Mesta—A promising Indian fibrous raw material

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ABSTRACT

The Paper Industry in India is mostly dependent on the vegetable kingdom for its raw materials. Until the seventies the major fibrous raw material used to be bamboo, but due to depletion of forests and ever increasing demand for pulp and paper, the industry was forced to go in for other fibrous raw materials like hard woods and non-wood plant fibers such as grasses, straws, jutesticks, bagasse etc in a big way. However, most of the non-wood plant fibers are being used only in small/medium size mills. However, the commissioning of Tamilnadu Newsprint Ltd., based on bagasse fiber has proved beyond doubt the potential of bagasse for big mills also. Next to bagasse, Mesta (also referred to as Kenaf) is one of the promising sources of fibrous raw material in our country.

In this article, our experiences at our mills regarding Mesta plant trials conducted are presented. The plant trials have clearly indicated that Mesta kraft unbleached pulp can be admixed with conventional bamboo/hardwood blend kraft unbleached pulp to an extent of 30% without any adverse effect on strength properties or cleanliness of the final unbleached kraft paper. However, bleaching trials with Mesta pulp could not be taken up due to certain inplant constraints.

If the problems in growth, collection, storage and processing are economically overcome, Mesta may prove to be one of the promissing non-conventional fibrous raw materials for both small/medium and large paper mills, especially, in southern parts of India where it is being grown extensively.

The Paper industry in india is mostly dependent on the vegetable kingdom for its fibrous raw materials. Until the seventies the major fibrous raw material used to be bamboo but due to the depletion of forests and ever increasing demand for pulp and paper., the industry was forced to go in for other fibrous raw materials like., mixed hard woods and non-wood plant fibers in a big way.

Among the non-wood plant fiibers, grasses like Sabai, Kher and agricultural residues like Wheat/Rice straws, Jute caddies/sticks, Cotton linters, Bagasse etc , are being used by Paper industry to a small extent in certain cultural/industrial grades of papers. But, most of these materials are being used in small/medium size mills. However, later on with the tremendous amount of research work carried out around the world, bagasse has become a viable alternate source of fibrous raw material even for bigger mills for manufacture of cultural varieties and newsprint grade papers. In India, the commissioning of Tamilnadu Newsprint Ltd., based on bagasse has proved beyond doubt the potential of bagasse for paper making for large Paper units.

Next to bagasse, Mesta (also referred to as Kenaf) is one more promising source of fiber in our country. Considerable amount of work on Mesta has already been reported in literature from time to time. However, Mesta has yet to gain the popularity as did bagasse.

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The A. P. Paper Mills Ltd., in its endeavour for development of suitable alternate non-wood fiibrous raw materials for paper Indnstry, initi-ated laboratory studies way back in seventies. Mesta was one of the non-wood fibrous raw materials studied in detail. In this article our experiences regarding kraft paper production with Mesta (plant trials) at our mills are presented. However, bleaching trials could not be taken up due to certain inplant constraints.

RAW MATERIAL :

Mesta is a trade name of the fiber extracted from plants, Hibiscus Sabdariffa and Hibiscus Cannabinus. Internationally, H. Sabdariffa is known as "Roselle" and Hibiscus Cannabinus is known as "Kenaf". But in our country, Mesta is commonly used for both the species. Of the two, Roselle is more hardy and less susceptible to pests and diseases and is also higher yielding.

Mesta basically consists of two constituents :

(i) Outer bast consisting of long thin fibers

(ii) Woody (core) portion containing short thick fibers similar to jute sticks.

The bast portion is about 35-45% on dry stalk basis. Data, vide Table-1, clearly indicates a pronounced difference in chemical composition and fiber dimen ions between bast and woody (Core) portions.

TABLE—1*

Proximate Analysis and Fibre Dimensions of Different Portions of Mesta

Bast Portion 35:45%					
Sl. No.	Particulars		Whole	Wood	Bast
I.	PROXIMATE ANALYSIS				
1.	Ash	%	2.8	1.8	2.9
2.	Acid Insolubles	%	0.2	0.1	1.09
3.	Hot water solubility	%	8.0	4.8	9.4
4.	1% NaOH solubility	%	22.6	26.0	22.8
5.	Alcohol-Benzene extractives	%	2.3	4.2	2.1
6.	Lignin	%	14.0	19.4	12 5
7.	Holo-Cellulose	%	83.7	78.4	84.1
8.	Pentosans	%	18.5	22.3	18.0
II.	FIBRE DIMENSIONS				
1.	Fibre length	mm	1.67	.95	2.31
2.	Fibre diameter	microns	23	32	19
3.	L/D ratio		73	30	122

* Unpublished results of APPM R&D Laboratory studies.

