Sorption of Toxic Metals by Medicinal Basidiomycetes

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Owing to the great amount of industrial activity throughout the last century, heavy metal contamination of the environment has become a serious problem threatening human health to a great extent. Cell walls of mushroom fruiting bodies and mycelium are excellent biosorbents for heavy metals. One of the most important metal-binding substances of mushroom cell walls is chitin (structural polyaminosaccharide). Chitin-containing biomass may serve as an effective toxic metal enterosorbent, as chitin–metal complexes are removed from the human body with other undigested remains of food.

Higher Basidiomycetes are known to be promising producers of biologically active substances. Preparations from fungal biomass and cultural media are used as antitumor, antiviral, anti-AIDS, and other medicines. Byproducts of the mushroom fermentation processes contain cell wall materials that can be used as a substrate for obtaining heavy metal sorbents.

The biosorption of eight toxic metal ions (lead, nickel, copper, cadmium, manganese, zinc, iron, and cobalt) has been studied using submerged mycelium of basidiomycetes known for their medicinal properties. They belong to the genera Pleurotus, Lentinus, Crinipellis, Coriolus, Piptoporus, Inonotus, and Phellinus. It was determined that sorption capacity depended on cell wall composition, species of metal, and sorption conditions. Isolated chitin–glucan complex exhibited higher sorption capacity in comparison with pure chitin. It has been found that alkali treatment of most mushroom mycelia improved their capacity to bind metals ions. It is quite possible that the removal of amorphous polysaccharides from cell walls by alkali hydrolysis generates more accessible space for metal binding within the glucan–chitin skeleton.

From 35 studied mushrooms, Coriolus hirsutus (Fr.) Pat. and Phellinus robustus P. Karst. showed the highest sorption activity. Heavy metal sorption from diluted solutions by C. hirsutus mycelium decreased in the order: Fe3+ > Cd2+ > Pb2+ > Cu2+ > Ni2+ > Co2+ > Mn2+ > Zn2+. C. hirsutus biomass sequestered 1.5–10 times more cadmium (one of the most toxic metals) than other investigated fungi. For Ph. robustus biomass the order of metal affinity was: Fe3+ > Cd2+ > Cu2+ > Zn2+ > Pb2+ > Ni2+ > Co2+ > Mn2+.

Investigations of C. hirsutus cell wall composition revealed that they contained 82% of polysaccharides including chitin (31%), associated with alkali-insoluble heteroglycan (13%). The latter consisted of glucose (84%), xylose (12%), and a minor amount of galactose (3%). Infrared spectra showed that various configurations of glycosidic bonds could be detected in polysaccharide fractions of C. hirsutus cell walls.

Binding of heavy metal ions by mushroom biomass depended on ion concentration and solution acidity. Investigation of the influence of pH on mycelium and chitin–glucan complex sorption capacity showed that the most favorable conditions for most heavy metal sorption are provided by a neutral or low alkaline medium, which reflects intestinal conditions.