Pulping of agave sisalana

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ABSTRACT

This paper deals with the pulping, bleaching and blending studies of sisal fibre, extracted from the leaves of Xerophytic plant A. Sisalana which is being exploited in wild and cultivated forms in states like Andhra Pradesh and Orissa. The Sisal fibre is one of the promising alternative long fiber sources for pulp and paper industry.

INTRODUCTION :

As the scarcity of conventional fibrous raw materials like bamboo and hard woods is increasing due to the stoppage of deforestation for ecological reasons, it is made necessary to choose and utilise alternate non-wood fibrous raw materials to meet the ever increasing demand of pulp & paper mills. The non-wood plant fibres, which are currently being used and those which offer potential for further use for manufacture of paper making pulps include agricultural residues such as bagasse, straw and natural growing grasses and the fibers which are grown for their fiber content such as mesta, jute, hemp, abaca, sisal, cotton etc. At the present, in India, straw, bagasse are the leading fibres being used next to bamboo and hard woods.

Agave Sisalana, a xerophytic plant commonly known as sisal which is presently being used widely for industrial rope making, sack making, brushes and mats etc. is one of the promising and good source of fibrous raw materials. However, much data is not readily available on its pulping characteristics. Hence, a detailed study was conducted in our laboratory and the findings are presented in this paper.

The sisal plants are grown in areas with high temperature and an annual rain fall of 1000 to 1250 mm. It is planted on barren hill slopes to check soil errosion.

As per Sisal Research Station (ICAR), Bamra (Orissa) findings,[2] this can be closely propagated by two forms of planting materials-Bulbils and Suckers. Bulbils are the main source. Bulbils emerge on the branches of the giant inflorescence known as pole, at ditching place of flowers.

These grow and develop itself on inflorescence and attain 3-5 cm size and 2-5 leaves. These can be collected and raised in the nurseries. Suckers are the small plants that come out from underground rhizomes. First cutting, in general starts at 3 1/2 years age. However,with intensive cultivation first harvest can be taken up at 2 1/2 years age.

Decortication of the leaves, to get the fibre, can be done either manully or using commercially available motorised simple Raspadors.

EXPERIMENTAL :

Chopping of locally procured sisal fibre was manually done to about 5 cm size. The proximate analysis of the sisal fibre was done as per TAPPI Standard testing methods. The fibre dimensions were also determined by using microscope. The comparetive results are given in Table-1.

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TABLE—1

PROXIMATE ANALYSIS AND FIBER DIMENSIONS

S. No.	Particulars		SISAL	MESTA BAST	BAMBOO	CASURINA/ EUCLYPTUS
1.	Ash	%	1.1	1.7	2-3	0.7-1.0
2.	Alcohol-Benzene Extractives	%	3.4	1.0	2-3	2-5
3.	1% NaOH Solubles	%	19.7	15.0	24-26	18-20
4.	Lignin	%	5.5	7.7	26-28	23-27
5.	Holo-Cellulose	%	84.0	89.8	69-72	70-72
6.	Pentosans	%	17.7	14.9	16-17	14-17
7.	Average Fiber length mm		2.2	2.5	2.0-2.2	0 8-1.0
8.	Fiber Diameter, Microns		10.4	10	12-15	11-15

TABLE—2

SISAL COOKING CONDITIONS AND RESULTS

S. No.	Particulars		SODA COOKS		KRAFTS COOKS	
			Cook—1	Cook—2	Cook—1	Cook—2
1.	Alkali as NaOH	. . %	5.0	5.0	—	—
2.	Alkali as Na_2O	. . %	—	—	10.0	13.0
3.	Sulphidity	. . %	—	—	17.3	17.3
4.	Bath ratio	. .	1:4	1:4	1:5	1:5
5.	Steaming time	. . Hrs	0.5	0.5	1.5	1.0
6.	Cooking time	. . Hrs	1.5	2.0	1.0	1.5
7.	Cooking temperature	°C	140	150	165	160
8.	Yield	. . %	78.0	75.4	66.6	61.8
9.	Residual Alkali (as NaOH)	. . Gpl	5.0	3.3	—	—
10.	Residual Alkali (as Na2O)	. . Gpl	—	—	7.0	9.7
11.	Permanganate No.	. .	28.3	28.0	25.5	14.5
12.	STRENGTH PROPERTIES AT 40° SR :					
a.	Burst Factor	. .	42.9	40.6	42.5	42 0
b.	Breaking Length	. . Mtrs	6500	6560	7040	7280
c.	Tear Factor	. .	139	124	130	142
d.	Double Folds	. . Nos	619	370	583	820

PULPING :

Soda as well as kraft cookings were done with different pulping conditions. The cooked material was subjected to mechanical action by running in valley beater with load for 4-5 minutes to get uniform pulp The resultant washed pulps were tested for permanganate numbers (K. No.) and strength properties.

