SUITABILITY OF HOME GROWN PAPER MULBERRY (*BROUSSONETIA PAPYRIFERA*) FOR PULP AND PAPER MANUFACTURE

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ABSTRACT

Paper mulberry (*Broussonetia papyrifera*) wood and bark may be successfully pulped by Kraft, Soda and Alkaline Peroxide Mechanical Pulping (APMP) processes. Kraft pulp from Paper mulberry whole wood has the superior strength properties compared to the Soda or APMP pulps. However, APMP process gives the higher yield than Soda or kraft pulps. High yield pulp from Paper mulberry bark may be used for the supplementation to the hardwood or nonwood pulps to improve their tear properties. The present study fully justify the establishment of Paper mulberry plantations on private and government land in the country.

INTRODUCTION

Paper mulberry (*Broussonetia papyrifera*) is one of the fastest growing hardwood species and has tremendous potential for use in pulp and paper. It is naturalized in India, China, Japan and the southern U.S.A (FAO,1980). It is extensively cultivated in East Asian countries for its bark and is planted as a source of pulpwood in India. To test its suitability for pulp and paper, pulping trials have also been made in Zimbaway and Uganda. The bast fibers in bark are used in Japan for the preparation of extremely strong and high quality paper (Bhat and Guha,1952; Streets, 1962; FAO,1980). In Pakistan, Paper mulberry is found in Peshawar, Islamabad extending to Gujrat and Lahore in the south and is very aggressive in its growth.

Paper mulberry has not yet been used commercially in Pakistan. Rather it is a least favoured species as being an obnoxious weed and poses strong competition to other forest crops. In the past no attention has been given to find out its suitability for various end uses. However, large scale Paper mulberry plantations are not raised in any part of country to produce sufficient wood for industrial and other uses. In literature, different uses of Paper mulberry are reported for the manufacture of a variety of products such as chipboard (Akbar, 1994) match sticks and inner bark is used for the manufacture of Tapa (FAO,1980).

Paper mulberry plantations can be easily raised in Pakistan. It can regenerate by seeds, root suckers and also by coppice. Direct sowing may give satisfactory results but stumps and transplant are probably the sorest method of regeneration. About 17 grams of seed may be enough to transplant one hectare at 2 x 2 m spacing (Bhat and Guha, 1952). Birds play an important role in its regeneration. Yield of about 15 tons of air dry wood can be obtained from one hectare plantation over a 10 year rotation, but in areas of higher rainfall a higher yield can be expected (Bhat and Guha,1952).

In order to highlight the commercial importance of home-grown Paper mulberry for paper manufacturing, a study was undertaken at the Pakistan Forest Institute, Peshawar to find out the suitable pulping techniques, optimum pulping parameters and to evaluate the physico-mechanical properties of the paper manufactured from home grown paper mulberry.

MATERIALS AND METHODS

In order to find the pulping characteristics of Paper mulberry, 7 year old tree was taken from Pakistan Forest Institute Research Garden and converted into 4 logs. Two logs were debarked and

chipped by using a two knife Appleton chipper. Bark from these logs was separately chipped manually. Remaining two logs were converted into chips with bark. All the three types of chips were screened through Sweden made classifier " STAFFI". N^3 fraction was used for pulping trials. Paper mulberry chips of debarked wood, bark and whole wood were pulped by using Kraft, Soda and Alkaline Peroxide Mechanical Pulping (APMP). Pulp from bark was mixed with *Eucalyptus camaldulensis* and *Populus deltoides* chemical pulp in different furnishes. The main purpose of blending the Paper mulberry bark was to investigate the possibility of using paper mulberry bark as a substitute of imported long fiber pulp in pulp furnish. At the end, pulping and papermaking characteristics of Paper mulberry wood and bark were compared with the pulping properties of other fast growing species like *Eucalyptus camaldulensis* and *Populus deltoides*.

RESULTS AND DISCUSSION

Fiber length of paper mulberry wood is in the normal range for hardwoods for pulping. It ranges from 0.82 to 1.01 mm (FAO,1980; Ayaz,1962). Fiber diameter ranges from 22 to 30 microns. Paper mulberry fibers are highly flexible (flexibility ratio 0.73) and have a low Runkel ratio (0.38). Greater the fiber flexibility and lesser the Runkel ratio, better the chance of forming well-bonded papers (Casey,1980). Fiber length of Paper mulberry bast fibers ranges from 2.6 - 10.0 mm with an average fiber length of 6.75 mm, more than the fiber length of softwoods. Suitable fiber length, higher flexibility ratio and lower Runkel ratio, all these characteristics clearly indicate the suitability of Paper mulberry wood and bark for pulp and paper manufacture (Nicolas and Navrro, 1964; Nicolas *et al*, 1970).

Paper mulberry debarked wood gives a cooked yield of 47 percent by using 18 percent active alkali and 25 percent sulphidity (Table 1).

Soda bark pulp can increase the tearing strength of eucalyptus and poplar chemical pulp from 6.56 to 9.74 $mN.m^2/g$ and 6.89 to 10.82 $mN.m^2/g$ respectively (Table 2). However, the bonding-properties decrease with the increase in soda bark pulp in the furnishes. Present findings are confirmed by the earlier reported work on paper mulberry and inclusion of pulp from bark to improve the tear strength of the paper (Bhat and Guha, 1952).

