Pak. J. Bot., 17 (1): 55-59, 1985.

CHEMICAL COMPOSITION OF WOOD OF SOME *EUCALYPTUS* SPECIES GROWING IN PAKISTAN

A. MAHMOOD AND T. MAHMOOD

Department of Botany,
University of Karachi, Karachi-32, Pakistan.

Abstract

Holocellulose, alphacellulose and lignin, three major cell wall components, of seven *Eucalyptus* species viz., *E.camaldulensis* Dehnh., *E.citriodora* Hook., *E.maculata* Hook., *E.mannifera* Mudie. *E.melanophloia,* F.Muell., *E.microtheca* F. Muell., and *E.tereticornis* Sm. were investigated from extractive-free wood of trunks and branches. Amount of holocellulose ranged between 67.80-77.93% in trunkwood and 67.22-76.19% in branch-wood, alphacellulose 40.9-47.1% in trunk-wood and 36.25-43.84% in branchwood and lignin 22.01-32.28% in trunkwood and 23.45-32.77% in branchwood. There was not much variation in the amount of these polysaccharides among the species investigated.

Introduction

In view of the acute shortage of softwood species to meet the growing demands of wood based industries specially pulp and paper, chemical analysis of wood of a number of tropical hardwood species have been made throughout the world. 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-a). On the basis of chemical analyses of some tropical hardwoods made by Palmer & Gibbs (1978), Kayama (1979-a), Shao Song (1979), Escolano *et al* (1981), and Mahmood (1983) and Mahmood & Mahmood (1984) it can be said that hardwoods could provide abundant raw material for pulp and paper industry.

Pakistan like all other developing tropical countries is also facing acute shortage of long fibered softwood species regarded as ideal raw material for pulp and paper manufacture. We should therefore look for fastgrowing hardwood species like *Populus* and *Eucalyptus* which are already being used for this purpose in a number of countries. Mahmood & Mahmood (1984) have reported chemical analyses of wood of four *Populus* species growing in Pakistan. Relatively little data is available pertaining to chemical components of *Eucalyptus* species. In the present study alcohol benzene extractives, holocellulose, alphacellulose and lignin contents of seven *Eucalyptus* species are reported. For the sake of comparison with trunkwood, branch wood was also analyzed for these chemical components.

Materials and Methods

Wood samples from trunks and branches of sound and healthy trees of *E.camaldulensis, E.citriodora, E.maculata* and *E.melanophloia* were obtained from Miani Forest Hyderabad, *E.mannifera* and *E.tereticornis* from Changa Manga Forest Division, Changa Manga and *E.microtheca* from B.K. Forest Nursery Bhawalpur. Wood was chopped and ground in an apex knife mill. Analyses were made on fraction of wood meals which passed a British Standard 40 mesh sieve (420 μm) and retained on a 60 mesh sieve (250 μm). Alcohol-benzene extractives and hot-water solubles were removed by TAPPI Standard Methods T6m-OS-59 and T207-OS-75, respectively Amount of holocellulose, alphacellulose and lignin were estimated from extractive-free wood. Holocellulose content was determined by modified chlorite method of Wise *et al* (1946) developed by Erickson (1962). Six one-hour sodium-chlorite treatments were required to fully delignify the wood. Holocellulose samples prepared by the method of Erickson were subsequently used for extraction of alphacellulose which was analyzed as described by Siddiqui (1976). Lignin was extracted by TAPPI Standard Method T13-0S-54.

Results and Discussion

Amount of holocellulose in trunkwood of *Eucalyptus* species varied between 67.80-77.93% whereas in branchwood it ranged between 67.22-76.19% (Table 1). Palmer & Gibbs (1977) found 69.50% holocellulose in the wood of *E.grandis* where as in *E.deglupta* 63.50% holocellulose has been reported (Kayama, 1979-b). This difference may in part be due to variation between species and method of extraction.

