

ESTIMATION OF HOLOCELLULOSE, ALPHACELLULOSE AND LIGNIN CONTENTS OF WOOD OF SOME *POPULUS* SPECIES GROWING IN PAKISTAN.

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Abstract

Holocellulose, alphacellulose and lignin contents of four *Populus* species viz., *P. ciliata* Wall. ex Royle, *P. deltoides* Marsh, *P. euphratica* Oliver and *P. eur-america* Guinier were investigated from extractive-free wood of trunks and branches. In trunkwood amount of holocellulose, alphacellulose and lignin ranged between 74.00-77.53, 41.22-47.80 and 22.64-26.79%, respectively whereas for branchwood the corresponding values varied between 73.60-78.63, 40.80-50.53 and 20.96-27.07%, respectively. Poplar wood on the average contained more holocellulose than wood of coniferous species whereas alphacellulose and lignin contents in poplar and coniferous woods were comparable.

Introduction

Most of the forests in Pakistan are confined to northern hilly regions and comprise chiefly of coniferous species. Coniferous wood is regarded as ideal raw material for pulp and paper manufacture in countries which are rich in other timber yielding species.

Pakistan is short of forests and coniferous wood is used as major source of timber. We should therefore look for fast growing angiosperms like *Populus* and *Eucalyptus* which are already being used for this purpose in a number of countries of the world. Poplar wood has proved eminently suitable for pulp and paper making and mills accept even one-year-old plants for use as raw material. Wood characteristics like low specific gravity, low lignin and high cellulose contents determine suitability of the wood for pulp and paper manufacture. Literature on these aspects in relation to poplars has been reviewed by Einspahr *et al* (1968) and Kennedy (1968). Chemical composition of poplar wood has been studied by Clermont & Schwartz (1951), Lengyel & Hajduczky (1964), Ferrari (1967) and Dickson *et al* (1974).

In Pakistan three *Populus* species viz., *P. alba*, *P. ciliata* and *P. euphratica* are native while *P. eur-america*, *P. deltoides* and *P. nigra* are introduced from different parts of the world (Beg & Sheikh, 1975). In present work wood of four *Populus* species

Table 1. Holo cellulose, alphacellulose and lignin contents of four Poplar woods (all values in percent of extractive-free wood).

SPECIES	HOLOCHELLULOSE		ALPHACELLULOSE		LIGNIN	
	TW	BW	TW	BW	TW	BW
<i>Populus ciliata</i>	76.60 ± 0.04	73.60 ± 0.36	41.22 ± 0.50	50.53 ± 0.26	24.30 ± 0.64	27.07 ± 0.42
<i>P. deltoides</i>	75.20 ± 0.10	78.63 ± 0.22	42.76 ± 0.65	44.82 ± 0.13	24.85 ± 0.51	20.96 ± 0.93
<i>P. euphratica</i>	74.00 ± 0.53	74.84 ± 0.69	45.75 ± 0.12	44.46 ± 0.58	26.79 ± 0.82	24.75 ± 0.01
<i>P. eur-americanana</i>	77.53 ± 0.48	75.33 ± 0.13	47.80 ± 0.91	40.80 ± 0.23	22.649 ± 0.07	24.70 ± 0.46

TW = Trunkwood

BW = Branchwood

was analyzed for holocellulose, alphacellulose and lignin contents and their suitability as raw material for pulp and paper manufacture is discussed.

Materials and Methods

Samples of wood of *Populus ciliata* and *P. eur-americana* were obtained from Changa Manga Forest Division, Changa Manga, while wood samples of *P. euphratica* and *P. deltoides* were obtained from Miani Forest, Miani Hyderabad Division. Wood obtained from sound and healthy poplar 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 and hot water solubles by TAPPI Standard Method T 207-OS-75. For extraction of holocellulose modified chlorite method of Wise *et al* (1946) developed by Erickson (1962) was adopted. Six one-hour sodium chlorite treatments were required to fully delignify the wood. Holocellulose prepared by the method of Erickson (1962) was subsequently used for alphacellulose analysis which was carried out as described by Siddiqui (1976). The lignin content was determined by TAPPI Standard Method T13_m-54.

