{0}C	40	40	40	40	40	40
Hypo Added	%	1.4	1.4	1.4	1.4	1.4	1.4
pH (initial)	-	7.98	8.00	8.1	7.99	7.98	7.96
Retention Time	Hrs	2	2	2	2	2	2
pH (final)	-	7.58	7.57	7.60	7.58	7.54	7.56
R-Cl_2	Gpl	Nil	Nil	0.00142	Nil	Nil	Nil
Cl_2 Consumed	%	1.4	1.4	1.39	1.4	1.4	1.4
Total Cl_2 Charged	%	**8.5**	**8.5**	**8.5**	**8.5**	**8.5**	**8.5**
Cl_2 Consumed	%	**8.5**	**8.5**	**8.49**	**8.5**	**8.5**	**8.5**
Shrinkage	%	**8.2**	**8.3**	**8.3**	**8.0**	**8.1**	**8.2**
Bleached Yield	%	**44.2**	**43.8**	**43.6**	**44.3**	**43.9**	**43.7**
Brightness	%	**77.2**	**78.0**	**78.9**	**76.8**	**77.5**	**78.2**

Table-1 Pulping conditions, Pulp yield and Kappa No. of *Heteropogon contortus* pulps.

O.D R. Material (gm)	600	600	600
Cooking Chemical (NaOH) (%)	14	15	16
Cooking Aid (%)	0.05	0.05	0.05
Cooking Time (Hrs)	3	3	3
Un Bleached Yield (%)	48.2	47.8	47.6
pH	12.20	12.31	12.44
RAA (GPL)	1.0	1.2	1.4
Total Solid	9.2	9.5	9.8
Kappa No	27.2	25.3	22.0
With Enzyme			
Dosing (gm/T)	300	300	300
Time (Min)	60	60	60
Kappa No	26.0	23.8	20.6

Result and Discussion:

Table-1. shows pulping condition and properties of unbleached pulp of *Heteropogon contortus* soda pulping.

Table-4 Strength properties of Bleached pulp of *Heteropogon contortus*

STRENGTH PROPERTIES OF BLEACHED *Heteropogon contortus*						
	Blank			With Enzyme		
	14%	15%	16%	14%	15%	16%
B. Wt	60.2	60.2	60.0	60.0	60.2	60.0
Breaking Length	3120	3100	3070	3300	3240	3200
Tear Factor	58.0	55.0	54.6	56.0	56.2	58.3
Burst Factor	14.7	15.2	15.7	17.6	17.4	17.0
Bulk	1.92	1.88	1.85	1.90	1.92	1.91
Ash %	2.0	2.1	2.1	2.0	2.1	2.1
^{O}SR	29	29	29	30	30	30

The unbleached pulp yield was 47.6to 48.2% with varying alkali charge from 14-16% in soda cook; Kappa No. was 22.0 to 27.2. It was observed that under the identical conditions of pulping, pulp yield and kappa number decreased with increase in alkali charge, after enzyme dosing Kappa No. was 20.6 to 26.0 Kappa no. decreased as compare to blank.

The physical strength properties of unbleached pulps of *Heteropogon contortus* are recorded in Table-2. It may be seen that the pulp produced using 14% alkali charge with better strength properties as compare to pulp produced using 15% and 16% alkali charge.

Table-3 Shows the condition and sequence of bleaching of *Heteropogon Contortus* with and without enzyme pulp.. Pulp yield recorded 44.2% , 43.8% and 43.8% treated with enzyme 44.3%, 43.9% and 43.7% without enzyme for the pulp produced using 14%,15%,16% alkali charge at 8.5% chlorine demand. Pulps have 77.2%, 78.0% and 78.9% with enzyme treated and 76.8%, 77.5% & 78.2 with out enzyme brightness. However pulp yield was observed almost same with and without enzyme.

The physical strength properties of bleached pulps are recorded in Table-4. It is observed that Tear factor is more in pulp produced with 14% alkali charge as compare to 15% & 16%.,but Breaking length and Burst factor is almost same in 14%, 15% & 16% alkali charge blank pulp. Bulk and ash content almost same in 14%, 15% and 16% alkali charge blank pulp. But as blank compare with enzyme treated bleached pulp strength properties of bleached pulp is more. All the pulp possess adequate strength properties and can be used for production of paper. This pulp can be used with other pulp mix in various proportion.

Conclusion:

On the basis of experiment carried out on *Heteropogon contortus* for pulp and paper making in industrial application, it seems to be a viable alternate source of raw material. This would also convey socio-economic and environmental benefits to the country, besides to meet the ever growing raw material demand in pulp and paper industry. We find that it can be easily used for producing chemical pulp in certain proportion alongwith other pulp. Further experiments are being conducted.

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