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SUITABILITY OF *CASUARINA EQUISETIFOLIA* WOOD FOR PULP AND PAPER INDUSTRY IN PAKISTAN

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Abstract

Wood chemical constituents such as holocellulose, alphacellulose and lignin contents of *Casuarina equisetifolia* were investigated from extractive - free wood of trunks and branches. In trunk wood amount of holocellulose, alphacellulose and lignin wee 73.08±3.91, 46.41±4.49 and 26.32±3.71% respectively, whereas for branch wood the corresponding values were 72.14±2.20, 42.87±2.66 and 27.73±1.55% respectively. The average fiber length, fiber diameter and fiber wall thickness was 978.28±48.26 mm, 14.81±4.97 μm and 6.95±2.86 μm respectively. The amount of holocellulose, alphacellulose and lignin in the trunk wood and branch wood when compared with other types of wood suggest that relatively high pulp yield can be obtained from them. However, short length and small diameter of fibers would render *Casuarina* wood unsuitable for making strong paper.

Introduction

Pakistan like all other developing countries is confronted with the problem of shortage of long fibered soft wood pulps to meet the demand of its pulp and paper industry. In view of the increasing demand of wood as raw material for pulp and paper industry, various materials of plant origin have been tested in Pakistan from time to time (Mahmood, 1984; 1984a, 1985b, 1986). In the present paper suitability of wood from *Casuarina equisetifolia* as raw material for pulp and paper industry is discussed.

Materials and Methods

Wood samples from trunks as well as branches were obtained from adult trees of *Casuarina equisetifolia* growing in the garden of the Botany Department, University of Karachi. The following procedures were adopted for anatomical and chemical analysis of wood.

a) Anatomical characteristics: Small blocks of wood were boiled in water and permanent slides representing transverse, radial and longitudinal sections were prepared. From these slides average fiber diameter, lumen diameter, cell wall thickness were determined with the help of an eye-piece micrometer. For the fiber length, small chips of wood were boiled in a mixture of 20% nitric acid and Potassium chlorate till the fibers started separating. After thorough washing with water the fibers were taken on a slide, stained in a weak solution of methylene blue and length of the fibers determined.

b) Chemical characteristics: Wood obtained from healthy *Casuarina* trees was chopped and ground in an Apex Knife mill. The fraction of wood meals which passed a 40 mesh British Standard sieve (420 μm) and retained on a 60 mesh sieve (250 μm), was used for analysis. Estimation of holocellulose, alphacellulose and lignin contents was carried out from extractive free wood. Alcohol benzene extractives were removed by TAPPI Standard Method T 6m. 59 (Anon., 1975) and hot water solubles by TAPPI Standard Method T 207.0S.75 (Anon., 1975). For extraction of holocellulose, modified chlorite method of

Table 1. Fiber characteristics of *Casuarina equisetifolia* softwood, hardwood and tropical hardwood.

Source	Soft wood Sadawarte & Prasad (1977)	Hard wood Sadawarte & Prasad (1977)	Tropical hard wood Kayama (1979)	*C. equisetifolia*
Fiber length mm	3.6	1.2	1.46	978.28$\pm$48.26
Fiber diameter (microns)	40.0	28.0	29.9	14.81$\pm$4.9
Cell wall thickness (microns)	---	---	8.3	6.95$\pm$2.86

Wise *et al.*, (1946) developed by Erickson (1962) was adopted. Six one-hour sodium chlorite treatment was required to fully delignify the wood. Holocellulose prepared by the method of Erickson (1962) was subsequently used for alphacellulose analysis using the method as described by Siddiqui (1976). The lignin content was determined by TAPPI Standard Method T 13m-54.

Results and Discussion

The two most important parameters which determine suitability of wood as raw material for pulp and paper industry are its fiber characteristics and chemical composition (Kayama, 1979). A close relationship exists between wood properties and pulp properties. Amount of polysaccharides such as holocellulose, alphacellulose and lignin are mainly related to pulping behaviour and the morphological properties of the fiber are mainly related to paper strength.

1. Morphological properties of fibers: The average fiber length of *C. equisetifolia* was 978.28±48.2 mm, fiber diameter 14.81±4.9 μm and wall thickness 6.95±2.8 μm (Table 1). The average fiber length of *C. equisetifolia* grown in India was 1.08 mm and mean average diameter as 11.0 μm (Guha & Madan, 1963) and in Egypt fiber diameter as 13.8 μm and wall thickness as 5.0 μm (El-Osta *et al.*, 1981).

