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ESTIMATION OF LINGIN, HOLOCELLULOSE AND ALPHACELLULOSE CONTENT OF EARLYWOOD AND LATEWOOD AMONG INNERWOOD AND OUTERWOOD OF BLUE PINE, (*PINUS WALLICHIANA*, A.B. JACKS.)

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Abstract

Three major cell wall components i.e. lignin, holocellulose and alphacellulose were determined for earlywood (juvenile wood) and latewood (adult wood) among innerwood and outerwood and at different height levels in Blue Pine trees. Latewood was consistently lower in lignin content and higher in holocellulose and alphacellulose content than earlywood. Both earlywood and latewood from innerwood were consistently higher in lignin content and lower in holocellulose and alphacellulose content than that of outerwood. There was slight difference in lignin content between D1 to D2, but increased to D3. Similarly the amount of holocellulose and alphacellulose decreased from D1 to D2 and D3. This decrease was in the order of 1-2% and was slight between D1 and D2 but increased to D3. These differences may be ascribed to the relative thickness of various wall layers in these components of growth increment or effect of age.

Introduction

Though the chemical composition of wood in general is well known, information on comparative chemical composition of earlywood (juvenile wood) and latewood (adult wood) among innerwood and outerwood and its variation at different height levels in the tree is meagre. Literature on coniferous growth zone chemistry has shown that amount of major cell wall components, viz., lignin, holocellulose and alphacellulose in earlywood and latewood cells is variable. Earlywood has slightly higher proportion of lignin than latewood and holocellulose and alphacellulose contents of earlywood are less than that of latewood (Ahlm & Leopold, 1963; Larson, 1966; Burkart & Watterston, 1968; Gladstone, 1968; Kai *et al*, 1972; Dickson *et al*, 1976; Siddiqui, 1976). Variation in the major cell wall components is also reported in samples taken from different height levels in the tree (Schuett & Augustin 1961; Von Byrd, 1964). The present paper reports differences in the amount of major cell wall components in earlywood and latewood among innerwood and outerwood and at different height in Blue pine trees.

Materials and Methods

Wood samples were obtained from five 55-70 years old *Pinus wallichiana* trees growing under natural conditions at Namli Maira Gallis Forest Division, N.W.F.P. In

Table 1. Extractives, lignin, holocellulose and alpha cellulose of Blue pine adult wood samples.

Tree No.	% *Extractives ** EW	% *Extractives *** LW	% Lignin EW	% Lignin LW	% Holocecllulose EW	% Holocecllulose LW	% Alphacellulose EW	% Alphacellulose LW
1.	7.64	7.06	27.30	26.50	69.50	71.60	45.30	47.00
2.	9.04	8.03	27.40	25.30	67.60	69.80	46.20	47.80
3.	9.14	6.85	26.80	25.10	70.45	72.30	46.10	47.20
4.	8.98	8.02	27.60	26.70	69.85	71.10	45.60	46.70
5.	7.29	5.59	27.00	26.80	69.10	71.00	46.10	48.70
Mean	8.40	7.11	27.22	26.08	69.30	71.18	45.86	47.48
**** SX	± 0.385	± 0.450	± 0.142	± 0.363	± 0.479	± 0.409	± 0.175	± 0.354

*Results are average of two analyses.
**EW = Earlywood.
***LW = Latewood.
****SX = Standard error of mean.

Table 2. Extractives, lignin, holocellulose and alpha cellulose content of Blue pine juvenile wood samples.

Tree No	% *Extractives * EW	% *Extractives ** LW	% Lignin EW	% Lignin LW	% Holocellulose EW	% Holocellulose LW	% Alpha cellulose EW	% Alpha cellulose LW
1.	11.76	10.47	28.40	27.10	67.60	69.30	43.10	45.00
2.	11.32	9.03	28.20	27.50	66.20	68.30	44.20	45.30
3.	10.39	7.74	28.70	27.20	68.90	70.60	44.10	46.00
4.	10.38	9.49	28.10	27.10	67.00	68.90	43.90	45.50
5.	13.26	12.14	28.30	27.30	67.90	69.80	43.30	45.30
Mean	11.42	9.77	28.34	27.24	67.52	69.38	43.72	45.42
**** SX	± 0.531	± 0.737	± 0.103	± 0.322	± 0.451	± 0.392	± 0.220	± 0.165

*Results are average of duplicated analysis.
**EF = Earlywood
***LW = Latewood
****SX = Standard deviation of mean.

