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CHEMISTRY OF WOOD

IX. Springwood and Summerwood

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CHEMISTRY OF WOOD

Part IX -- Springwood and Summerwood¹

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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 split 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 6 representative species chosen for study are recorded in the accompanying table.

¹Presented before the Cellulose Division of the American Chemical Society, Washington, D. C., April 1924. Published in Industrial & Engineering Chemistry, 18:608-9 (1926).

²Industrial & 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 percent of the total wood substance in springwood than in summerwood is already available in a recent paper³ 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

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.

³Industrial & 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	Mois- ture	Solubility in Cold: water	Hot: NaOH	1% acid	Ace- tic	Meth- oxyl	Pento- sans	Lignin	Cellu- lose	Pentosans in cellu- lose
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
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

(continued on next page)

Table 1.-- Analyses of springwood and summerwood of some American woods (continued)
(Results in percentages on oven-dry (105° C.) samples.)

Species	Sample	Mois- ture	Solubility in			Ace- tic	Meth- oxyl	Pento- sans	Lignin	Cellu- lose	Pentosans in cellu- lose
			Cold	Hot	1% NaOH	acid					
			water								
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

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