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Detection of Lignans in Western Hemlock by Radiography*

M. L. PARKER, G. M. BARTON and L. A. JOZSA

Western Forest Products Laboratory, Canadian Forestry Service,
and Faculty of Forestry, University of British Columbia, Vancouver, B.C.

Summary

Evidence of the detection by radiography of α-conidendrin and hydroxymatairesinol, major lignans of western hemlock wood, is presented. Advantages of this new technique to wood chemists, as well as implications to wood technologists in terms of erroneous measurement of the specific gravity of unextracted wood by X-ray densitometry, are discussed.

Floccosoids are whitish flecks of a natural crystalline extractive of western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] wood called α-conidendrin [Barton 1963]. They occur rather infrequently in western hemlock and resemble the white decay pockets of certain fungi, for example *Fomes pini* (Thore) Lloyd at certain stages of their development, but can be differentiated easily by solubility of the floccosoid material in dilute alkali. They are innocuous and should not affect the end utilization of western hemlock wood containing them.

Theories of the formation of these water-insoluble floccosoids based on translocation of either the water-soluble glucoside or a close relative of α-conidendrin, hydroxymatairesinol, have been advanced [Barton, Daniels 1969]. However, recent studies show that α-conidendrin is formed *in situ* by enzymatic control of *p*-quinonemethide units [Krahmer, Hemingway, Hillis 1970].

An earlier microscopic examination [Barton 1963] of the white flecks has shown the deposits to be completely included in the vertical tracheids, with none being detectable in the ray cells. These white deposits appear in clusters randomly throughout earlywood and latewood areas of growth rings.

Radiographs of 2-mm thick, oven-dry samples of western hemlock wood containing floccosoids were made to determine if floccosoids could be detected by radiography and, also, to assess the effect that this extractive material might have on tree-ring density measurements determined by X-ray densitometry [Parker 1970; Parker, Jozsa 1973; Parker, Schoorlemmer, Carver 1973]. An examination

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of the X-ray negatives revealed that the floccosoids, appearing visually on the wood as whitish flecks, could be easily detected on the radiographs as areas of high density (high X-ray absorption). In addition, there was the somewhat surprising discovery that, besides the general areas of diffuse high density, there were discrete, small points of very high density revealed by the X-ray negatives that were not discernible on the wood surface with a low-power stereo microscope. This

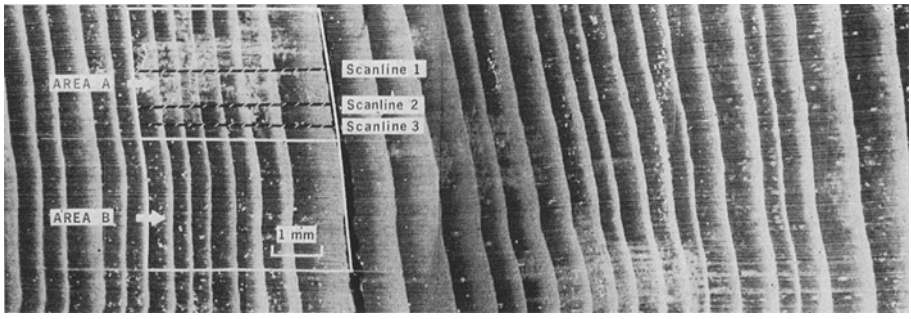

Fig. 1. Radiograph of a 2 mm thick transverse section of western hemlock containing lignan deposits. A negative image is presented; therefore, the low density areas are dark and the high density areas are light

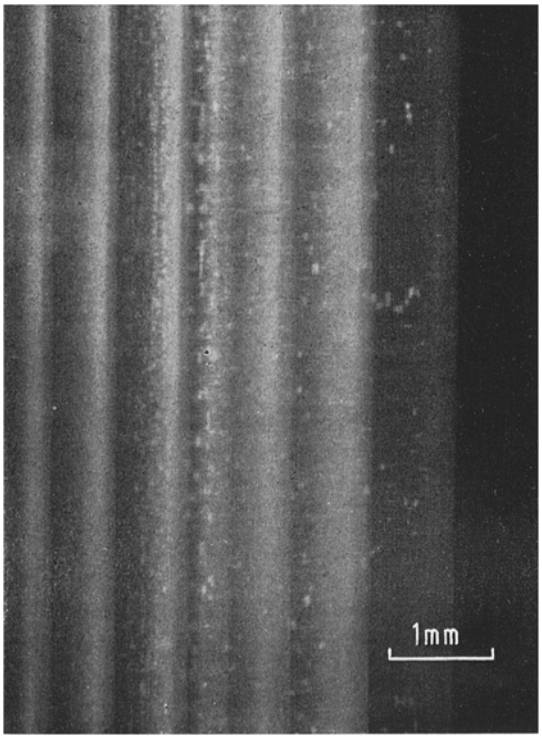

Fig. 2. Radiograph of a 2 mm thick radial section of western hemlock showing distribution of lignan deposits

