Chemi-mechanical Pulping of Mesta Core for Quality and Newsprint Grade Papers

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ABSTRACT: *Mechanical pulping of the chemically treated core part has been carried out using laboratory double disc refiner. The pulp after screening has been bleached in two stage H_2O_2 treatment and then blended from 10 to 40% with bamboo-hard wood bleached pulp. The bleached core pulp has also been blended with best fibre chemical pulp from 10-50%.*

From the results of physical strength properties of the hand sheets made out of the blended pulps, it is inferred that the core part can be utilized for both quality and newsprint grade papers; core fraction can be upto 30% for quality paper and 50% for newsprint grade paper.

INTRODUCTION

Mesta as one of the future potential sources of raw materials in paper manufacture, is being actively considered since few years both in India (1, 2) and abroad (5, 6). The various pulping processes studied are:

Mechanical pulping of whole mesta	(1, 2)
Chemical pulping of whole mesta	(6)
Chemical pulping of bast fibre	(5)

Perusal of literature showed that process for separate pulping of mesta core part has rarely been studied. In India, after separation of the bast fibre (retting) the core part is found to have very limited use as fuel in rural areas and can be considered almost as a waste material. As the bast fibre has been in use commercially as cortage fibre (5), the problem of collection and transport of core part in large scale, should not therefore, pose any serious problems for large scale utilisation. The amount of bast fibre produced annually in India is 2.17 lakh tons and with 65-70% of core, it is estimated to be 5.05 lakh tone. It was considered, therefore worthwhile undertaking a separate study for the mesta core part alone.

EXPERIMENTAL

Mesta was collected from Parvathipuram area of Andhra Pradesh for the present study. The air dry core material and bast fibre were cut separately into 1-2 inch size manually. The chopped materials were powdered separately in a laboratory Willey grinding machine and screened through 40 and 60 mesh screens. The accepted fraction of bast fibre and core powders were taken for chemical analysis.

Pulping of the core part was carried out in a laboratory Rotary digester of 20 litres capacity. The chips were treated with 2% sodium sulphite for one hour at 120°C and bath ratio was kept as 1:2.7.

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The digested chips were passed through laboratory Sprout waldren 12" double disc refiner at four passes i.e. at 80, 60, 20 and 5 thou respectively. The spent liquor after the first pass was analysed for the C.O.D. and total solids.

The refined material was then screened in a laboratory vibrating screen to separate the sieves.

The resultant pulp was then beached with two stage hydrogen peroxide upto a brightness of 68 ±1% El.

Mesta bast fibre chips were cooked with 10 % active alkali for four hours (hold time at maximum temperature = 2.0 hrs) at 160°C. Bath ratio was kept 1:5. The resultant pulp after proper washing was bleached by CEHH sequence to 68 ± 1% El brightness.

Resultant mesta bast bleached pulp was beaten in a laboratory Valley beater to 40° SR and blended with bleached chemi-mechanical core pulp proportionately. Hand sheets from different blends after conditioning was tested for physical strength properties.

Mill bleached pulp (bamboo : hard wood = 80 : 20) was beaten in laboratory Valley beater to 40° SR and blended with bleached chemi - mechanical core pulp proportionately. The corresponding hand sheet from different blends was tested for optical and physical strength properties. Opacity was tested using Elrepho brightness tester at 557 nm and smoothness, porosity was determined using Bendsten smoothness and porosity tester.

RESULTS AND DISCUSSION

According to proximate chemical analysis of mesta bast fibre and the core part (Table 1) 1% NaOH and alcohol-benzene solubilities in the core part are more than double than in the bast fibre. Lignin content in the fibre is 8.9% while in core part, it is as high as 17.5%. The low extractive and lignin contents in bast fibre make it favourable for obtaining bleachable grade pulp with lower requirement of cooking and bleaching chemicals. The ash content in the core part is, on the other hand, quite low (1.15%) compared to the fibre part (2.58%).

Table 1.

