# BAMBOO AS A SOURCE OF LONG FIBER PULP IN PAKISTAN.

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## ABSTRACT

Three home-grown bamboo species (*Dandrocalamus hamiltonii, Dandrocalamus strictus* and *Bambusa tulda* ) were pulped by soda process to investigate their pulping potential as a source of long fiber pulp in Pakistan. All the species can be pulped by soda process. *D. hamiltonii* gave the highest yield and the best tearing strength properties. Tearing properties were comparable to the kraft pulp made from *Pinus roxburghii* and imported Southern pine kraft pulp. However, the bonding properties of bamboo pulp were inferior to the softwood kraft pulp. This paper also gives the salient advantages of bamboo pulping over softwoods.

## INTRODUCTION

Pulp and papermaking is one of the most important and economic aspects of bamboo utilization in Southeast Asian countries (Tamolang.*et.al* 1980). Since 1909, bamboo is utilized as a staple fibrous raw material in pulp and paper industry in many countries. Attractiveness of bamboos as raw material in pulp and paper industry is due to its rapid growth, easy availability (Vermah and Bahadur, 1980), better fiber characteristics, pulping suitability and their versatility in manufacturing various grades of paper. All these factors have contributed to the increased use of bamboos in papermaking.

Suitability of bamboo species has been evaluated for various grades of pulp and paper and for different pulping process (Guha,1961; Guha.et.al, 1975; Guha and Pant,1961; Karnick,1961). As a result of these investigations, use of bamboo pulp is expected to increase in future. The future role of bamboo chemical pulp may be as a cheaper substitute of long fiber pulp, which is always an essential part of furnish in a better quality paper. Increase in the use of bamboo chemical pulp is expected to grow in future in the light of environmental regulation and consequent ban on logging in some areas. Normally, 10-40 percent long fiber pulp is blended to manufacture various grades of paper. This is necessary both to contribute desired strength properties, such as tear strength to the product and also to assist wet-end running condition, particularly, on light weight papers produced at high speed. Presently, more than 10 million tons of bamboos are produced annually in the world (Sharma,1980) and 50 percent of the total non-wood pulp is manufactured from bamboo.

In Pakistan, bamboo species were grown on trial basis in different parts of the country mostly Punjab after 1971 war. As a result of these trials, Pattoki (KASUR), Sargodha and Mandibhaudin emerged as the promising sites in Punjab areas for the cultivation of *Dandrocalamus hamiltonii* and *Bambusa tulda*. Farmers actively participated in bamboo cultivation to avail the benefits of gap between demand and supply of bamboos in the country. Soon, Pakistan attained the self-sufficiency in variety of products manufactured from

bamboos. Furthermore, Pakistan also targeted the Middle East bamboo market particularly in the market segment of bamboo used for tent poles. Pakistan started producing surplus bamboo in Eighties. Surplus bamboo supply could not find its place in the international market due to strong competition from big bamboo producing countries. These market constraints highly influenced the farmers' decision in planting more bamboo on their lands. Most of the farmers uprooted the stumps and developed a negative opinion about bamboo propagation. In case of surplus bamboo production in the country, strategies should have been developed to find out the new markets abroad or to create the new demand in domestic industries like pulp and paper and board industries for which the bamboo is suitable raw materials.

The main objective of the present study is to evaluate the pulping potential of home-grown bamboo species and to identify their uses as a source of long fiber pulp to supplement non-wood pulp.

## MATERIALS AND METHODS

To investigate the suitability of different home grown bamboo species for pulp and paper manufacture, three bamboo species (*Dandrocalamus hamiltonii, Dandrocalamus strictus* and *Bambusa tulda*) were selected for soda pulping. Six mature bamboo clums, two from each species were collected from Pakistan Forest Institute Research Garden, Peshawar. Bamboo clums were converted into chips and classified in STAFFI classifier. N3 fraction of chips was used for soda pulping by using 20 percent sodium hydroxide on oven dry basis. The chips were digested at 165° C for two hours. Chips liquor ratio was kept at 1:6 during digestion. Physico-mechanical properties of soda pulp were determined according to TAPPI Standard Method T-220-03-71.