For the initial trial about 80 T of green Mesta (two months old first crop) grown in wet land in Bobbili taluka of Vizianagaram Dist. in Andhra Pradesh was procured.

For the subsequent trials, about 330 T of green matured Mesta (of about four months old)was procured from the same Bobbili area.

The initial moisture content of the Mesta was very high, (65-72%), and it was found difficult to chop the material in Rag Choppers. The material was therefore allowed to air dry in the open yard for about one month before conducting initial trial. However, due to open drying the material was covered with coal dust Also during the process of sun drying with intermittent rains during September & October months the Mesta was covered with considerable amount of dirt and silica. Further, due to wet ground the material was attacked by fungus and stored Mesta deteriorated considerably. This was reflected in the proximate analysis of the Mesta (vide Table-2) i. e. higher ash, lower holo-cellulose contents, higher alkali solubility and lignin content.

TABLE—2

Proximate Analysis of Mesta Whole Used in First Plant Trial

Sl. No.	Particulars		I Trial Mesta	Normal Mesta
1.	Ash	%	6.41	1.2-2.8
2.	Acid Insolubles	%	2.87	0.06-0.20
3.	1% NaOH Solubility	%	28.1	22.6-30.3
4.	Alcohol-Benzene Extractives	%	2.5	2.3 4.9
5.	Lignin	%	18.7	13.0-14.0
6.	Holocellulose	%	75.7	83.0 84.8
7.	Pentosans	%	19.3	18.5-20.0

For the subsequent trials December 81 & March 82), the material procured in November, 81 was stored in open yerd, but much deterioration was not observed as there were no rains and the material was also mature. However, the material got covered with coal dust which subsequently got in to the system during pulping.

CHIPPING/CHOPPING :

When green Mesta was subjected to cutting in the Rag Chopper it was observed that the rotor of the chopper got jammed very severely, completely paralysing the working of chopper. Even during chopping of air dried material (10-14% moisture) following problems were encountered;

(i) Because of the bast fibers separation, frequent jamming of the feed roll and rotor was observed. However, by increasing the knife clearances, the jamming was reduced to certain extent;

(ii) Drive side bearing of the rotor getting heated up considerably even for 3-4 hr. continuous running;

(iii) Knife change was requried after every four hours;

(iv) Very low chopping rate was observed. (0.5-0.6 T/hr compared to 0.8-1 0 T/hr with waste gunny).

COOKING/PULPING

Initial laboratory studies indicated that inorder to obtain an acceptable grade pulp the following cooking conditions are required to be maintained :

Active Alkli	..... 16.0%
Cooking temperature	..... 165° C
Steaming Time	..... 90 min
Cooking Time	..... 60 min
Bath ratio	..... 1 : 6

However, due to certain practical difficulties at plant level the following conditions were adopted during the plant trial :

		I Trial	II Trial	III Trial
Chips Moisture	%	50-60	10-14	10.0
Active alkali	%	15.00	15.00	15.00
Sulfidity of white Liquor	%	20	19-22	18-22
Bath Ratio	%	1:3	1:3.8	1:3.8
Steaming time	min	60	60	60
Cooking time	min	150	150	75
Cooking Temperature	°c	150-155	150-155	160-165

Cooking was carried out in spherical rotary digester of 27 M^3 capacity. Because of bulky nature of the material, the B.D. weight of the chips charged to the digester was only 2.7-3.5T and the loading time for each digester was 4 hrs. Mesta chips were initially filled into gunny bags (each weighing 8-10 kgs (A D.) and then fed in to the digester by emptying the bags with manual paking to improve packing of the chips.

After the completion of cooking cycle, the digester was degased and the contents were washed in to the digester and then dumped in to the dump/blow pit provided with a strainer. The black liquor collected from the strainer was pumped to the pulp mill to be mixed with regular black liquor.