Proximate chemical analysis			
Particulars		Mesta bast fibre	Mesta core
1% NaOH solubility,	%	14.26	30.1
A-B solubility,	%	1.45	4.6
Holocellulose,	%	89.2	82.4
Klason lignin,	%	8.94	17.5
Pentosan,	%	---	22.75
Pith,	%	---	27.80
Ash,	%	2.58	1.15

Fibre dimensions

	Bast fibre	Core
Average fibre length, mm.	2.65	0.7
Average fibre diameter, micron	20.5	31.6

Fibre length of mesta core, though lesser than the fibre part, it is comparable to that of hard woods. The fibre diameter of the core is on the other hand, higher than the fibre. Fibre length of mesta bast fibre is comparable to that of soft woods. Length to diameter ratio is quite less in case of mesta core indicating these by lesser fibre flexibility.

Pulping of mesta core was carried out with 2% sodium sulphite at 120°C. Pulp yield was 84% (Table 2). After sequential refining, the pulp reached to a freeness of 35° SR. The spent liquor, after first stage of refining, had low COD (1250 ppm) as well as solid content (1436 ppm).

Table 2.

Mechanical pulping of mesta core		
Particulars		Results
Chemical applied (Na_2SO_3),	%	2.0
Bath ratio		1 : 2.7
Cooking temperature,	°C	120
Time to cooking temperature,	hrs	0.5
Time at cooking temperature,	hrs	1.0
Total pulp yield,	%	84.0
Refining sequence		
80 thou		one pass
60 thou		one pass
20 thou		one pass
5 thou		one pass
Spent liquor analysis		
Total solids,	ppm	1436
Total dissolved solids,	ppm	1164
Total suspended solids,	ppm	272
C.O.D.		1250

The bleaching consisted of peroxide treatment in two stages. $MgSO_4$ and Na-silicate have been added in 0.5 and 1% respectively. The stabilising effects of these chemicals on H_2O_2 is well known. Bleaching studies of mesta core pulp (Table 3) show that the brightness of 68% El can be achieved. Addition of ~2% H_2O_2 for mechanical pulp in two stages has been reported earlier (8) and therefore similar conditions were maintained.

Table 3.

Bleaching of core pulp

Particulars		Results
PEROXIDE-1 State		
H_2O_2 applied,	%	2.0
Sodium Silicate applied,	%	1.0
$MgSO_4$ applied,	%	0.5
Caustic applied,	%	0.6
Consistency,	%	10.0
Temperature,	°C	45
Retention time,	hrs	3.0
H_2O_2 consumed,	%	1.34
PEROXIDE-2 Stage		
H_2O_2 applied,	%	1.5
Sodium Silicate applied,	%	1.0
$MgSO_4$ applied,	%	0.5
Caustic applied,	%	0.6
Consistency,	%	10.0
Temperature,	°C	45
Retention time,	hrs	3.0
H_2O_2 consumed,	%	1.35
Brightness, (El)	%	68.2

Kraft pulping studies of mesta bast fibre (Table 4) indicate that the pulp yield is 64.4% which is higher than any conventional raw material at same kappa number (25 ± 1). Cooking chemical demand is lesser here due to low lignin and extractive content in the raw material. The unbleached pulp consumed 7.63% total chlorine to attain a brightness of 66.7% El (Table 5).

Table 4.

Chemical pulping of bast fibre

Particulars		Results
Active alkali applied as Na_2O,	%	10.0
Sulphidity of cooking liquor,	%	17.2
Bath ratio		1 : 5
Maximum temperature,	°C	160
Time to maximum temperature,	hrs	2.0
Time at maximum temperature,	hrs	2.0
Total yield,	%	64.4
Kappa no.,	no.	25.4

Table 5.

Bleaching of bast fibre pulp

Particulars		Results
Pulp kappa no.		25.4
Chlorination		
Cl_2 applied,	%	4.7
Cl_2 consumed,	%	4.68
End pH		2.1
Alkali extraction		
Caustic applied,	%	1.6
End pH		9.3
Hypo-1 stage		
Hypo applied as average Cl_2,	%	2.0
Buffer applied as NaOH,	%	0.25
Hypo consumed as average Cl_2,	%	2.0
Retention time,	hrs	4.0
Hypo-2 stage		
Hypo applied as average Cl_2,	%	1.0
Retention time,	hrs	1.0
Hypo consumed as average Cl_2,	%	0.95
Brightness (El),	%	66.7
P.C. No.,	no.	9.4

Strength properties of bast fibre pulp at 40° SR and its blending with bleached core chemi-mechanical pulp is presented in fig. 1. It can be seen that the bast fibre pulp has very high strength; the tensile (77.5), tear (8.91) and burst (6.25) index values are better than that in soft wood pulp. It can therefore be safely used alone or as a furnish mix for manufacture of quality papers.