Pulping properties of Bamboo species were compared with the pulping characteristics of kraft pulp manufactured from *Pinus roxburghii* (Siddiqui, 1981) and imported kraft pulp from Southern pine. In order to evaluate the economical benefits of bamboo pulping over pine pulping in Pakistan, market prices of bamboo and pine wood were obtained from the local markets. Information about the advantages of bamboo pulping over softwood pulping were collected from literature.

## RESULTS AND DISCUSSION

From the results shown in Table 1, it is clear that *D.hamiltonii* has the highest yield 51.28 percent and the best tearing strength at freeness, 31 SR°. Better yield of *D. hamiltonni* may be due to its higher cellulose content than other two species (Casey, 1980). However, *D. strictus* soda pulp has the maximum bonding properties at 41 SR°. Comparatively lower Runkel ratio ( 1.37) of *D. strictus* may be regarded as the major contributor to the bonding properties. *D. hamiltonii* and *B. tulda* have Runkel ratio, 1.94 and 2.18 respectively. Tear properties declines if the pulp is beaten more than 30 SR. Better tearing properties of *D.hamiltonii* soda pulp may be explained on the basis of its higher fibre length ( 2.91 mm) than *D.strictus* (2.24 mm) and *B.tulda* (2.41 mm),( Anon 1990).

Table 1. Pulp and Paper Making Properties of Three Bamboo species

| Species | Cooked yield % | Freeness SR | Bulk $cm^3$ | GAR Sec/100 ml | Breaking Length (m) | Tear Factor | Stretch % | Folding Endurance D.F. |
|---|---|---|---|---|---|---|---|---|
| B.tulda | 49.91 | 16 | 1.22 | 1 | 2733 | 115 | 1.40 | 4 |
| | | 26 | 1.18 | 2 | 4166 | 154 | 1.50 | 27 |
| | | 42 | 1.10 | 39 | 5944 | 151 | 2.20 | 166 |
| *D.hamiltonii* | 51.28 | 15 | 1.64 | - | 2255 | 111 | 2.00 | 4 |
| | | 31 | 1.28 | 9 | 4944 | 200 | 2.50 | 127 |
| | | 41 | 1.15 | 52 | 5995 | 178 | 3.20 | 237 |
| *D.strictus* | 48.40 | 21 | 1.15 | - | 3826 | 124 | 1.50 | 22 |
| | | 30 | 1.10 | 5 | 4720 | 145 | 1.80 | 52 |
| | | 41 | 0.96 | 37 | 7066 | 124 | 2.50 | 108 |

Higher tearing strength of *D.hamiltonii* compared to the other bamboo species confirm the relationship between fiber length and tearing strength. Fold, stretch and Garley properties improve while the bulk decreases with the increase in SR° value. From the results it appears that if bamboo pulp is to be added in pulp furnish to improve the tear strength, then bamboo pulp should not be beaten more than 30 SR°.

Table 2. Properties of Bamboo Pulps as Compared to Softwood Pulps.

| | Bamboo Pulps (Soda) | | | Soft wood Pulp (kraft) | |
|---|---|---|---|---|---|
| | *B.tulda* | *D.hamiltonii* | *D.strictus* | *Pinus roxburghii* | Southern pine U.S.A |
| Yield% | 49.51 | 51.28 | 48.40 | 44.2 | 43.2 |
| S°R | 41 | 41 | 41 | 45 | 45 |
| Bulk $cm^3/g$ | 1.10 | 1.15 | 0.96 | 1.48 | 1.53 |
| Burst Factor | 50 | 53.30 | 68 | 77 | 44 |
| Breaking Length (m) | 5944 | 5995 | 7066 | 9200 | 7400 |
| Tear Factor | 151 | 178 | 124 | 138 | 90 |

In Table 2, pulping characteristics of bamboo soda pulp from three home-grown species have been compared with the pulping properties of *Pinus roxiburghii* (Siddiqui, 1981) which is an indigenous species in Pakistan and imported kraft pulp from Southern Pine. Yield of bamboo soda pulp is comparatively higher than the kraft pulp from softwoods. No doubt, softwood kraft pulp

have higher breaking length but tear strength of bamboo soda pulp are comparable to the softwood kraft pulp. Bulk of bamboo pulps are comparatively lower than the softwood pulp.

