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NAA for studying detoxification of Cr and Hg by Arthrobacter globiformis

Bacterial reduction and detoxification of potentially toxic metals is one of most promising strategies for the bioremediation of contaminated environmental media. In our previous studies we have established that the Gram-positive bacterial strain Arthrobacter globiformis isolated from basalts taken from ecologically mostly polluted region of Georgia (Marneuli) can reduce and detoxify of Cr(VI) with high efficiency [1]. In the present investigation instrumental neutron activation analysis (INAA) was applied to study (1) accumulation of Cr(VI) in A. globiformis in the presence of Hg(II); (2) accumulation of Hg(II) in bacterial cells; and (3) effects of Hg (II) and mixture of Cr(VI) - Hg(II) on the elemental composition of bacteria. Our experiments were focused on the dose-dependent effects of Cr (VI) and Hg(II). Cr(VI) as [K2CrO4] and Hg(II) as [Hg(NO3)2• H2O] were added to the bacterial cell cultures at an early stationary phase of their growth. Two sets of experiments were performed. In the first set the concentration of Hg(II) varied within the range of 50–5000 μg/L. In the second set a 500 μg/L concentration of Hg(II) was added to the bacterial cells at each given concentration of Cr(VI) within the range of 50–1000 mg/L. According to the results obtained, the dose-dependent character of Cr(VI) accumulation by the tested bacterial strain was not significantly affected by the presence of Hg(II). Accumulation of Hg(II), similar to the Cr(VI) accumulation, follows well the Lengmuir-Freundlich model. Besides, NAA measurements showed increased content of Fe in bacteria under Hg and Cr action, suggesting that Fe-containing biomolecules play a decisive role in detoxifying of heavy metals by A. globiformis. A concentration of 5000 μg/L of Hg(II) was found to be critical for A. globiformis. At this concentration of Hg(II) the concentrations of both essential (Na, Mg, Al, Cl, K, Mn, Zn) and some non-esential elements (Rb, Sb, Sc, As) changed drastically along with a decrease of the biomass of bacteria by a factor of 2. One may assume that under this high exposure to Hg(II) the structure of the bacterial cell wall was destroyed. Acknowledgement: We are grateful to STCU for their support (Grant #4330)

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