Considerable amount of fibers, mostly fines, passed through the strainer of blow pit were noticed in black liquor. However, no serious operational problems like foaming etc. were encountered. The analysis of Mesta black liquor is presented in Table-3.

As the earlier laboratory studies have indicated the necessity of mechanical action for defibrating, the raw pulp was passed through disc refiner of 1000 HP with a plate clearance of 0.5-0.9 mm and with an applied load of 40-50 amperes. The refined pulp freeness varied from 25-40° SR. Subsequently, the defibered pulp was washed on rotary drum washers (2 Nos in series). The mat formation was observed to be not proper and lot of foam was also encountered. The washed unbleached Mesta pulp was stored in chests and then supplied to the paper machine.

The pulp yield was observed to be about 45% in the first trial and 47% in the subsequent trials. The permanganate number was in the range of 22-29 in the firsr trial, 21-30 in second trial and 18-25 in third trial. The lower yield in the first trial may have been due to the decayed and premature state of the Mesta itself. The permanganate number has come down in the third due to increased cooking temprature i.e. 160-165°c instead of 150-155°c. maintained earlier.

The unbleached pulp yield, permanganate number (K. No) and unbleached strength properties (laboratory beater evaluation at 40° SR) are presented in Table-4.

TABLE—3

Analysis of Mesta Black Liquor

S. No.	Particulars		I Trial	II Trial	III Trial	Bamboo	Hardwood
1.	oTw at 70 °C	Range	11.5-13.0	13.0-18.0	12.5-17.5	17.0-22.5	13.5-16.0
		Average	12.5	14.5	14.0		
2.	Total Solids, Gpl	Range	144.8-155.5	143.5-235.0	136.0-205.0	173.0-236.0	150.0-180.0
		Average	149.2	184.7	167.0		
3.	T. T. A., Gpl	Range	23.6-28.7	20.9-30.6	22.5-38.8	34.5-41.0	25.0-32.0
		Average	26.0	25.6	29.2		
4.	RAA, Gpl	Range	10.2-13.2	6.2-14.7	6.2-20.9	7.8-11.6	5.4-8.5
		Average	11.7	11.7	11.1		
5.	Fiber Content, Gpl	Range	0.60-2.30	0.10-3 38	0.10-1.90	0.18-0.35	0 10-0.20
		Average	1.4	1 23	0 38		
6.	Silica Content, Gpl	Range	0.10-0.70	0.05-0.56	0 05-0.20	2.8-4.0	1.4-2.0
		Average	0.25	0 17	0.09		
7.	Organics, %	Range	48.9-53.0	48.5-53.5	47.0-50.0	51.4-57.3	54.0-60.3
		Average	51.4	49.5	48 5		
8.	Inorganics, %	Range	45.9-51.1	46.5-51.5	50.0-53.0	42.7-48.6	39.7-46.2
		Average	48.6	50.5	51.5		
9.	Calorific Value, BTU/Lb	Range	5300-5800	5250-5700	5200-5650	5300-6100	5450-6150
		Average	5600	5500	5500		

TABLE—4

Mesta Pulp Yield And Unbleached Pulp Characteristics.

Sl. No.	Particulars			I Trial	II Trial	III Trial	Bamboo:Hardwood (60:40) Pulp
1	Yield,	%		44.0	47.0	47.0	45-46
2	Permanganate No.		Range	22.3-29 0	21.0-30.0	17.7-28.1	18-22
			Average	25.2	25.1	21.2	20.0
3	Ash,	%	Range	6.7-8.5	3.2-4.5	2.2-4.4	2 5-3.5
			Average	7.8	3.9	3 1	2.8
4	Freeness,	°SR	Range	30-40	23-40	18-38	—
			Average	35	32	28	40
5	Strength Properties :						
	i) Burst Factor		Range	25-30	31-38	28-40	31-34
			Average	27.7	35 6	34.9	32.5
	ii) Breaking Length, (meters)		Range	4260-4845	5540-7183	5530-7780	5030-6060
			Average	4637	6395	6234	5650
	iii) Tear Factor		Range	51-65	63-83	62-79	75-106
			Average	57	75	71	90
	iv) Double Folds, Nos.		Range	13-47	40-235	38-205	53-190
			Average	31	162	83	90