From Table 3, it is clear that basic density of paper mulberry is higher than the basic density of poplar wood but lesser than the eucalyptus wood (Suleman and Nadeem,1990; Akbar, 1994). Basic density of fast growing species is generally low. Such a low density fast growing species are more economical giving high pulp yield and have better paper properties (Logan, *et al*,1984). Paper mulberry wood has shorter fiber length as compared to poplar but it is significantly higher than eucalyptus. Yield of kraft pulp from Paper mulberry is equivalent to the poplar wood. Kraft pulp from bark fibers have high tear strength and may be used as substitute of imported long fiber pulp for supplementation to the non-wood and hardwood chemical pulps. It may be inferred that paper mulberry has better pulping characteristics than eucalyptus kraft pulp but poor properties compared to the poplar wood.

If adequate wood supply is ensured through extensive cultivation of paper mulberry, bast fiber pulp may become the best substitute of imported long fiber pulp, which is a necessary component of all grades of paper to increase the tearing strength of the paper and paper products. Import bill of long fiber can be reduced to a greater extent by using bast fiber pulp as a substitute. Paper mulberry wood pulp is short fibered pulp. An addition of 25 percent of long fibered pulp is necessary to the pulp furnish for successful commercial paper making (Bhat. *et al*, 1952). However, if paper mulberry tree is pulped without debarking then the need of long fiber portion can be reduced to greater extent.

Table 1. Pulping Conditions and Evaluation of Products from Paper Mulberry

Pulping process	Cooking time (mins)	Cooking temp. (°C)	Cooked yield (%)	Freeness (SR°)	Bulk (cm^3/g)	Tensile index (KN.m/kg)	Tear index ($mN.m^2/g$)
Bark							
Kraft pulping (13% A.A at 25% sulphidity)	120	170	38.5	-	1.53	47.50	24.10
Soda pulping 10% A.A	60	170	40.0	35	1.61	37.09	31.3
AMP (10% NaOH & 2% H_2O_2)	24 hours room temp.		80.0	29	1.25	46.91	17.2
Wood (debarked)							
Kraft pulping (18% A.A at 25% sulphidity)	120	170	47.0	29	1.12	40.73	3.8
				42	0.87	53.14	3.3
				62	0.75	58.45	3.1
APMP (10% NaOH & 2% H_2O_2)	24 hours room temp.		90	65	1.09	48.73	4.9
Whole wood							
Kraft pulping (15% A.A at 25% sulphidity)	170	53.2	28	0.92	55.73	55.73	5.5
			43	0.67	67.94	67.94	5.7
			66	0.59	0.59	72.11	5.8

Table 2. Blending of Pulp from Paper Mulberry Bark with other Hardwood Pulps

Blends	Ratio	Freeness (SR°)	Bulk (cm^3/g)	Tensile index (KN.m/kg)	Tear index ($mN.m^2/g$)
P.M. bark: Euc. kraft	20:80	60	0.80	47.01	9.74
Soda pulp	0:100	65	1.23	72.60	6.38
P. bark: Pop. kraft	20:80	60	0.92	43.16	10.82
Soda pulp	0:100	65	1.28	95.50	8.04
P.M. bark: P.M. wood	20:80	60	1.08	48.90	9.16
Soda: kraft	10:90	60	1.01	56.52	5.79
CMP: kraft	20:80	58	1.09	48.73	9.14
	10:90	60	1.31	41.27	7.12
P.M. whole wood kraft pulp	0:100	66	0.59	72.11	5.80

Table 3. Comparison of Physical, Anatomical and Pulping Characteristics of Three Fast-Growing Hardwood Species

	Paper mulberry		Eucalyptus	Poplar
	Whole wood	Bark	(*E. camaldulensis*)	(*P. deltoides*)
Basic density (kg/m^3)	480	-	546	464
Fiber length (mm)	0.82-1.01	2.6-10.0	0.81	1.07
Fiber diameter (μ)	22.30	28.13	14.80	25.20
Wall thickness (μ)	3.00	3.98	3.24	3.74
Runkel ratio	0.38	0.39	0.77	0.42
Active alkali (%)	15	13	15	15
Sulphidity (%)	25	25	25	25
Cooking temp. (°C)	170	170	170	170
Yield (%)	53.20	38.50	48.85	53.06
Freeness (SR°)	65	-	65	65
Bulk (cm^3/g)	0.59	1.53	1.23	1.28
Tensile index (KN.m/kg)	72.11	47.50	72.60	95.50
Tear index (mN.m^2/g)	5.8	24.10	6.38	8.04

It is concluded from the results that paper mulberry wood can be pulped without debarking by using 15 percent active alkali at 25 percent sulphidity. Alkaline peroxide mechanical pulping (APMP) is the most suitable pulping process to manufacture high yield pulp from paper mulberry bark. On the basis of present findings, it can be concluded that Paper mulberry is a suitable woody raw material for pulp and paper manufacturing. Its bark may be used to manufacture long fiber pulp for supplementation to the short fibered non-wood or hardwood pulps. It is therefore recommended that efforts should be made for the establishment of paper mulberry plantations on government as well as private land.

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