Substitution of bast fibre pulp by core chemi - mechanical pulp decreases the strength properties. Increasing mesta core pulp in the furnish increases the bulk steadily, which is a positive sign for manufacture of newsprint grade pulps using core pulp 40% substitution of bast fibre pulp by core pulp is tolerable for manufacture of writing and printing papers. At 50% substitution, the furnish is best suitable for newsprint grade pulp as it has very high bulk (2.89); formation remain uniform and lint free upto 50% substitution.

Strength properties of bamboo + hard wood pulp (80 : 20) at 40° SR and its blending with core chemi - mechanical pulp is presented in Fig. 2.

Burst, tensile index and double fold values decrease proportionately with increase in core pulp in the furnish. Bulk increase steadily with increase in core pulp in the furnish. Tear index remain more or less same. At 40% substitution with bulk (2.56), tensile (32.6), burst index (1.47), the furnish is suitable for manufacture of newsprint. Formation of hand sheet is uniform and lint free in all sets. At 30% substitution with tensile (36.3) and burst index (1.88), the furnish can be used for manufacture of low grade writing and printing papers.

Printing, smoothness and porosity are properties quite important for newsprint grade of paper. Surface properties of hand sheets made from bast fibre and core pulp are given in Table 6 and of bamboo-hard wood mixed pulp with mesta core in Table 7. The printing opacity (3) of newsprint grade paper (7) are reported to be 90-93%. It can be seen in Table 6 that furnish having 30-50% core pulp are in this range and 3040% core pulp with bamboo-hard wood mixed pulp (Table 7). The smoothness values are however, comparatively found to be in the higher side. The porosity values of newsprint grade paper (280-1100 ml/min) are satisfied by these two sets of furnishes also.

Table 6.

Surface properties of bast fibre + core pulp

Furnish		Printing opacity	Smoothness	Porosity
Bast fibre(%)	Core pulp (%)	(%)	(ml/min)	(ml/min)
100	0	77.2	300	60
90	10	80.3	1100	75
80	20	88.4	1200	320
70	30	90.3	1250	320
60	40	92.9	1800	800
50	50	93.4	1900	1000

Table 7.

Surface properties of (bamboo+hardwood)+core pulp.

Furnish		Printing opacity	Smoothness	Porosity
Bamboo+hardwood(%)	Core pulp (%)	(%)	(ml/min)	(ml/min)
100	0	80.0	280	90
90	10	84.9	400	160
80	20	87.8	1100	340
70	30	91.2	1300	340
60	40	93.3	1800	1100

ECONOMICAL FEASIBILITY

1. In view of the dwindling forest resources, the cost of wood raw material is bound to increase in future. In such circumstances, use of alternative source of raw material, should be made imperative in our country. Mesta is considered one such raw material for the future.
2. The core part is presently used only as fuel in rural areas. Its cost is difficult to calculate as it has no industrial use presently. It is certain that its cost is low compared to wood or the bast fibre.
3. The only cost it will incur is during chemi-mechanical pulping process because of electrical energy and chemical consumption.
4. Therefore, addition of core pulp to the bast fibre (Table 6) can only bring down the cost of the furnish.
5. Addition of core pulp to bamboo-hard wood mixed pulp will have similar repercussion on total cost of furnish.

CONCLUSIONS

1. The core part of mesta has much shorter fibre (0.7mm) than the bast fibre (2.65mm) but the diameter of the core part is 31.6 in stead of 20.5 micron in bast fibre.
2. The mesta core pulp could be produced by chemi-mechanical process.
3. The core can be added upto 50% with bast fibre and upto 40 % with bamboo - hard wood pulp for producing newsprint.
4. Addition of core improves the printing opacity and smoothness values.

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