Chemistry of Natural Compounds, Vol. 34, No. 3, 1998

SORPTION OF METAL IONS BY TECHNICAL LIGNINS AND THEIR DERIVATIVES

G. N. Dalimova, P. Yu. Shtyrlov, and M. R. Yakubova

UDC 547.99.992

Atomic absorption analysis has been used to study the sorption of lead, zinc, and iron ions by technical lignins and their derivatives. The capacity of technical lignins and some of their derivatives for forming complexes can be used for nature-protecting purposes and for the enterosorption of heavy-metal ions.

We have used atomic absorption analysis to study the sorption of lead, zinc, and iron ions by technical lignins and their derivatives.

The greatest sorption of lead and zinc ions took place on HLCSH (among the initial lignins). This is probably connected with the higher level of carbonyl groups in HLCSH: 7.1%, as compared with 4.3 and 3.5% in HLRH and HLSD, respectively. This hypothesis correlates with the conclusions from an IR-spectral investigation of the sorption of lead ions by hydrolysis lignins, where a shift of the absorption band of the stretching vibrations of an ester carbonyl at 1700 cm^{-1} by 80 cm^{-1} in the low-frequency direction showed the formation of a coordination bond between the stereochemically free pair of electrons of the lead and the oxygen atom of the carbonyl group.

In all probability, the analogous change in the stretching vibrations of CO groups observed in the IR spectra of DML, PMGL, and FPMGL (samples 7-9) witnesses a similar mechanism of metal–ligand complex formation with samples 1-3 (Table 1). According to the results of atomic absorption analysis, FPMGL sorbed more lead and zinc ions than PMGL and DML, which can be explained by the participation of the P=O group in binding the metal ions. In favor of this hypothesis is the change in frequencies in the region of stretching vibrations of the P=O bond (1070-1200 cm^{-1}) detected in the IR spectrum of FPMGL and indicating the possible presence of coordination and ionic metal–ligand bonds.

The sorption capacities of sulfo- and nitrolignins in relation to lead and zinc ions were greater than those of the other modified samples of hydrolysis lignin. This experimental fact can be explained by the previously established probability nature of the formation of a metal–ligand bond on the sorption of lead acetate by the above-mentioned lignins.

The sorption of iron ions on technical lignins took place considerably more feebly, and the tendencies observed in the sorption of lead and zinc ions did not appear. On analyzing the results for the sorption of iron ions it was possible to observe that neither the initial nor the modified lignins could be sorbents for iron ions.

For the sorption of lead ions almost all the samples, and in the case of zinc ions HLCSH, SL, and FPMGL, can be used as sorbents for these metal ions.

Thus, the capacity of technical lignins and some of their derivatives for forming complexes with lead and zinc ions can be used for nature-protecting purposes (purification of sewage) and also for the enterosorption of heavy-metal ions in the gastrointestinal tract, especially in view of the hepatoprotector properties of hydrolysis lignin itself [1].

EXPERIMENTAL

Determination of the Metals Content of Lignins. Lignin samples (25 mg) were weighed out on a Sartorius microanalytical balance with an accuracy of ±0.05 mg and each was ashed in porcelain crucibles in a muffle furnace at 550-

---

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, Tashkent, fax (3712) 89 14 75. Translated from Khimiya Prirodnykh Soedinenii, No. 3, pp. 362-363, May-June, 1998. Original article submitted December 29, 1997.

0009-3130/98/3403-0326$20.00

TABLE 1. Amounts of Metals Sorbed on Samples of Technical Lignins

Lignin sample	Pb^{2+}		Fe^{3+}		Zn^{2+}	
	mg/g	%	mg/g	%	mg/g	%
1. HLCSH + Me	157.5	54.9	1.74	1.0	41.2	20.4
2. HLRH + Me	67.8	23.6	2.62	1.5	6.4	3.2
3. HLSD + Me	32.9	11.5	1.80	1.0	2.6	1.3
4. SL + Me	165.1	57.5	7.3	4.3	12.5	6.2
5. NL + Me	136.0	47.4	3.0	1.8	36.6	18.1
6. CL + Me	100.0	34.8	14.3	8.3	4.5	2.2
7. DML* +Me	100.6	35.1	1.3	0.8	7.9	3.9
8. PMGL* + Me	83.3	29.0	3.5	2.1	10.9	5.4
9. FPMGL* + Me	132.8	46.0	3.7	2.1	14.7	7.3
10. OGL* + Me	46.4	16.2	1.9	1.1	5.1	2.5
11. FGL* + Me	100.3	35.0	1.5	0.9	7.4	3.6
Initial lignins						
12. HLCSH	0.05		0.16		0.014	
13. HLSD	0.12		0.06		0.0135	
14. HLRH	0.10		0.08		0.005	

---

*Meanings of these abbreviations unknown (but GL alone = "hydrolysis lignin" and F appears to stand for "phosphate"). For the others, see the paper at pp. 319-321 — Translator.

570°C for 2.5 h. The ash was dissolved in the minimum amount of concentrated nitric acid with moderate heating (sand bath) for 2 h, and then the solution was evaporated to the state of moist salts.

The moist salts were dissolved in 25 ml of 10% nitric acid, the solution was transferred to a 50-ml measuring flask, and the volume was made up to the mark with distilled water. The concentration of metal ions was determined on a Perkin-Elmer 3030 B atomic absorption spectrophotometer at a wavelength of 217.0 nm with a deuterium corrector background in a propane-air flame.

REFERENCE

1. T. Yu. Smetannikova, L. I. Salitrinnik, and O. I. Sergienko, in: Abstracts of Lectures at an International Scientific Conference on Progress in Technology and Techniques in the Food Industry [in Russian], Krasnodar, Sept. 19-21, 1994 (1994), p. 204.