These results also clearly indicate that bamboo soda pulp may be included in pulp furnishes to increase the tear strength of the paper. On the basis of present study it is suggested that *D. hamiltonii* chemical pulp should be preferred for supplementing to the short fiber pulp for the enhancement of tear strength of paper. Generally, all the three bamboo species may be used for the manufacture of long fiber pulp.

Bamboo fibers are longer than those of hardwoods but are shorter than those of most of coniferous woods (Vermah and Bahadur, 1980). Bamboo fiber is rather characteristics in developing the maximum strength properties within a short beating time and require less than 50 percent time as against coniferous kraft pulp (Anon, 1962), because bamboo fibers are more slender and have higher lumen width (Clark,1978). In many respect bamboo offers advantages

Table 3. Advantages of Bamboo Pulping over Softwood Pulps.

| Characteristics | Bamboos | Softwoods |
|---|---|---|
| Market Price Rs/Ton | 2000-3000 | 9000-10,000 |
| Productivity Tons/ hectare/year | 15 | 10* |
| Rotation (year) | 4-6 | 25- 60 |
| Ability to Coppice | Yes | Nil |
| Debarking | No Need of debarking | Debarking needed |
| Charge Capacity Benefit % | 120 | 100 |
| Bleaching | Easy three stage bleaching | More than three stage bleaching |
| Beating Time | Short beating time | Longer beating time |
| Yield % | 40-50 | 40-45 |
| Environmental Status | Sound | Poor |
| Recurring Management Expenses | Low | High |
| Harvesting, Transportation | Easy | Difficult |

* *Pinus taeda*

over softwoods as a raw for papermaking (Varmah and Bahadur, 1980). Bamboos and softwoods as raw materials for pulp and paper have been compared in Table 3. No doubt softwoods are considered the best raw materials due to their world wide availability and superior anatomical characteristics but bamboos have also some advantages over softwoods in terms of higher growth rate, material cost, harvesting and transportation costs, rotation period, coppice

power, per hectare productivity, recurring management expenditures, debarking expenditures, lower demand of chemical for pulping and bleaching and environmental consideration.

From the results and comparison with softwood pulps, it is evident that home-grown bamboo species (*D.hamiltonii, D.strictus* and *B.tulda*) may be used as cheaper substitute of softwoods for the manufacture of long fiber pulp. Pakistan which do not have the enough softwood resources for pulping may use cheaper bamboo soda pulp for supplementation to the hardwood or non-woody pulp to increase the tear strength of locally produced paper. Pulping of bamboos by soda process is environmentally more sound than kraft pulping of conifers. Moreover, soda process can be operated comparatively in small scale and also with small capital (Kazuki, 1962). India, which is the biggest producer of bamboo pulp wholly or partly depends on bamboo chemical pulp because bamboos are the only long-fibered resources easily available in the country and extraction of conifer is expensive (Sharma, 1980). Similarly, pulp industry in Pakistan have already some advantages in non-wood pulping and it can easily avail the benefits of bamboo pulping. The elements of advantages include:

1. Most of the pulping units either use soda process or neutral sulphite process for non-wood pulping. Both the processes are equally suitable for bamboo pulping (Casey, 1980).

2. Market for long fiber pulp already exists.

3. Farmer's willingness and easy technology for bamboo propagation.

Use of bamboo in pulp and paper becomes more important in the present situation, when Pakistan has limited forest resource and demand for wood pulp is increasing due to population growth, educational, cultural and industrial advances in the country. Manufacturing long fiber pulp from home-grown bamboo will be the most economical use of bamboo because of adding highest value to the locally produced bamboos. Industrial utilization of bamboo in pulp and papermaking may save a lot of foreign exchange through import substitution, create the new jobs in bamboo producing areas and help in achieving self-sufficiency in pulp production by extending the raw material base for the local paper industry. These objectives can only be achieved if bamboo resources in the country are increased through farmer's participation, developing markets and offering remunerative prices of bamboo crops. Farm forestry and social forestry may play an important role in planting of bamboos on farmlands. Increased income from bamboo may result into Socio-economical changes in rural areas in short span of time.