The cooking conditions and results obtained are presented in table-2.

BLEACHING :

Bleaching of kraft pulp of K. No. 14.5 was done using CEH sequence. The bleaching conditions and results are recorded in table-3.

TABLE—3

BLEACHING CONDITIONS AND RESULTS OF SISAL KRAFT PULP

S.No.	Particulars		
1)	Unbleached pulp K. No.	%	14.5
2)	a. Chlorine dosage as Cl_2	%	4.6
	b. Consistency	%	3.0
	c. Time	Hrs	1.0
3)	Alkali Extraction stage :		
	a. Alkali dosage as NaOH	%	2.5
	b. Consistency	%	10.0
	c. pH		11.5/11.4
	d. Retention time	Hrs	1.5
	e. Temperature	°C	60-65
4	HYPOCHLORITE STAGE :		
	a. Hypo dosage as Cl_2	%	1.6
	b. Consistency	%	10.0
	c. Buffer to pH 8.5-9.0	%	0 41
	d. Temperature	°C	40-45
	e. Brightness	%	83.5
	f. Viscosity (0.5 CED)	cps	8.6
5)	STRENGTH PROPERTIES AT 40 SR :		
	a. Burst Factor		41.5
	b. Breaking Length	Meters	7380
	c. Tear Factor		101
	d. Double Folds	Nos.	49

BLENDING EXPERIMENTS :

To know the effect of blending sisal pulp with bamboo and mixed hard wood blend pulp (30 : 70), blendings were done at different proportions after beating individually to 40 SR. The resultant blended pulps strength properties are furnished in Table-5.

RESULTS AND DISCUSSION :

The proximate analysis (Vide Table-1) indicate that the lignin content (5.5%) is very less compared to bamboo and hard woods like casurina, eucalyptus, characteristic of the non-wood fibrous raw materials. The Holo-Cellulose content is very high (84%) compared to bamboo and hard woods like casurina/eucalyptus But, it is less than the mesta bast.

SODA COOKING :

The permanganate number (28.0) of soda cook pulp is on higher side though the lignin content of the material is much less. This may be due to the presense of lot of specky material present in the pulp.

The unbleached pulp burst factor and breaking length are comparable to bamboo kraft pulp while the tear factor is much better and is comparable to even soft wood pulps.

This can be attributed to the longer fibre length (2.2mm) and very high slenderness ratio (211).

KRAFT COOKING :

With 13.0% cooking chemical the pulp yield is 61.8% with permanganate number of 14.5. The yield is higher than bamboo and hard woods but less than mesta bast fiber (Vide Table-4). The tear factor is much better than bamboo pulp. But the tear factor is less than mesta bast fibre pulp. The kraft pulp can be bleached to a brightness of 80% with a total chlorine demand of about 6.0%. This facilitates to produce higher brightness pulp with better strength properties as a supplement to imported pulps.

BLENDING EXPERIMENTS :

The blending study results (vide Table-5 & Fig.1 show that the tear factor of bleached pulp (bamboo : wood-30-70) can be improved to an extent of 10-17% by blending 10-20% of sisal bleached pulp. However, this blending ratio depends Upon the individual mills requirements and overall economics.

