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TYPES OF BIOSORBENTS OBTAINED BY CHEMICAL MODIFICATION OF WASTE FROM FOOD PRODUCTION ENTERPRISES

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Abstract. Biomasses of microorganisms are used as sorbents in the determination and sorption separation of heavy metal ions from the composition of industrial effluents and waste. A biosorbent was prepared from Saccharomyces Cerevisiae microorganism and yogurt whey, and the composition of the biomasses was studied.

Key words: Sorbent, microorganisms, whey, biosorption, Saccharomyces Cerevisiae

Amino acids, as well as covalent bonds with sulfhydryl groups in proteins. Thus, the toxic effects of heavy metals are not specific in nature, so they can combine with proteins, nucleotides, coenzymes, phospholipids, porphyrins, i.e. with practically all types of substances involved in cellular metabolism. In addition, by interacting with the groups of the active center of enzymes of microorganisms or replacing individual ions in them, heavy metals lead to their inhibition. When talking about the anthropogenic effect on biota, it should be noted that many metals in concentrations are necessary for the life of soil biota (Zn, Cu, Mn, Co, Cr, etc.), however, at high concentrations they become toxic and a number of metals are very toxic in small amounts. Concentrations (Ag, Pb, Hg, Cd, etc.) and can be affected in one way or another. Currently, many studies are being conducted on the effects of metals in the soil on microscopic fungi. It is known that pollution soil heavy metals can oppress the community microscopic fungi in the soil or stimulate their development. For example, in some types of soil, strontium dramatically increases the formation of toxins and stimulates the growth of Fusarium fungi. The greatest toxic effect on soil biota is set for cadmium (Cd), the lowest - for lead (Pb). In soils constantly polluted with industrial waste, micromycetes are able to accumulate Cu and Ni in a dry amount of 0.3-1.5%. This ability of fungi allowed a number of authors to propose[6]

Reduction of heavy metal ions by microbial cells

Microbial cells can convert metal ions from one oxidation state to another, thus reducing their toxicity [9]. Bacteria use metals and metalloids as electron donors or acceptors to produce energy. Metals in the oxidized form can serve as terminal acceptors of electrons during the anaerobic respiration of bacteria. Reduction of metal ions by enzymatic activity can lead to the formation of less toxic forms of mercury and chromium [4].

Bioremediation of heavy metals by microorganisms

The toxicity of heavy metals is the ability of the metal to have a harmful effect on microorganisms, and it depends on the bioavailability of the heavy metal and the absorbed dose [3]. The toxicity of heavy metals involves several mechanisms, namely disruption of destructive enzymatic functions, reaction as redox catalysts to produce reactive oxygen species (ROS), disruption of ion regulation, and direct effects on DNA and protein formation. does [2] . Physiological and biochemical properties of microorganisms can be changed by the presence of heavy metals. Chromium (Cr) and cadmium (Cd) can cause oxidative damage and denaturation of microorganisms, as well as weaken the bioremediation ability of microbes.

Chromium Cr(III) can change the structure and activity of enzymes by reacting with their carboxyl and thiol groups [5]. Intracellular cationic Cr(III) complexes interact electrostatically with negatively charged phosphate groups of DNA, which can affect transcription, replication, and cause mutagenesis [3].

Heavy metals such as copper (Cu(I) and Cu(II)) can catalyze the production of ROS through Fenton and Haber-Weiss reactions, which act as soluble electron transport. It can cause severe damage to cytoplasmic molecules, DNA, lipids and other proteins [8]. Aluminum (Al) can stabilize superoxide radicals responsible for DNA damage [10]. Heavy metals can disrupt vital enzymatic functions through competitive or non-competitive interactions with substrates leading to configurational changes in enzymes [3]. In addition, it can adhere to the cell surface and enter through ion channels or transmembrane transporters, causing ion imbalance [6].

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Cadmium (Cd) and lead (Pb) have a harmful effect on microbes, destroy cell membranes and destroy DNA structure. This toxicity is caused by displacement of metals from their native binding sites or ligand interactions [7]. Changing the nucleic acid structure, causing functional disorders, destroying cell membranes, inhibiting enzyme activity and oxidative phosphorylation [8, 9] affect the morphology, metabolism and growth of microbes.

The propensity of heavy metals to be stimulatory or inhibitory to microorganisms is determined by related factors such as total metal ion concentration, chemical forms of the metals, and redox potential. Environmental factors such as temperature, pH, low molecular weight organic acids, and humic acids can alter the transformation, transport, valence state, and bioavailability of heavy metals to microorganisms. Heavy metals form free ionic species at acidic pH, with more protons available to saturate metal binding sites. At a high concentration of hydrogen ions, the surface of the adsorbent is more positively charged, so the attraction between the adsorbent and metal cations decreases, which increases its toxicity.

Temperature plays an important role in the adsorption of heavy metals. An increase in temperature increases the adsorbate diffusion rate across the outer boundary layer. The solubility of heavy metals increases with increasing temperature, which improves the bioavailability of heavy metals [4]. However, the effect of microorganisms is enhanced by increasing the temperature in a suitable range, and this enhances the microbial metabolism and enzyme activity, which accelerates bioremediation. The stability of the microbe-metal complex depends on the sorption sites, the configuration of the microbe cell wall, and the ionization of chemical moieties in the cell wall. The outcome of the degradation process depends on the substrate and a range of environmental factors.

Mechanism of microbial detoxification of heavy metals

Microorganisms adopt different mechanisms to interact and survive in the presence of inorganic metals. Different mechanisms used by microbes to survive metal toxicity are biotransformation, extrusion, enzyme utilization, production of exopolysaccharide (EPS) [1 , 6] and synthesis of metallothioneins. In response to metals in the environment, microorganisms have developed remarkable mechanisms of metal resistance and detoxification. The mechanism involves several procedures including electrostatic interaction, ion exchange, precipitation, redox process, and surface complexation [7]. The main mechanistic means of resistance to heavy metals by microorganisms are oxidation of metals, methylation, enzymatic reduction, reduction of metal-organic color, reduction of metal, cleavage of metal ligands, metal efflux pumps, demethylation, sequestration of intracellular and extracellular metals, o Exclusion and production with a permeability barrier. of metal chelators such as metallothioneins and biosurfactants [8].

Microorganisms can neutralize metals by valence conversion, volatilization, or extracellular chemical precipitation [4]. Microorganisms have a negative charge on their cell surface because there are anionic structures that allow microbes to bind to metal cations [9]. The negatively charged sites of microbes involved in metal adsorption include hydroxyl, alcohol, phosphoryl, amine, carboxyl, ether, sulfhydryl, sulfonate, thioether, and thiol groups.

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