Sesbania aculeata-A potenial raw material for small and big paper mills

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SUMMARY

Investigations were carried out in the laboratories to find out the suitability of *Sesbania aculeata*, a commonly cultivated species for green manure, fodder and temporary shade. for making bleachable grade kraft pulp. Unbleached pulp of 20 Kappa number could be produced with 16% active alKali at 165°C (H factor 1°55) with a promising yield of 51%. The colloidal stability during evaporation and the burning properties of the resultant black liquor were also studied. The bleaching experiments carried out had yielded a pulp of brightness of 80% ISO with 55% total chlorine in standard CEHH sequence. The burst and tensile strengths are better than those of other short-fibred pulps at the same tear index.

Due to actue shortage of bamboo, a conventional raw material for Indian Pulp and Paper Industry various organisations have been on the look out for alternative raw material. As the small quantity of softwoods available in the country is in inaccessible regions, the industry has to run towards the tropical forests and agricultural residues for expansion and new ventures. A promising and potential raw material in this context is *Sesbania aculeata* which is also known as *Sesbania cannabina* which is grown as a rainfed or occasionally as an irrigated crop as green manure and for using the fibre in making the fishing nets and ropes. Investigations carried out to find out the pulp and paper making characteristics of this raw material are presented in this article.

AGRONOMICAL CHARACTERISTICS

Sesbania aculeata var, cannabina is popularly known in India as Daincha (Prickly sesban). It is a quick growing annual legume, belonging to the family Leguminusae, sub family Papilionaceae. It is a suffruticose, shrubby annual native to Australia, and cultivated during rainy season throughout India upto an altitude of 1,220 m; also occasionally found in marshes and swamps. Stem green, sparingly prickly, branched from the bases; leaves abruptly pinnate with linear oblong, glabrous leaflets; flowers in 3-4 flowered recemes 1.25 cm, long, pale yellow, unspotted or spotted red to black; pods 15-25 cm. long, straight or slightly curved with slightly indented margins.

IPPTA, Vol. 19 No. 3, Sept , 1982

Daincha has gained great popularity as green manure crop for rice, sugarcane, cotton and coconut crops. It is also cultivated for its fibre which is used chiefly for making fishing nets. lines and sails. Besides, daincha has been found efficacious in the reclamation of saline and alkaline land. Its fibre is coarse silken in appearence resembling hemp and is resistant to sea water. It is reported to be much superior to jute in strength and durability.

Plantation of Sesbania aculeata was raised in Saharanpur over an area of 0.7 hectare. Out of the total area, a plot of 0.25 hectare was planted with seeds obtained from Pakistan Forest Research Institute through FAO, Rome and the rest of the area was planted with seeds planted with seeds purchased from the National Seeds Corportation, India.

EXPERIMENTAL

The raw material was received in the form of bundles. The top portion was chopped off to remove leaves, thin branches and seeds. The sample with bark were fed to the laboratory chipper. The chips were screened on a waterous Vibratory Screen. The fraction passing through a 44 mm square mesh and retained on 6.5 mm square mesh was taken for studies.

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PULPING

Pulping experiments were carried out in series digester consisting of six bombs, each of 2.5 litres capacity, rotating in electrically heated polyethylene glycol bath. In each bomb, 300 gm OD chips were taken. At the end of the cooking period, the bombs were removed from the bath and cooled by immersion in a water tank. Each bomb was opened and the black liquor was collected after filtering through nylon cloth. Chips were broken and then disintegrated after adding 8 litres of cold water. The pulp was finally washed on a buchner funnel with cold water until the filtrate was almost colourless. Cold water washing was carried out as no special problems were encountered with these pulps as experienced in case of hardwoods. The washed pulps were screened on a flat screen fixed with a slot screen of 0.2 mm width.

BLEACHING

Optimisation of chemical demand in different stages of bleaching, viz. C, E and H stages was carried out on similar lines as reported earlier (3) with some modifications in chlorination by plotting residual chlorine (mg/1) against chlorine applied instead of plotting chlorine consumed vs chlorine applied.

Fibre length measurements were carried out using PIRA electronic fibre length counter. Slides for this purpose were prepared using pulp slurry of 0.05% consistency. For obtaining average fibre length, the length of 300 fibres was measured at $50 \times$ magnification using a projection microscope.