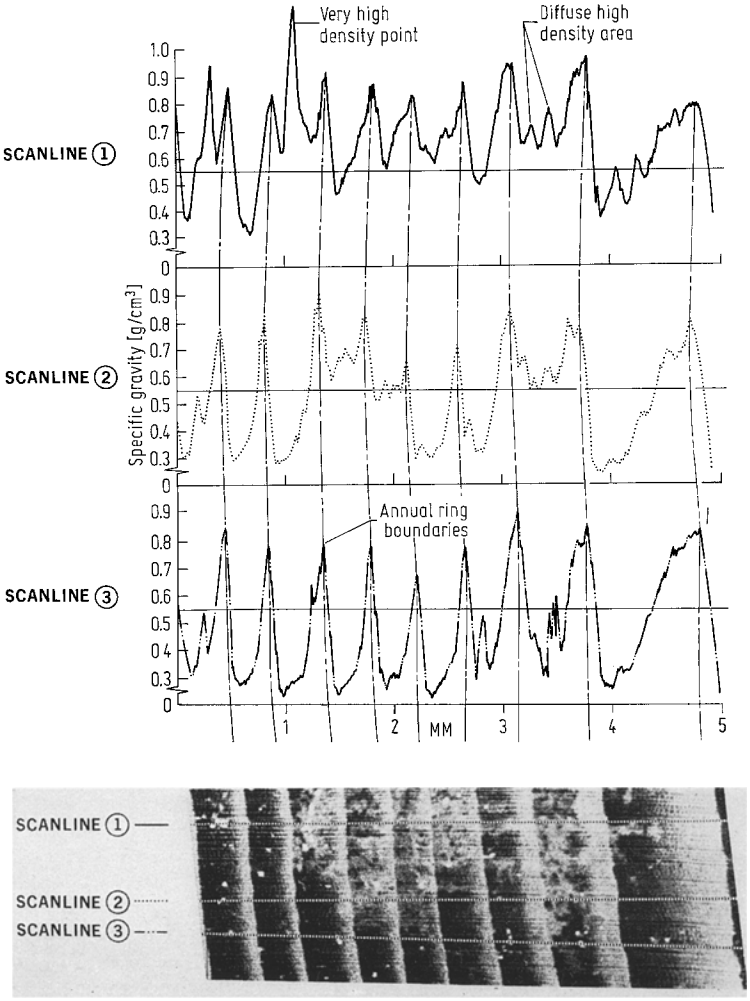

Fig. 3. Tree-ring density plots of three radial scans across a radiograph of a 2 mm thick transverse section of western hemlock. The plots show the intra-ring density pattern of nine annual rings, as well as the relative density of the two types of extractives

suggested that there were two distinct types of lignan deposits present; however, there was a general uniformity in the appearance of these deposits on microtome cross sections examined with transmitted light.

In order to determine if there were, in fact, two distinct types of lignan deposits present, small samples of a 2 mm thick transverse section (Fig. 1) were removed and analyzed chemically to determine if the more diffuse extractive material (Area A) was the same as the extractive substance in the very high density zones (Area B). A thin-layer chromatographic comparison [silica gel, chloroform-methanol (7 : 1)] of the two areas revealed that the former, as expected, was α-conidendrin, while the latter was a mixture of hydroxymatairesinol and α-conidendrin in an approximate ratio of 2:1.

Assuming the higher density spots are hydroxymatairesinol, the distribution of these two lignans is illustrated by the X-ray negatives of 2-mm-thick transverse sections (Figs. 1 and 2) of western hemlock wood. These lignan deposits are located in the lumina of longitudinal tracheids. This results in a vertical orientation of each individual deposit (Fig. 2), although these deposits on the samples examined do not extend for the full length of tracheids. The tree-ring density plots (Fig. 3), produced by making densitometer scans along three radii, demonstrate that the areas containing extractives are of higher density than wood where this material is not present. The density scale is calibrated for wood and may not be directly applicable to the extractive material, but the density plots clearly indicate that these extractives are present in the form of two distinct high-X-ray absorption levels. In the areas of diffuse high density extractives, characterized by a concentration of α-conidendrin, the apparent density of earlywood is much higher than it is in areas where the extractives are not present; *and* the discrete high density spots, consisting mainly of hydroxymatairesinol, give the appearance of being more dense than the densest part of the latewood.

X-ray densitometry can thus be a useful tool to a wood chemist in checking the distribution of certain extractives, but must be used with caution by wood technologists in determining specific gravity because of extractive interference.

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M. L. Parker, Research Scientist
Department of the Environment
Canadian Forestry Service
Western Forest Products Laboratory
6620 N. W. Marine Drive
Vancouver 8, British Columbia
(Formerly Research Associate, Univ. B. C. Faculty of Forestry)

G. M. Barton, Research Scientist
Western Forest Products Laboratory
Vancouver 8, British Columbia

L. A. Jozsa, Wood Science Technician
Faculty of Forestry
University of British Columbia
Vancouver 8, British Columbia