Alphacellulose content of trunkwood varied between 40.09-47.01% and that of branchwood between 36.25-43.84% (Table 1). Palmer & Gibbs analyzed *E.grandis* and reported 42.20% of alphacellulose while Sadawarte & Prasad (1977) found 44% alphacellulose in wood of *Eucalyptus* species. Wood of *E.deglubta* is reported to contain 40.50% alphacellulose (Kayama, 1979-b). Thus values of Alphacellulose of *Eucalyptus* woods in the present study are comparable to those given by Palmer & Gibbs (1977), Sadawarte & Prasad (1977) and Kayama (1979-b). The lignin content of trunkwood and branchwood of *Eucalyptus* species estimated in present study varied between 22.01-32.28% and 23.45-32.77% respectively. Lignin content of *Eucalyptus* wood reported by Palmer & Gibbs (1977), Sadawarte & Parasad (1977), Motokazu & Raysabro (1979) and Kayama (1979-a & b) were 23.20, 25.00, 23.2, 30.60% and 23.4% respectively, which on the average basis are slightly lower than present values. This difference in the lignin content may be attributed to species variation and/or the method of extraction employed.

Our results indicate that holocellulose, alphacellulose and lignin contents of *Eucalyptus* wood are comparable to other fast growing angiosperms (Kayama, 1979-b; Manavalan *et al*, 1979; and Bhargava & Dwivedi, 1981). Comparing polysaccharide contents of *Eucalyptus* woods with corresponding values obtained for coniferous woods of Pakistan (Mahmood, 1983), it is noted that *Eucalyptus* woods on the average contain higher holocellulose than coniferous woods, while amounts of alphacellulose and lignin in the

Table 1. Holocellulose, alphacellulose and lignin contents of trunk and branch wood of some *Eucalyptus* species (all values in percent of extractive free wood).

SPECIES	HOLOCELLULOSE		ALPHACELLULOSE		LIGNIN	
	TW	BW	TW	BW	TW	BW
E. camaldulensis Dehnh.	75.00 ± 0.19	73.80 ± 0.20	47.01 ± 0.26	42.72 ± 0.36	24.50 ± 0.77	26.60 ± 0.68
E. citriodora Hook.	77.23 ± 0.39	76.19 ± 0.17	43.00 ± 0.48	36.25 ± 0.18	22.48 ± 0.86	23.56 ± 0.32
E. maculata Hook.	77.93 ± 0.36	75.36 ± 0.15	46.33 ± 0.71	43.54 ± 0.28	22.01 ± 0.57	24.18 ± 0.88
E. mannifera Mudie.	70.30 ± 0.90	73.58 ± 0.06	42.56 ± 0.36	42.86 ± 0.26	28.92 ± 0.74	26.45 ± 0.28
E. melanophloia F.Muell.	74.48 ± 0.36	75.76 ± 0.18	44.13 ± 0.19	43.84 ± 0.25	26.96 ± 0.08	23.45 ± 0.36
E. microtheca F.Muell.	67.80 ± 0.88	74.89 ± 0.16	40.09 ± 0.78	39.40 ± 0.36	32.28 ± 0.97	24.76 ± 0.81
E. tereticornis Sm.	69.40 ± 0.46	67.22 ± 0.46	42.18 ± 0.88	41.16 ± 0.52	31.30 ± 0.92	32.77 ± 0.37

TW = Trunkwood
BW = Branchwood

two types of wood do not show much variation. Results also show that holocellulose, alphacellulose and lignin contents of branchwood are comparable with those of trunkwood (Table 1). The alcohol benzene extractive contents of *Eucalyptus* in trunkwood (T.W.) and branchwood (B.W.) are 5.19±0.49 and 5.48±0.58 respectively (Table 2), which are less than obtained for T.W (7.64) and B.W (6.72) of coniferous wood (Mahmood 1983), but are higher than in T.W (3.06±0.38) and B.W (3.81±0.28) of *Populus* wood (Mahmood & Mahmood, 1984).