TABLE—5

KRAFT PAPER PROPERTIES WITH MESTA FURNISH

Sl. No.	Particulars		1st Trial (Agraja)		2nd Trial (Asha)			3rd Trial (Agraja)					
1	Mesta furnish %		NIL	30	NIL	60	100	10	5	5	5	5	5
2	Quality of paper		MGPK 150	MGPK 150	MGPK 100	MGPK 100	MGPK 150	MGPK 220	MGPK 220	MGPK 150	MGPK 140	MGPK 120	MGPK 90
3	Machine speed, spm		119.127	100	100	80	65	75/76	75/76	120/125	100/115	131/142	165
4	SR box freeness °SR		33-36	33-34	28-30	28-32	32	26-28	25-32	30-32	31-35	30-35	26-32
5	Bulk, cc/gm		1.49-1.54	1.45-1.54	1.45-1.50	1.42-1.48	1.38-1.55	1.47-1.57	1.40-1.52	1.48-1.50	1.43-1.57	1.50-1.62	1.50-1.54
		Avg.	1.50	1.49	1.48	1.46	1.44	1.54	1.48	1.49	1.51	1.55	1.52
6	Burst factor		19-23	20-22	19-22	22-24	18-23	14-16	14-18	14-18	20-22	20-22	20-22
		Avg.	21	21	21	23	22	16	16	17	21	21	21
7	Breaking length, km.	MD/	4.6-5.0/	4.4-48/	4.4-5.2/	5.1-5.7/	4.7-6.7/	3.6-4.7/	3.6-4.7/	4.3-5.0/	4.4-5.4/	4 2-5.8/	3.7-4.7/
		CD	3.2-3.6	3.2-3.6	3.0-3.7	3.7-4.9	3.2-5.0	2.7-3.4	2.9-3.6	2.8-3.7	3.4-4.5	3.2-4.2	3.2-3.7
		Avg.	4.8/3.6	4.6/3.3	4.7/3.4	5.4/4.1	5.8/4.0	4.1/3.0	4.0/3.1	4.6/3.3	4.8/3.8	4 9/3.5	4-4/3.5
8	Tear factor	MD/	90-106/	80-106/	78-92/	78-90/	85-111/	63-105/	77-118/	88-98/	68-77/	64-83/	90-117/
		CD	95-110	93-109	80-95	81-94	94-117	75-115	80-117	98-107	77-19	73-97	88-120
		Avg.	93/102	90/99	80/90	83/87	96/105	90/100	93/100	93/102	72/84	89/83	99/109
9	Double folds, Nos.	MD/	130-200/	130-155/	40-110/	44-135/	124-885/	91-431/	70-383/	40-95/	46-81/	43-90/	24-94/
		CD	80-110	70-122	30-50	35-40	120-220	35-197	26-195	31-82	24-89	21-51	23-57
		Avg.	145/90	140/89	68/42	99/52	379/124	194/90	135/72	80/49	62/46	61/33	54/37
10	Cobb, g/m²	TS/	22-27/	23-27/	20-24/	20-24/	20-21/	23-28/	23-38/	26-31/	22-25/	23-26/	24-32/
		WS	29-42	34-45	24-30	35-34	34-39	48-62	49-89	42-84	26-32	29-35	40-42
		Avg.	24/34	24/38	22/27	22/30	20/36	27/53	27/67	29/62	24/30	25/32	27/41
11	Ash, %		2.2-2 8	2.8-3.7	2.6-3.0	2.5-2.8	2.4-2.6	3.0-3.5	2.6-3.4	2.2-2.8	3.2-3.4	2.7-3.1	2.8-3.3
		Avg.	2.5	3.3	2.8	2.6	2.5	3.2	3.0	2.5	3.3	2.9	3.0

Note : MG PK—MG Plain Kraft

PAPER MACHINE OPERATIONS :

I Trial :

In the first, trial Mesta pulp was mixed with bamboo-mixed hardwood pulp (60 : 40) in 30 : 70 proportion and about 21 T of MG Plain Karft of 150 GSM was made on our No. 2 (AGRAJA) machine. During this run no serious problems were encountered regarding the runnability of the paper machine. However, the machine was run at a slightly reduced speed, 100 metres/min as against normal 120 metres/min.