Comparing the length, diameter and cell wall thickness of fibers of *C. equsetifolia* with corresponding average values of soft woods and hard woods as reported by Sadawarte & Prasad (Table 2) the fibers of *C. equisetifolia* have shorter length and smaller diameter. However the cell wall thickness of fibers is comparable with those of tropical hardwoods. In view of the short length and small diameter of fibers, it can be suggested that the wood of *C. equisetifolia* may not be suitable for making strong paper.

2. Chemical components: Alcohol benzene extractives in the trunk wood was 10.27% while in branch wood they were 10.46%. Hot water extractives in trunk wood were 13.02% while in branch wood they were estimated to be 12.69% (Table 2). The holocellulose content in the trunk wood was 73.08%, alphacellulose 46.41% and lignin 26.32%, while in branch wood holocellulose was 72.14%, alphacellulose 42.87% and lignin 27.73%.

Table 2. Chemical components of *Casuarina equisetifolia*, Japanese hardwoods, tropical hardwoods, conifers and some fast growing angiosperms of Pakistan.

Source	Tropical hardwoods Kayama (1979)	Japanese hardwoods Kayama (1979)	Conifers of Pakistan. Mahmood (1985)	Fast growing angiosperms of Pakistan Mahmood (1983)	*C. equisetifolia* Trunk wood	Branch wood
Solubles in hot water	4.5	5.2	3.5	3.4	13.02±2.78	12.69±5.08
Solubles in alcohol benzene	---	4.9	7.5	4.6	10.27±2.55	10.46±3.69
Holocellulose	77.8	69.9	69.1	74.4	73.08±3.91	72.14±2.20
Alpha-cellulose	48.1	46.3	44.1	43.9	46.41±4.99	42.87±2.66
Lignin	23.4	30.0	32.9	25.7	26.32±3.71	27.73±1.55

Not much work seem to have been done on the utilization of *Casuarina* wood for pulp and paper manufacture. Guha & Madan (1963) carried out laboratory experiments in sulphate pulping of *C. equisetifolia*. Easy bleaching pulps in good yield could be prepared and the species was regarded as promising raw material for writing and printing papers. Guha *et al.*, (1970) have indicated that *C. equisetifolia* is a suitable raw material for chemical and semi-chemical pulp but it is unsuitable for mechanical pulps. Bawagan & Faulmino (1978) found a good quality dissolving pulp from *C. rumphiana* wood using the prehydrolysis - sulphate process. Chemical constituents of wood of three *Casuarina* species were determined by El-osta *et al.*, (1979). Samples of *C. glauca* wood were pulped using the Kraft process. The pulp yield appeared to be relatively high.

Wood chemical characteristics like low alcohol benzene extractives, high cellulose and low lignin contents are regarded favourable chemical characteristics for a pulp and paper material (Kayama, 1979).

Comparing the values determined for *C. equisetifolia* with the corresponding average values for woods of tropical and Japanese hard wood (Kayama, 1978), conifer and fast growing angiosperms of Pakistan (Mahmood, 1983, 1985), we find that *C. equisetifolia* wood has a higher content of hot water and alcohol benzene extractives while holocellulose, alphacellulose and lignin contents are comparable with other woods (Table 2).

Keeping in view of the chemical characteristics of *C. equisetifolia* wood it would suggest that relatively high pulp yield can be obtained. But short length and small diameter of fibers renders the material unsuitable for making strong paper.

In the light of the multifarious roles of *Casuarina* such as sand stabilization, wind reduction, rehabilitation of depauperate soils, the provision of fuel and as a component of agro-forestry systems, large scale plantations of *C. equisetifolia* along the coastal regions of Karachi will be of immense value particularly when *C. equisetifolia* is a salt tolerant species (Yadav, 1981), and has been reported to bear root nodules (Athar &

Mahmood, 1985). Trials on wood of *C. equisetifolia* in India and Egypt for its use as raw material for pulp and paper industry have been encouraging (Guha & Madan, 1963; Guha *et al.*, 1970; El-osta *et al.*, 1979). The results of present investigation supplement these findings. The result of chemical analysis of branchwood as presented in this report suggests that they can also be a potential source of raw material for pulp and paper industry.

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