Table 2. Alcohol-Benzene extractive contents of *Eucalyptus* woods (All values in percent of oven dried wood)

Species	ALCOHOL BENZENE EXTRACTIVES	
	T.W	B.W
E.camaldulensis	1.60 ± 0.09	3.75 ± 0.91
E.citriodora	10.42 ± 0.76	6.39 ± 0.88
E.maculata	5.98 ± 0.10	7.28 ± 0.79
E.mannifera	3.92 ± 0.68	5.80 ± 0.26
E.melanophloia	5.92 ± 0.52	8.43 ± 0.68
E.microtheca	3.43 ± 0.53	3.10 ± 0.25
E.tereticornis	5.18 ± 0.72	3.58 ± 0.26
Average	5.19 ± 0.49	5.48 ± 0.58

T.W = Trunkwood
B.W = Branchwood

Since *Eucalyptus* wood has higher holocellulose content, lesser alcohol-benzene extractives and comparable amount of lignin to coniferous wood it can be said that *Eucalyptus* wood is chemically highly suitable for pulp and paper industry.

Acknowledgement

This work was accomplished under Pakistan Science Foundation Research Project No. S-KU/BIO (14/1) which is sincerely acknowledged. We also acknowledge the help of Divisional Forest Officer Changa Manga Forest Division, Changa Manga and Miani Forest, Miani, Hyderabad Division for the wood samples.

References

Anonymous, 1975. Standard and suggested methods. *TAPPI* Georgia, USA

Bhargava, G.G. and R.P. Dwivedi 1981. *Gmeline arborea* (Gamari) pulping alone and mixed with bamboo. *IPPTA*, 18: 19-25.

Erickson, H.D. 1962. Some aspects of method in determining cellulose in wood. *Tappi*, 45: 710-719.

Escolano, J.O, Tamolang, F.N. and N. Francisco. 1981. Research studies on tropical hardwoods for pulp and paper manufacture. *NSDB Technol. J.*, 6: 22-38.

Kayama, T 1979-a. Pulping and paper making properties and wood properties of tropical hardwoods. *Forpride Dig*, 8: 42-50.

Kayama, T. 1979-b. Kraft pulping of some growing tree species. Proc. *JCS/ACS Chemical Congress*, 18 pp.

Mahmood, A. 1983. Investigations on wood anatomy of conifers and polysaccharide components of *Eucalyptus*, Poplars and Conifers of Pakistan. Final Res. Report, PSF Project, Bot. Dep. Karachi University, Pakistan, 133 pp.

Mahmood, A. and T. Mahmood 1984. Estimation of holocellulose, alphacellulose and lignin contents of wood of some *Populus* species growing in Pakistan. *Pak J. Bot.*, 16: 43-48.

Manavalan, R., S M. Anand, B M. Mithal, and J.S. Chawla 1979. High alphacellulose from fast growing Indian Plants. *Indian pulp Pap;* 34: 17-18.

Motokazu, K. and O. Raysabro 1979. Extractive contents of *Eucalyptus* woods and sulphate pulping. *Kami Pa Gikyoshi*, 33: 592-597.

Palmer, E R. and J A. Gibbs 1977. Pulping characteristics of *Pinus kesiya* and *Eucalyptus grandis* from Zambia. *Rep. Trop.Prod. Inst. L.* 47, pp. 24.

Palmer, E.R. and J.A. Gibbs 1978-a. Pulping characteristics of six hardwoods from Guyana. *Rep. Trop. Prod. Inst. L.* 50, pp.43.

Sadawarte, N.S. and A.K. Prasad. 1977. The effect of fiber morphology on pulp sheet properties. *IPPTA*, 14: 29-34.

Siddiqui, K M. 1976. Relationship between cell wall morphology and chemical composition of early-wood and latewood in two coniferous species. *Pak. J. For.*, 26: 21-34.

Shao-Song, C. 1979. Experiments on the use of hardwoods growing in Kwangtung for pulp. *Lin. Yeh K'o Haueh*, 15: 199-204.

Wise, L.E., M. Murphy, and A.A.D. Addico 1946. Chlorite holocellulose, its fractionation and bearing on summative wood analysis and on studies on the hemicellulose. *Paper Trade. J*, 122: 35-43.