**REFERENCES**


Anon 1962. Industrial Experience in Bamboo Pulp. Pakistan Industrial Development Corporation in Pulp and Paper Prospects in Asia and The Far East. FAO. Bangkok. pp 350-351.

Anon 1990 Fiber Morphology of Bamboo Species Grown at Pakistan Forest Institute, Peshawar. Annual Progress Report( 1989-1990) Pakistan Forest Institute Peshawar. pp 124-125.

Casy, J.P. 1980. Pulp and Paper Chemistry and Chemical Technology. third edition Vol 1. John Wily & Sons New York. pp 549-554.

Clark, James d'A. 1978. Pulp Technology and Treatment for Paper. Miller Freeman Publishing Inc. San Francisco. p 654.

Guha, S.R.D. 1961. Bamboo as a raw material for paper and board making. Indian buyer. 1(2). 142.

Guha,S.R.D; Pant,P.C. 1961. Bamboo Pulps by Neutral Sulphite Semichemical Pulping. Research

and Industry. 6(2) 49.

Karnik, G.M. 1961. Viscose rayon grade pulps from bamboo (Dendrocalamus strictus) by water prehydrolysis sulphate process. Indian Pulp and Paper. 15(11) 655.

Kazuki,ono. 1962. The Development of the Bamboo Pulp Industry and its Techniques in Japan.in Pulp and Paper Prospects in Asia and The Far East vol ii FAO Bankok. pp 356-371.

Siddiqui, K.M. 1981. Evaluation of Chir Pine (*Pinus roxburghii*) Sarg as raw material for pulp and paper. Pakistan Forest Institute Peshawar 83pp.

Sharma, Y.M.L 1980. Bamboos in the Asia-Pacific Region. in " Bamboo Research in Asia". Gilles and Amy (Ed) Proceedings of workshop held in Singapore 28-30 May IUFRO. p 109.

Tamolang, F.N, Felipe, R.L, Jose, A.S, Richard, F.C, and Zenite, B. E. 1980. Properties and Utilization of Philippine Erect Bamboos. In Bamboo research in Asia. Gilles and Amy (Ed) Proceedings of workshop held in Singapore 28-30 May IUFRO. pp 189-200.

Varmah,J,C and Bahadur, K.N. 1980. Country Report and Status of Bamboo Research in India. Indian Forest Research ( Botany). 6(1). 28 p

## ANATOMY AND SUITABILITY OF MAZRI (*NANNORRHOPS RITCHIANA*, GRIFF.) FOR PULP AND PAPER AS BASED ON FIBER CHARACTERISTICS

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### ABSTRACT

Mazri, beside it's traditional uses in making of various household and other utility articles, is also very rich in fibers. Studies on fiber characteristics like average fiber length, relative fiber length and Runkel ratio show that the fibers from Mazri are suited for the production of pulp and paper of good quality. Mazri fibers being "medium long" can supplement hardwood and non-woody pulps as pulp furnish. At present low and scattered supplies and competition from traditional uses are the technical and economic constraints in it's utilization as a raw-material for pulp and paper.

### INTRODUCTION

Mazri (*Nannorrhops ritchiana*) is a gregarious, tufted, low growing palm with robust, prostrate and branching stem, reaching a height of more than 6 m. Leaf blade is about 1 m long, cuneately flabellate, rigid, plicate, split to the middle or lower into 8-15 curved, 2-fid segments often with inter-posed fibers; petiole 15-30 cm long, unarmed, concave with a mass of rust coloured wool at the base (Parker, 1956). Mazri grows naturally in Makran, Kharan, Khuzdar, Harnai and Sibi in Balochistan and Kohat and Kurram Agency in the province of NWFP (Mughal, 1992).

Mazri leaves are used as raw-material to support an important cottage industry, in the nearby areas of it's production, in the provinces of Balochistan and NWFP. Men, women and children prepare various household and other utility articles like mats, baskets, brushes, brooms, fans, hats, sandals, ropes and cordage etc from Mazri leaves. The average annual production of