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THE ABSORBING CAPACITY OF MACROPHYTES IN REGARD TO COPPER, COBALT AND NICKEL

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In cameral conditions, the absorbing capacity of macrophytes of different ecological groups in regard to cations of heavy metals - copper, cobalt and nickel – was studied. There was also explored the residual concentration of ions of heavy metals after the exposure of plants in the solution as an index of the biological absorption of toxicants. There was revealed a high absorbing capacity of immersed hydrophytes in wastewater with the simultaneous presence of some ions of heavy metals. Such kinds as *Ceratophyllum demersum* and *Elodea canadensis* were suggested for phytoremediational measures with the exposure of plants in the water no longer than 12 - 15 days.

Key words: macrophytes, heavy metals, copper, cobalt, nickel, cleaning of wastewater, wastewater, pollution of water with heavy metals.

Because of the elevated anthropogenic load on the wastewater and underdrained waters the level of pollution of these objects with different pollutants, in particular, with heavy metals is very high now [4]. The most dangerous among them are biogenic microelements. We study the absorbing capacity of different kinds of water macrophytes in regard to such cations as copper, zinc, nickel, cobalt, lead.

Earlier we discovered the high sorptional capacity of immersed macrophytes - Elodea canadensis and Ceratophyllum demersum - in regard to ions of different heavy metals [3]. The special interest is presented with the behavior spec of studied kinds in the presence of some cations of heavy metals. For this, we simulated water systems with dissolved salts of heavy metals of exact concentration in laboratory conditions with considering of processes of hydrolysis, coprecipitation and complexation.

The most unpretentious kinds of macrophytes, spread everywhere on the territory of Central Russia [1, 5]. The residual concentration of heavy metals after the exposure of macrophytes was fixed by means of the method of atomic adsorptional spectrometry on the 3rd, 6th, 12th, 15th day. The results of the research of the residual concentration of copper and cobalt in model solutions shown in the table 1.

Table 1 – The change of the concentration of ions of heavy metal ions Cu : Co

Macrophytes	Metals	Concentration (mg/l)

		3rd day	6th day	12th day	15th day	Control
Elodea canadensis	Cu	0,410	0,270	0,173	0,122	2,046
	Co	0,138	0,157	0,151	0,151	2,003
Lemna trisulca	Cu	1,850	1,510	1,223	0,980	2,046
	Co	0,158	0,159	0,156	0,162	2,003
Lemna minor	Cu	0,980	0,822	0,672	0,438	2,046
	Co	0,175	0,172	0,177	0,179	2,003
Utricularia vulgaris	Cu	0,888	0,985	0,839	0,454	2,046
	Co	0,180	0,150	0,159	0,154	2,003
Ceratophyllum demersum	Cu	1,032	0,864	0,464	0,342	2,046
	Co	0,169	0,160	0,169	0,153	2,003

The data of this experiment prevailing absorbing of ions of cobalt with macrophytes from the solution containing cobalt and copper in a concentration of about 2 mg/l, especially during the first 6 days of exposure plants. So, in the experiment with swimming kinds of duskweed (Lemna) the concentration of copper on day 6 after exposure of the plants decreased by only 1.4 and 2.5 times, whereas the concentration of cobalt - 12.6 and 11.6 times.

Immersed macrophytes have higher sorptional capacity in regard to copper and cobalt, but here we see the tendency to accumulation of predominantly cobalt by plants. Possibly, it could be explained, firstly, with the less atomic radius of cobalt compared with copper, it means the bigger bioavailability; secondly, with the structure of the electronic covering of the atom of cobalt, which determines the bigger leaning to complexation than copper has, it means the bigger biological activity of this metal, also cobalt as part of enzymatic complex of plants [2]. The lowest index of the residual concentrations of heavy metals that means the best absorbing and cleaning of the solution, was observed in a case with Elodea Canadensis. The concentration of copper has decreased 7.5 times jn the 6th day, the concentration of cobalt - 12.8 times. During some next days, the concentration of these metals kept decreasing and reached the minimum on the 15th day. The phenomenon of desorption of cations of heavy metals back into the solution, that was observed earlier, was not seen in the case with Elodea canadensis during over two weeks of the experiment. That proves the presence of high qualities of this macrophytes, what is necessary for bioremediation of wastewaters and underdrained waters of copper and cobalt.

We analyzed also the absorbing capacity of experimental macrophytes in regard to copper and nickel at the simultaneous presence of these ions in the solution (table 2).

Table 2 – The change of concentration of ions of heavy metal (Cu: Ni)

Macrophytes	Metals	Concentration (mg/l)

		3rd day	6th day	12th day	15th day	Control
Elodea canadensis	Cu	0,196	0,151	0,081	0,094	2,000
	Ni	0,079	0,071	0,067	0,060	2,000
Lemna trisulca	Cu	0,284	0,242	0,204	0,224	2,000
	Ni	0,079	0,073	0,083	0,084	2,000
Lemna minor	Cu	0,333	0,299	0,274	0,240	2,000
	Ni	0,101	0,081	0,074	0,080	2,000
Utricularia vulgaris	Cu	0,411	0,383	0,234	0,178	2,000
	Ni	0,105	0,070	0,072	0,077	2,000
Ceratophyllum demersum	Cu	0,067	0,067	0,093	0,095	2,000
	Ni	0,052	0,040	0,048	0,074	2,000

The same as in the previous experiment plants absorb nickel firstly, not copper. However, at the presence of nickel the absorbing of copper from the solution by macrophytes goes much quicker than at the presence of cobalt. Likely, it could be explained with a great chemical similarity of copper and nickel. The absorbing capacity during the first 3-6 days of exposure is higher at Ceratophyllum demersum both in regard to the copper cation (the concentration of the metal has decreased 30 times in a model solution), and in regard to the nickel cation (the decrease of the residual concentration 38 times). Beginning since the 12th day of the experiment the phenomenon of the desorption of heavy metals back into the solution was observed. That proves the minor increase of the concentration of copper and nickel.

In the case with Elodea canadensis the concentration of copper and nickel in the solution has decreased, reached the minimum of the 15th day. Therefore, these kinds of immersed macrophytes have the best sorption of heavy metals from solutions, that allows us to recommend Elodea canadensis and Ceratophyllum demersum for the phytoremediation of wastewater.

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