order to overcome the effect of site and other silviculture conditions on chemical composition, trees not very far from each other (5-7 meters) were selected. Similarly to minimise any variation in the chemical composition of wood due to position of sample in the tree, samples of cross sectional disc 5 cm in thickness were obtained from the same internode i.e. internode 45 counting from top of each tree. In order to study the effect of height level of the sample in the tree on composition of wood, three discs were removed from the trunk starting upward from internode 45 from the top of trees 1, 2 and 3, at intervals of approximately 15 internodes and were called D1, D2 and D3 respectively. Trees 4 and 5 were not included due to abundance of compression wood. The discs were wrapped in polythene bags and transported to the laboratory. Each disc was then cut in to small strips and radial wedges were used for the determination of chemical composition. Only samples free of compression wood were used in analysis. Earlywood and latewood components were separated with a sharp knite under a magnifying glass. Wood chips for each tree were composited separately for each tree. Samples were chopped, air dried and ground in a Wiley mill to wood meal which passed through a British standard 40-60 mesh (250 μm – 420 μm) fraction. Alcohol-benzene extractives were removed by TAPPI standard method T6m-59 and hot water solubles by TAPPI standard method T207-OS-75. (Anon.,1975). Lignin was determined by modified TAPPI standard method T13m-54 and 0.5 gm of conditioned wood meal rather than standard 1 gm was used. The amount of 72% sulphuric acid in primary hydrolysis and its dilution in secondary hydrolysis was adjusted according to the amount of wood meal. For extraction of holocellulose, modified chlorite method of Wise *et al* (1946) developed by Erickson (1962) was adopted. Five-one-hour sodium chlorite treatments were found sufficient to delignify the wood completely. Amount of alphacellulose was determined by the method of Siddiqui (1970).

Results and Discussion

(a) *Differences in the chemical composition of earlywood and latewood and among innerwood and outerwood:*

In all the five trees earlywood was found consistenly higher in lignin (1-2%) and lower in holocellulose and alphacellulose (2-3%) than latewood (Tables 1 & 2). This pattern corroborates with values reported for other conifers (Larson, 1966; Siddiqui, 1976). Differences in the amount of three major cell wall constituents may be explained on the basis of differential thickness of cell wall layers in earlywood and latewood. For example, compound middle lamella has slightly higher values for lignin (Meier & Wilkie, 1959, Meier, 1961), while secondary wall particularly its S_2 layer is rich in cellulose. Stamm & Sanders (1966) and Siddiqui (1976) have worked out relationship between area ratio of compound middle lamella and secondary wall to the cell wall. According to them the area ratio of compound middle lamella is higher in earlywood and that of secondary wall in latewood.

Table 3. Variation in chemical composition of earlywood and latewood due to different height level in the sample trees of Blue pine.

Tree No	% *Extractives EW	% *Extractives LW	% Lignin EW	% Lignin LW	% Holocellulose EW	% Holocellulose LW	% Alphacellulose EW	% Alphacellulose LW
	Adult wood							
D1 Disc cut at a distance of 45 internode interval (starting from top)								
1.	7.46	7.06	27.30	26.50	69.50	71.60	45.30	47.00
2.	9.04	8.03	27.40	25.30	67.60	69.60	46.20	47.80
3.	9.04	6.85	26.70	25.10	70.35	72.30	46.10	47.20
Mean	8.57	7.13	27.13	25.63	69.15	71.23	45.87	47.33
SX	± 0.466	± 0.363	± 0.218	± 0.437	± 0.812	± 0.475	± 0.285	± 0.240
D2 Disc cut at a distance of 15 internode interval from disc D1								
1.	6.90	5.35	27.70	26.60	68.10	69.90	44.10	46.10
2.	8.61	6.56	27.70	25.70	67.90	69.80	42.80	45.60
3.	7.66	6.69	26.70	25.50	69.30	71.50	43.40	45.30
Mean	7.72	5.87	27.37	26.10	68.43	70.40	43.47	45.66
SX	± 0.495	± 0.416	± 0.333	± 0.338	± 0.437	± 0.550	± 0.348	± 0.233
D3 Disc cut at a distance of 15 internode interval from disc D2								
1.	4.92	4.62	28.10	26.90	66.50	68.20	42.60	45.50
2.	7.85	7.11	28.30	27.30	69.30	70.80	43.00	45.10
3.	7.25	6.06	27.50	26.10	68.50	69.30	42.20	44.80
Mean	6.67	5.93	27.96	26.73	68.10	69.43	42.60	45.13
SX	± 0.894	± 0.722	± 0.240	± 0.353	± 0.832	± 0.753	± 0.231	± 0.203

EW = Earlywood
LW = Latewood
SX = Standard error of mean.
* = Results are average of duplicated analysis.

Difference in chemical factions taken from earlywood and latewood were also evident within trees and individual trees (Tables 1 & 2). These differences may be attributed to the inherent genetical characteristics of the individual tree (Kennedy & Joworsky, 1960) or may be due to inherent age effect (Larson, 1966). The chemical composition of innerwood and outerwood followed the pattern of earlywood and latewood (Tables 1 & 2) described above. These results confirm the findings of earlier workers (Kennedy & Jaworsky, 1960; Larson, 1966; Burkart & Watterston, 1968. Dickson *et al,* the trees (Tables 3 & 4). A consistant difference (1%) increase in lignin and (1-2%) decrease in holocellulose and alphacellulose content was noted among innerwood and outerwood zones at all hight levels in the trees (Tables 3 & 4). The increase in lignin content between D1 & D2 was very slight but it increased from D2 to D3. Similarly the decrease in holocellulose and alphacellulose was slight between D1 & D2 but increased from D2 to D3. Some similar drop in alphacellulose was noticed from base to the top of the tree by Zobel *et al.* (1966). Slight changes in chemical composition of earlywood and latewood between 2 m and 6 m height level have also been reported in red pine (Larson, 1966). These differences may be ascribed to the relative thickness of various cell wall layers in these components of growth increment (Siddique, 1976) or to the effect of age (Anon., 1962; Larson, 1966).

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