Results and Discussion

Values of holocellulose, alphacellulose and lignin contents in wood on the four *Populus* species are given in Table 1. Amount of holocellulose in trunkwood varied between 74.00 – 77.53% whereas in branch wood its amount ranged between 73.60 – 78.63%. Clermont & Schwartz (1951) reported that holocellulose fraction of *Populus* wood is high and may range upto 80%. When compared with holocellulose content of other hardwoods as reported by Palmer & Gibbs (1977), Pandey & Mehta (1979), Manavalan *et al* (1979), Bedetti *et al* (1979) and Mahmood (1983), it was found that holocellulose content of the poplar wood and other hardwoods is comparable. The amount of holocellulose as reported by these workers was 67.1–69.5, 68.78, 72.0–77.0, 70.5–82.5 and 67.2–76.6%, respectively.

Alphacellulose content of trunkwood ranged between 41.22–47.80% while in branchwood it varied between 40.80–50.33%. Alphacellulose content of hardwood as estimated by Sadawarte & Prasad (1977), Smith *et al* (1977), Palmer & Gibbs (1977), Mahmood (1983) and Jan & Jozef (1982) was 40.0–44.0, 39.6–49.8, 41.2–47.9, 41.3–47.8 and 45.0–50.0%, respectively. Present values are close to the range given by these workers.

The amount of lignin in trunkwood varied between 22.64–26.79% whereas in branchwood this amount ranged between 20.96–27.07%. Lengyel & Hajduczky (1964)

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

Species	ALCOHOL BENZENE EXTRACTIVES	
	T.W	B.W
<i>P. ciliata</i>	2.09 ± 1.19	3.52 ± 0.41
<i>P. deltoides</i>	4.17 ± 0.14	4.02 ± 0.36
<i>P. euphratica</i>	2.42 ± 0.15	5.79 ± 0.19
<i>P. eur-american</i>	2.92 ± 0.04	3.32 ± 0.17
Tw = Trunk wood	Average 3.06 ± 0.38	3.81 ± 0.28
BW = Branch wood		

reported lignin content of six *Populus* species which ranged between 18.4-23.0% whereas Einspahr *et al* (1968) reported lignin content between 17.2-19.3%. Dickson *et al* (1974) determined lignin content of eighteen *Populus* hybrid clones from 18.1-25.0% lignin. Values obtained in present study are little higher than those reported by Lengyel & Hajduczky (1964), Einspahr *et al* (1968) and Dickson *et al* (1974). This difference may be due to variation within and/or between species and difference in method of extraction. However, amount of lignin in poplar wood analyzed in present study is comparable with that of other hardwoods investigated by Sadawarte & Prasad (1977), Palmer & Gibbs (1977). Mahmood (1983) has reported holocellulose (59.87-70.7%), alphacellulose (39.08-49.33%) and lignin contents (25.52-39.83%) in wood of ten conifers from Pakistan. If these values are compared with corresponding values for poplar wood, the later on the average contained more holocellulose while amount of alphacellulose and lignin in both types of wood did not show much variation. Results also showed that values of holocellulose, alphacellulose and lignin for branchwood are comparable with those obtained from trunkwood. Kayama (1979) after analysing pulp and paper making properties of 60 species of tropical woods concluded that chemical properties of tropical woods are mainly related to pulping behavior while morphological properties are related to paper strength. Chemical properties such as low amount of alcohol benzene extractives, high holocellulose and low lignin contents are regarded as favourable characteristics for a pulp and paper material. The alcohol-benzene extractive contents of Poplars in T.W and B.W are 3.06 ± 0.38 and 3.81 ± 0.28, respectively (Table 2.). These values are much less than obtained for T.W 7.64 and B.W 6.72 of coniferous wood (Mahmood, 1983).

Thus in view of the fact that Poplar wood has higher holocellulose content, lesser alcohol-benzene extractives and comparable amount of lignin to coniferous wood which is regarded as ideal material for pulp and paper manufacture, it can be said that Poplar wood possesses favourable chemical characteristics for a pulp and paper material.

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