TABLE—4

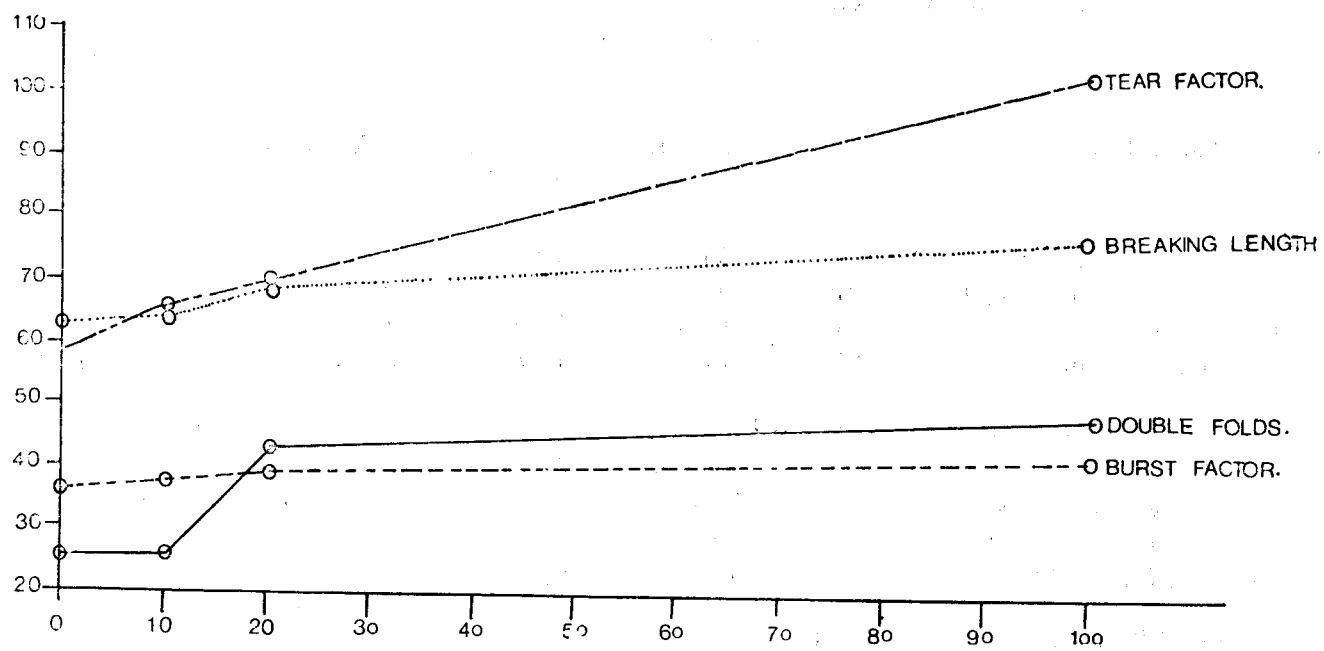
PULPING CHARACTERISTICS OF SISAL VS OTHER FIBROUS RAWMATERIALS

S. No.	Particulars		SISAL	MESTA BAST	BAMBOO	CASURINA/ EUCALYPTUS
1.	Bulk density, Kgs/M3		71	87	200	220
1.	Cooking chemical as Na_2O	%	13	10	15-16	14-15
2.	Pulp Yield	%	61.8	70.6	45-47	46-50
3.	Permanganate No.	%	14.5	15.7	21-24	16-18
4.	**Unbleached Pulp Properties at 40° SR :**					
a)	Burst Factor		42.0	46.7	32-35	37-45
b)	Breaking length, Meters		7280	7260	6000-7000	6400-8000
c)	Tear factor		142	199	90-95	55-65
5.	Bleaching Chemical % (As chlorine)		6.2	6.5	13-15	8-9
6.	**Bleached Pulp Properties at 40 SR :**					
a)	Burst factor		41.8	45.9	30-35	34-36
b)	Breaking length, Meters		7380	6420	5000-5500	6400-6600
c)	Tear factor		101	149	65-75	45-50

TABLE-5

BLENDING RESULTS OF SISAL BLEACHED PULP WITH WOOD : BAMBOO (70:30) BLEACHED PULP

S No.	Particulars	100% (wood + bamboo) Pulp	10% Sisal Pulp + 90%(wood + bamboo)	20% Sisal Pulp + 80% (wood + bamboo) Pulp	100% Sisal Pulp
1.	Burst Factor	36.4	37.0	38.2	41.8
2.	Breaking length	6320	6420	6870	7380
3.	Tear factor	59	65	69	101
4.	Double Folds	26	26	43	49



PERCENTAGE OF SISAL PULP

-----BURST FACTOR·····BREAKING LENTH(X100)---TEAR FACTOR ——DOUBLE FOLDS

CONCLUSIONS:

As the cooking chemical requirement is less and the yield, bleachability and strength properties of the sisal fibre are better compared to conventional bamboo hard woords, bagasse etc-, sisal fibre can be exploited as a promising source by encouraging extensive plantations to supplement che imported long fibre pulps. Ho wever, the overall economics depends upon the individual mills requirements,proximity to the availability of the material and the facilities available to handle this bulky material etc.

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