The strength properties of the kraft paper were normal and the clean liness was also satisfactory. Sli ght sizing problem was experienced : but, the over all quality of the kraft paper was satisfactory.

II Trial

In the second trial about 7 T of MG Plain kraft 100 GSM was made on No. 1 (ASHA) machine with 60% Mesta. The bamboo hardwood blend (60 : 40) Pulp was refined separately and then blended with refined Mesta pulp in 60 : 40 (Mesta - bamboo-hardwood) propertions. The Mesta pulp was not further refined in the stock prepartion as the incoming pulp freeness was in the range of 30-40° SR. However, the blended stocks was passed through the brushing refiner without load

The paper made with 60% Mesta furnish had good properties but the paper was quite specky with lot of black spots. An increase in rosin and alum consumption, 1.2% and 5% respectively compared to normal dosage of 0.9% of rosin and 4.5% of alum was observed for maintaining the normal level of sizing and cobb.

With 60% Mesta in furnish the paper machine speed was reduced to 80 m/min as compared to the normal speed of 100m/min. Another problem encountered during this trial was regarding the need for frequent felt cleaning due to the presence of more dirt and shives.

An attempt was made to run 100% Mesta pulp also on this machine itself. In the initial stages the paper could not be passed for sometime due to very high hydration of Mesta pulp preventing proper water drainage in the fourdrainer section leading ultimately to felt Plugging and crushing. After changing the felt and further reducing the speed to 65 m/min, runnability improved and some paper could be made. However, the quality was drastically affected. Lot of variation in basis weight and very poor cleanliness were the major Problems, but the strength properties were normal. Henee, it was converted to mill wrapper.

III Trial :

In this trial about 680 T of defence kraft paper 90-240 GSM was made with 5-10% of Mesta pulp in furnish on No. 2 (AGRAJA) machine. No adverse effect on chemical and physical properties of MG Defence kraft paper with the inclusion of Mesta pulp (5-10%) in the furnish was observed. The paper properties are furnished in Table — 6.

TABLE—6

Chemical Analysis of MG Kraft Paper

Sl No.	Particulars	Tolerance limit	Without Mesta	With 5-10% Mesta
1.	Hot Water pH	5.5-7.5	6.0-6.9	6.1-6.3
2.	Chlorides as NaCl, %	0.05	0.024-0.028	0.024-0.028
3.	Sulfates as Na_2SO_4, %	0.25	0.073-0.091	0.091
4.	Alkalinity as $CaCO_3$, %	2.0	1.104-1.710	1.68-1.80
5.	Fattyacids, %	0.25	0.150-0.178	0.178

CONCLUSIONS :

1. Mesta plant has roots and leaves to an extent of 15% which do not have much fibre value. These should be removed in the field itseif to avoid process problems.
2. Since Mesta is bulky in nature and occupies a large volume it should be packed and baled properly before transporting to mills site.
3. As Mesta tends to deteriorate on open storage, especially when it comes into contact with moist earth; proper storage methods are to be adopted.
4. It is preferable to allow Mesta to air dry at the field itself before transportation to reduce the costs and minimise the storage and cutting problems at mills.

5. As chip size and uniformity of the materials is very important, proper choppers/ cutters are to be designed/developed to handle such heterogeneous material effectively.

6. As the bulk density of chopped Mesta is very low 90-100 kg/m³ compared to bamboo and hardwood chips of 200-240 kg/m³ the digester pulp output will be low. This can be overcome to certain extent by adopting "cubing" of chopped Mesta.

7. Slight mechanical treatment / refining is needed after cooking to reduce the shives and to get cleaner pulp.

8. Mesta kraft unbleached pulp can be admixed with conventional bamboo/hardwood blend pulp up to 30% without any adverse effect either on strength properties or cleanliness.

9. Strength properties of Mista pulp especially Burst Factor and Tensile strength are quite comparable with those of bamboo pulp and that Tear factor is comparable to that of mixed hard wood pulp.

10. Operation of paper machine with 100% Mesta pulp alone is observed to be difficult due to very high hydration unless proper modifications are made on fourdrainer part and at stock preparation stage.

Hence, if the problems in growth, collection, storage and processing are economically overcome, Mesta can prove to be one of the promising non-conventional raw materials for both small and medium as well as bigger paper mills especially in Southern part of India, where it is grown extensively.

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