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SORPTIVITY OF TECHNICAL LIGNINS AND THEIR DERIVATIVES

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We found that technical lignins can selectively absorb the principal steroids of a living organism, bile acids and cholesterol.

We used the principal cell steroid cholesterol and the bile acids cholic, taurocholic, and deoxycholic as sorbates in model investigations under conditions close to those of the internal organism. The sorbents were technical lignins, hydrolyzed lignin of cotton-seed husks (HLCH), hydrolyzed lignin of rice husks (HLRH), hydrolyzed lignin of wood chips (HLWC) and their modified derivatives, sulfolignin (SL), piperidinomethylated hydrolyzed lignin (PMHL), and phosphorylated piperidonomethylated hydrolyzed lignin (PPMHL). The controls were polyphepanum and bilignin, which are based on HLWC and are used in medicine [1].

The starting lignins were washed with hot distilled water to purify them from minerals and organic acids and were used further after drying. Experiments were performed at least in triplicate using the lignins (100 mg) mentioned above in alcoholic medium of cholic, taurocholic, and deoxycholic acids and cholesterol. The sorbate concentrations were determined using Pettenkofer reagent [2] before and after incubation at 37°C for 3 h. The cholesterol concentration was determined by the Liebermann—Burchard reaction [3]. The results showed that all technical lignins have a high sorptivity relative to the control except for HLCH (Table 1). Treatment of the starting lignins (HLCH, HLRH, HLWC) with hot water increases their sorptivity. This is explained by a change in the surface structure [4]. Thus, the starting lignins are considered to be sorbents with transitional pores according to the average radii of the submicroscopic capillaries (24-48 Å) [5]. Such sorbents typically have S-shaped sorption—desorption isotherms and can absorb large quantities of sorbate [6]. Modification of the starting lignin by sulfonation, piperidinomethylation, and phosphorylation of piperidinomethylated hydrolyzed lignin also changes the sorptivity and may be due to a change of the sorption mechanism.

The high sorptivity of SL was demonstrated previously using IR spectral studies [7] and was confirmed in the present work. SL does not bind cholesterol. With respect to selective sorption, this can be considered as a positive aspect that can be used further in practice. Therefore, we can talk about sorption that occurs through covalent binding, i.e., chemosorption. The reason for the selectivity is probably the 1.16% sulfur in the SL macromolecule.

In constrast with bile acids, which are present in the bile as sodium salts of the amide derivatives with glycine and taurine, cholesterol lacks such reactive groups as –NH– and $–SO_3H$. These groups may participate in the binding of bile acids by SL.

Piperidinomethylation and phosphorylation sharply decreases and even destroys the sorptivity of lignins for particular sorbates, for example, for PPMHL. This lignin sample sorbs deoxycholic acid and cholesterol, probably with formation of H-bonds between the sorbates phenol OH and the P=O group.

Thus, the study of sorption by technical lignins and their derivatives of the principal steroids of the living organism, bile acids and cholesterol, showed that treatment of the starting lignins with hot water increases their sorptivity compared with the control and may be due to a structure change that improves capillary—pore parameters such as the average radius of submicroscopic capillaries, specific surface area, and total pore volume [5]. The study also showed that modification of the starting lignin changes the selectivity of the sorption. This may be due to a change in the sorption mechanism, in particular, chemosorption. Chemosorption is specific and depends on both the sorbent and the sorbate properties.

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TABLE 1. Sorptivity of Technical Lignins and Their Derivatives for Bile Acids and Cholesterol, %

Lignin sample	Acid			
	Cholic	Deoxycholic	Taurocholic	Cholesterol
HLCH	40.2	14	0	0
HLRH	60	32.2	15	77
HLWC	70	22.2	30	73
SL	67.2	50	20	0
PMHL	25	32.2	30	73
PPMHL	0	0	30	83
Bilignin	51	5.3	0	0
Polyphepanum	70	22	20	13

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