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FOREST PRODUCTS LABORATORY UNITED STATES FOREST SERVICE

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CHEMICAL ANALYSES OF WOOD

Not infrequently the Forest Products Laboratory receives requests for complete chemical analyses of wood, when inquiry shows that the information wanted is not general but specific, as for instance: Will this wood spoil the flavor of foods? Will it make a good storage battery separator? How can it be bleached? Is it resistant to acid? What is the coloring matter in this wood? Why won't our make of water-proofing compound stick to this wood?

Ordinarily, analyses of wood are expressed in such terms as cellulose, lignin, methoxyl, water-soluble content, and pentosans. The most elaborate figures on such constituents, obtained after much time and trouble, may not give the desired answer to a specific question about a piece of wood, whereas some simple practical test or one or two specific (partial) chemical determinations would yield all the information needed; or the answer to the particular question may already be known.

Value of Chemical Analysis.--"Complete" analyses of wood are of importance in the study of changes that occur in wood through organic agencies and certain industrial processes. They have furnished valuable information on the processes of wood decay, and on the manner of damage wrought by marine wood borers and by white ants. Similar data on wood attacked by other pests would probably be of use in the work of control or suppression. Wood analyses have thrown light on the gradual conversion of wood into coal, and on differences between various parts of the tree structure. By aiding the study of pulping reactions at successive stages they lead to closer control of and better technic in pulping.

ANALYSIS OF WOODS

[Results in percentages of weight of oven-dry (105° C.) samples] | [Results in percentage of total cellulose]

Species	Solubility in			Acetic acid	Meth-oxyl	Pento-sans	Cellu-lose	Lignin	Pentosans in cellulose	Alpha cellulose
	Hot water	Ether	1 per cent NaOH							
Yellow cedar	3.11	2.55	13.41	1.59	5.25	9.85	53.86	31.32	8.57	62.68
Incense cedar	5.38	4.31	17.69	0.91	6.24	11.70	41.60	37.68	10.48	46.92
Redwood (heartwood)	9.86	1.07	20.00	1.08	5.21	9.43	48.45	34.21	8.85	78.81
Western white pine	4.49	4.26	14.75	1.03	4.56	8.86	59.71	26.44	6.69	64.61
Longleaf pine	7.15	6.32	22.36	0.76	5.05	9.53	58.48	--	8.67	--
Douglas fir	6.50	1.02	16.11	1.04	4.95	8.59	61.47	--	6.30	--
Western larch	12.59	0.81	22.14	0.71	5.03	12.47	57.80	--	8.90	--
White spruce	2.14	1.36	11.57	1.59	5.30	12.46	61.85	--	10.43	--
Tanbark oak	5.60	0.80	23.96	5.23	5.74	19.59	48.03	24.85	22.82	56.77
Mesquite	15.09	2.30	28.52	2.03	5.55	14.73	45.48	30.47	18.55	76.48
Balsa	2.79	1.23	20.37	5.80	5.68	18.49	54.15	26.50	21.04	75.64
Hickory (shellbark)	5.57	0.63	19.04	2.51	5.63	19.61	56.22	23.44	22.96	76.32
Eucalyptus	6.98	0.56	18.57	1.85	6.73	21.54	57.62	25.07	22.41	68.86
Basswood	4.07	1.96	23.76	5.79	6.00	22.09	61.24	--	25.37	--
Yellow birch	3.97	0.60	19.85	4.30	6.07	26.26	61.31	--	29.26	--
Sugar maple	4.36	0.25	17.64	4.46	7.25	23.16	60.78	--	25.37	--

Analytical Table.--The above table of proximate analyses of American woods is based on analytical methods in use at the Forest Products Laboratory. These analyses are not absolute. Even such important components as cellulose and lignin are to some extent "unknown" aggregates, varying in characteristics with different woods. They are determined by empirical methods, the results of which may vary with the detailed technique used. Furthermore, considerable variations occur in the chemical composition of wood of any one species, so that no single analysis can be expected to cover all cases or even to fit any other case exactly. Hence the figures here given should be taken as a general indication rather than a fixed measure of the components of a given sample of wood.

Specific chemical determinations may serve important needs. The proportion of alpha-cellulose in a given wood may indicate its value as raw material for rayon, cellophane, and the like. Determination of extractive matter (gums, oils, resins, etc.) is often of first importance. High ether-soluble content denotes resin, as in southern pine "lightwood." Water-soluble material may indicate tannins, dye components, or valuable carbohydrates. The amount of water-soluble or alkali-soluble extractives may determine the usefulness of a wood for various types of tanks and containers. Methoxyl content is of interest to the wood distiller.

Question of Species.--It is impossible by chemical analysis of wood substance to identify the exact species of a piece of wood. The determination of extractives may aid in identifying a species, but this is seldom conclusive in itself. In identifying species, wood structure is more decisive than the chemistry of wood.

Hardwoods and Softwoods.--Between the two broad classes of hardwoods and softwoods, however, the chemist can distinguish. Reference to the table on the inside pages will show that hardwoods are about twice as high in pentosan content as softwoods, and that they give a higher yield of acetic acid on hydrolysis. Usually, also, hardwoods are higher in methoxyl content than softwoods.

Heartwood and Sapwood.--In softwoods, the water-soluble and ether-soluble extractives are all higher in the heartwood than in the sapwood, while the cellulose and lignin percentages are generally lower. In the case of hardwoods it is less easy to generalize. In some species, as the oaks, extractives run higher and cellulose lower in the heartwood than in the sapwood; in others, as pignut hickory, the opposite is the case.

Springwood generally has more lignin and less cellulose than has summerwood.