Proximate analyses were carried out according to APPITA and TAPPI standards. Estimation of Kappa number, intrinsic viscosity of pulp and black liquor viscosity and the measurement of physical and optical properties were carried out according to standard methods¹. Swelling volume ratio of black liquor was determined using the method of Oye and coworkers².

RESULTS AND DISCUSSIONS

Studies on physical data : Bulk density and basic density of chips are quite low viz., 158 kg/m^3 and 353 kg/m^3 respectively with the resultant advantage of easy penetration of cooking liquor. This reduces the percentage of rejects. Proximate analysis data given in Table 1 show that silica content is quite negligible unlike other agricultural residues. Extractives are also quite low.

Pulping studies: Kraft pulping experiments were carried out on small scale with 16% chemical at 165°C and varying the cooking time from 30 to 50 minutes. The pulping results are given in Table 2

TABLE--1 PHYSICAL DATA ON SESBANIA ACULEATA

Built donaide - C 1 ! 1 / B		
burk density of chips, kg/m ³	=	158
(at 9.0% dryness)		
Basic density of chips, kg/m ³	_	353
Proximate analysis	0/	00 1
A 1	76 ON	UD wood
Asn		0.8
Total lignin (ash free)		0,0
(lalass line (asit fice)		21.9
(klason lignin + acid soluble lignin)		
Holocellulose		710
		/4.6
Solublitties in		
(a) Boiling water		<i>C</i> 1
		6.1
$(0) \cup I N, NaOH$		24.4
(c) Alcohol-Benzana		1.0
		1.9

 TABLE-2
 KRAFT PULPING EXPERIMENTS ON SESBANIA ACULEATA

_	Particulars	I	11	III
1,	Cooking time, min.	30	fΟ	
2.	H factor	5.0	8.0	1155
3.	Total pulp yield, %	53.8	52.1	51.7
4.	Screen rejects, %	20	1.0	0.3
5.	kappa number of the		1.0	
	unbleached pulp	32.3	20.9	18.4
6.	Black liquor			10.1
	(i) Total solids, % w w	15.69	15.74	15 72
	(ii) Residual active alkali as			10.12
	Na_2O , g/l expressed on			
	200 gpl solids	8.8	8.95	8.5
۰.	Constant conditions during coo	oking	070	0.5
	Active alkali as Na O, %	16.0		
	Sulphidity of the cooking			
	liquor, %	250		
	Chips to liquor ratio	1:4		
	Cooking temperature, °C	165		
	Cooking schedule			
	Raising time to 00 C, min.	30		
	From 100°C to 165°C, min.	10)		

and strength properties are presented graphically in Figs 1 to 3. From the pulping and sttength evaluation results, 16% chemical at 165°C for 90 minutes was taken as the optimum condition. Large scale pulping was carried out on Sesbania aculeata in two batches of six bombs, under the above conditions. Results are given in Table 3 and strength properties are presented graphically in Figs 4 to 6. Bleachable grade pulp of Kappi number around 20, could be obtained at a pulp yield of 51% under the above pulping conditions. The strength properties specially burst and tensile strength are quite good (4.4 kPam²/g and 62 Nm/g respectively at 3°0 ml CSF) at a

IPPTA, Vol. 19, No. 3, Sept., 1982



Fig. 1-Burst Index V/s CSF for Sesbania Aculeata

Unbleached Pulps



Fig. 3-Tear Index V/s CSF for Sesbania Aculeata **Unbleached** Pulps



Fig. 2-Tensile Index V/s CSF for Sesbania Aculeata **Unbleached** Pulps



Fig- 4-Burst Index V/s CSF for Sesbania Aculeata Unbleachd and Bleached Pulps

IPPTA Vol. 19, No. 3, Sept.,, 1932



Fig 5-Tensile Index V/s CSF for Sesbania Aculeata Unbleached and Bleached Pulps





tear strength of 7.8 mNm²/g. This pulp has an average fibre length of mm. 0.83

Black liquor studies : Results of the studies carried out on black liquor obtained from the kraft pulping of *Sesbania aculeata* under the above optimum conditions are given in Table 3. No precipitation was observed during evaporation of the black liquor even upto 55% solids. This shows the colloidally stable nature of the black liquor. Black liquor exhibited low viscosity even at high concentration (55% solids== 43.7 cps) and had a good burning quality as revealed by swelling volume ratio test.

