Water remediation using biosurfactants and metallothioneins immobilized in bacterial cellulose and alginate microcapsules

Contamination with heavy metals and synthetic organic compounds is common in the wastewater of many industrial processes, causing serious threats to human health and ecological systems. Currently used methods for treating sewage water, although effective in reducing the level of pollutants, they do not eliminate them completely. According to the literature, even minimal concentrations of heavy metals and synthetic organic compounds in the aquatic environment, at the level of a nanogram per liter, can cause disastrous effects. The accumulation of heavy metals and synthetic organic compounds is becoming an increasingly serious civilization problem. The high toxicity of heavy metals and the toxic properties of some organic substances make the selection of appropriate methods for purifying water resources of great scientific and practical importance.

Various industrial-scale treatment technologies are used to remove heavy metals, preservatives, pesticides and drugs from water media, such as chemical precipitation, flocculation, coagulation, solvent extraction, adsorption, complexation, electrokinetics, membrane filtration, etc. In recent years, environmental purification uses various new solutions based on synthetically cross-linked polyacrylic hydrogels. However, large-scale use of synthetic materials may not be a practical solution because they are very expensive. For some time now, research has been carried out on replacing synthetic hydrogels with natural, biodegradable products, e.g. produced by microorganisms. To meet the challenges, we intend to obtain biopolymer materials composed of microbial biosurfactants and metallothioneins immobilized in bacterial cellulose and alginate microcapsules. These innovative materials are to be used to create a system that removes heavy metals and organic compounds polluting the natural environment. An innovative aspect of the project is the use of new microbiological surfactants and metallothioneins, not previously used in the processes of removing toxic metals from sewage water. The biosurfactants used in the research will be lipopeptides produced by *Bacillus subtilis* and *Pseudomonas fluorescens* bacteria, which are characterized by high biodegradability and low toxicity. They also show high stability under various pH, temperature and salinity.

The main goal of the proposed research project is to conduct systematic basic research enabling the characterization of modified natural hydrogels, as well as determining the impact of lipopeptide biosurfactants and metallothioneins on the adsorption properties. A special added value of the project is the comprehensive approach to correlating experimental results with the results of molecular dynamics simulations. Our additional goal is to check the toxicity of modified biopolymers towards healthy cells.

The research tasks planned as part of this project are basic research, however, they may constitute the basis for developing a modern water treatment method in the future. Moreover, they will constitute a solid foundation for conducting further, more detailed research in this area. The use of biosurfactants and metallothioneins immobilized in bacterial cellulose and alginate microcapsules in the water remediation process may be a more ecological alternative to currently used synthetic polyacrylic hydrogels.