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CHEMISTRY OF WOOD

IX - Springwood and Summerwood

By GEORGE J. RITTER
Chemist
and
L. C. FLECK
Associate Chemist

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G. J. Ritter and L. C. Fleck

The purpose of the work reported in this paper is to compare the chemical composition of springwood and summerwood in the annual rings of trees.

Springwood differs from summerwood in physical appearance, type of cell structure, density, and thickness of cell wall. It was thought that analysis of the springwood and summerwood of representative species might show characteristic differences in the chemical composition of the two bands of growth and thus afford an additional means of classifying woods. The principal differences discovered were general, however, rather than individual.

Preparation of Samples for Analysis

In separating springwood from summerwood, it is most practicable to cut the bands from thin (3-mm.) cross sections of wood having wide annual rings of growth. The width of the rings varies not only in different trees but also during different periods in the history of the same tree. The latter condition makes it quite difficult to obtain suitable rings for springwood and summerwood samples representing a number of consecutive years in both the sapwood and heartwood of a tree. When suitable cross sections and areas of wood have been selected, the springwood and summerwood zones are aplit apart with a sharp wood chisel and removed separately. This material is ground and sieved to 80-100-mesh size.

The methods of analysis are the same as described in the sixth paper of this series.[2] The results obtained for springwood and summerwood of the six representative species chosen for study are recorded in the accompanying table.

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[1] Presented before the Cellulose Division of the American Chemical Society at Washington, D. C., April, 1924.

[2] Industrial & Engineering Chemistry, 14, 1050 (1922).

Lignin and Cellulose

The outstanding result of this work is the uniformly high yield of lignin in springwood as compared with that in summerwood, showing that the wood substance laid down in the early growing season differs chemically from that grown in the late growing season. The high proportion of lignin to total constituents in the springwood is accompanied by a low percentage of cellulose except in the heartwood of loblolly pine and of red alder, in which the percentage of cellulose is also slightly higher in the springwood. Even here, however, the ratio of lignin to cellulose is higher in the springwood than in the summerwood.

An explanation of why the lignin constitutes a larger per cent of the total wood substance in springwood than in summerwood is already available in a recent paper[3] by Ritter in which it was shown that the lignin is located partly in the cell wall mixed with the cellulose and partly in the middle lamella with very little, if any, other substance present. If the ratio of lignin to cellulose in the cell wall, exclusive of the middle lamella, is the same in springwood as in summerwood, then the lignin in the middle lamella, which constitutes a greater proportion of the total wood substance in the springwood, would account for the higher proportion of lignin in springwood than in summerwood.

The remaining determinations showed no uniform differences in chemical composition between springwood and summerwood, although a tendency was apparent toward higher percentages of (a) pentosans in the springwood; (b) pentosans in the isolated springwood cellulose; (c) extractives in the springwood.

Conclusions

(1) The data of this paper indicate that: (1) A higher percentage of lignin exists in springwood than in summerwood. An explanation is offered for the different lignin yields in the two bands of growth.

(2) Cellulose forms a larger percentage of the total wood substance in summerwood than in springwood.

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[3] Industrial & Engineering Chemistry, 17, 1194 (1925).

Table 1.--Analyses of springwood and summerwood of some American woods.

Results in percentages on oven-dry (105° C.) samples.

Species	Sample	Moisture	Solubility in			Acetic acid	Methoxyl	Pentosans	Lignin	Cellulose	Pentosans in cellulose
			Cold water	Hot water	1% NaOH						
Douglas fir											
Heartwood											
Springwood	318	6.92	3.00	4.67	15.10	0.62	3.48	11.97	32.61	55.95	8.31
Summerwood	319	4.82	2.15	3.76	14.56	.71	3.40	9.89	29.20	59.35	6.50
Western white pine											
Heartwood											
Springwood	316	4.78	3.76	5.16	22.08	1.42	3.68	10.07	26.30	57.60	7.27
Summerwood	317	3.47	4.29	5.42	21.47	1.40	3.85	9.82	25.30	60.00	6.94
Loblolly pine											
Sapwood											
Springwood	302	2.82	3.28	3.49	11.11	1.28	4.05	11.59	28.12	58.06	8.78
Summerwood	303	3.39	2.18	2.97	11.01	1.41	4.18	11.12	26.78	61.21	8.69
Heartwood											
Springwood	304	3.13	7.50	7.16	18.14	1.00	6.17	12.77	26.78	53.44	11.52
Summerwood	305	2.16	7.64	6.44	21.19	1.11	6.88	12.12	24.18	52.87	11.20
Red alder											
Heartwood											
Springwood	300	3.25	3.02	4.01	20.49	3.69	5.18	22.37	24.70	58.38	22.80
Summerwood	301	3.16	3.03	4.16	21.15	3.60	5.55	23.36	23.03	57.16	22.90

(continued)

Table 1 (continued)

Species	Sample	Moisture	Solubility in			Acetic acid	Methoxyl	Pentosans	Lignin	Cellulose	Pentosans in cellulose
			Cold water	Hot water	1% NaOH						
Catalpa											
Sapwood											
Springwood	312	6.76	9.12	12.44	34.45	3.33	4.44	22.39	23.64	50.37	25.94
Summerwood	313	4.04	7.29	10.11	27.97	4.45	4.10	22.35	18.68	56.49	22.09
Heartwood											
Springwood	314	6.17	7.51	11.65	34.27	3.39	4.97	21.33	24.29	50.38	24.77
Summerwood	315	4.76	2.69	5.26	24.15	4.07	3.37	21.50	19.35	58.45	21.24
White ash, sp. gr. 0.68											
Sapwood											
Springwood	308	3.93	8.84	10.99	23.71	3.11	5.49	21.45	24.35	49.73	23.14
Summerwood	309	2.89	6.13	8.18	19.32	2.76	5.44	20.51	23.68	54.17	20.15
White ash, sp. gr. 0.71											
Sapwood											
Springwood	306	4.52	4.04	4.95	17.71	2.76	6.34	20.34	25.57	53.56	19.50
Summerwood	307	3.51	2.90	3.57	14.57	2.49	6.01	19.35	23.52	57.66	16.97
White ash, sp. gr. 0.81											
Sapwood											
Springwood	310	5.34	7.35	8.38	22.95	2.74	5.80	20.17	23.94	52.34	18.56
Summerwood	311	3.54	6.85	7.34	19.64	2.41	5.74	20.52	20.83	57.47	14.33