Bleaching studies : The pulp was bleached by CEHH sequence to a brightness of 80% ISO. The large scale bleaching conditions and results are given in Table 5. The strength evaluation results are presented graphically in figs 4 to 6. The total chlorine requirement to obtain a final brightness of 80% ISO was only

TABLE-3 LARGE SCALE PULPING OF SESBANIA ACULEATA

1.	Active alkali as Na ₂ O,	%	16.0
2.	Sulphidity of the cooking liquor,	%	25. 0
3.	Chips to liquor ratio		1:4
4.	Cooking temperature,	°C	165
5.	Cooking schedule		
5.4	Raising time to 100°C,	min	30
	From 106°C to 165°C,	min	1 0 0
	At 165°C,	min	9 0
6.	H factor		1155
7.	Total pulp yield.	%	51.4
8.	Screen rejects.	6	0.3
9.	Kappa number of the pulp	/0	210
10.	Black liquor		
	i) pH		10.1
	ii) Total solids.	%w/w	15.1
	iii) Residual active alkali as Na ₈ O.	/0 /	
	g/l expressed on 200 gpl solids		7.8
	iv) Swelling volume ratio ml/g		42
	v) Brookefield viscosity cps at 80°C	r	
	a) at 35% total solids	•	32
	b) at 45% total solids		12
	c) at 50% total solids		22
	d) at 55% total solids		23
	a) at 55% total solids		44

TABLE-4 FIBRE LENGTH DISTRIBUTION AND AVERAGE FIBRE LENGTH OF SESBANIA ACULEATA

Range (mm)	% Frequeucy number		
0.40 - 0.58	5.3		
0.60-0.78	37.0		
0.800.98	43.7		
1.00-1.18	9.7		
1.20-1.38	4.0		
1 40-1.58	0.3		
Average fibre length	0.83 mm		

IPPTA, Vol. 19, No. 3, Sept., 1982

TABLE-5 BLEACHING OF SESBANIA ACULEATA PULP

Kappa number of	the pul	р		21.0
Chlorination				
Chlorine applide.	% on r	oulo		4.5
Final pH	/0 r	F		2.1
Chlorine consume	d. % o	n pulp		4.32
Alkali extraction				1
Sodium hydroxide	applie	d.%		2.0
pH. initial/final		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		10.8/10.7
Hypochlorite I star	ge			•
Hypochlorite appl	ied as c	hlorine.	%	6. 7
pH maintained		,	`` >	>9
Buffer used as Na	OH %		().08
Hypochlorite cons	umed a	s chlorine	. %	0.6
Hypochlorite II sta	age		, 10	
Hypochlorite appl	ied as c	hlorine. 9	1/2	0.3
Buffer used as Nat	OH. %	, ,	0	0.04
pH maintained	· · · · · · · · ·		>	>9
Hypochlorite cons	umed a	s chlorin	e. %	0.1
Yield loss during	bleachir	ig. %	.,,,	4 .7
Total chlorine apr	lied/co	nsumed.	%	5.5/5.0
Total sodium hvdi	oxide u	ised. %	/0	2.12
Brightness of the	oulp. %	ISO		79.5
Intrinsic viscosity	of the t	pulp, cm ³	/g	825
Constant condition	s · · · · ·			
(Thiori-	Alkali-	Hypo I	Hypo II
	ation	extrac-	stage	stage
		tion		
Consistency, %	3	8	8	8
Temperature °C	30	60	40	40
Time, min	30	60	120	120

5.5%. The low requirement of hypochlorite in later stages indicates the good response of *Sesbania aculeata* pulp for bleaching with a slight decrease in tear strength.

CONCLUSIONS

- 1. A bleachable grade pulp of Kappa number 20 with a yield of 51% can be obtained with this raw material by kraft pulping with 16% chemical at 165°C for 90 min.
- 2. A pulp of 80% ISO brightness can be obtained with only 5.5% chlorine using CEHH bleaching sequence.
- 3. The resultant black liquor has good colloidal stability, low viscosity and good burning properties.
- 4. Unbleached and bleached papers of satisfactory quality can be made from this raw material.

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IPPTA, Vol. 19, No. 3, Sept., 1982