Cellulose-pectin hydrogels cross-linked with divalent metal ions for immobilization of antagonistic microorganisms

Today, one of the main global challenge is to stop environment degradation and to ensure food safety. One of effective strategy of life quality improvement is to replace common fossil-based products by natural-based biodegradable materials of plant or biotechnological origin. Impact of agricultural practices on global warming and pollution of soil and water is very significant, especially usage of fertilizers and agrochemicals. Limitation of using agrochemicals in food production is necessary and one of the solutions is application of natural methods of stimulating yield and protection against pathogens. Antagonistic microorganisms can significantly enhance plant productivity and yield in cropping systems through their influence on plant growth and suppressing plant disease. In order to provide such beneficial microorganisms to crop plants an usage of protective substances is required. Agrogels, which are used as carriers of beneficial microorganisms now, are based on artificial polymers, which are soil pollution.

The aim of the project is application of natural biocomposite based on bacterial cellulose produced by microorganisms and pectins acquired form apples as a new carrier of antagonistic microorganisms.

Fully biodegradable hydrogel with high water capacity will be able to improve water retention in soil as well. Bacterial cellulose, described as “never-dried” material can play similar function to artificial hydrogels. Previous research shown that bacterial cellulose, synthetized by *Komagateibacter xylinus* strain, can form stable biocomposite-hydrogel with pectic compounds. However, interactions between bacterial cellulose and pectins which determine hydrogel properties have not been characterized yet. In the project detailed research on the interactions between components of the hydrogel are planned. To this purpose three kinds of pectins will be used: soluble in water, soluble in calcium chelator and soluble in sodium carbonate. This separation of pectic compounds extracted from apple parenchyma make possible precise description of cellulose-pectin interactions and in consequence further hydrogel modifications. The main modifications of hydrogel properties will be cross-linking of pectic compounds with selected divalent metal ions, such as Ca^{2+}, Mg^{2+}, Fe^{2+} and Zn^{2+}, and enzymatic and ultrasound treatment. Cross-linking of pectic component of the hydrogel will let for regulation of biocomposite porosity and tailoring of its rheological properties in a controlled way. Application of ultrasounds and enzymes enables obtaining required structure of the hydrogel in macro- and supramolecular scale.

Next project stage if preparation of the hydrogel in the form suitable to immobilization of antagonistic microorganisms. It will be conducted by two methods:

- immobilization of microorganisms in thin layers of the hydrogel, which could be used as coatings for plant crops,

- encapsulation of microorganisms by means of spray-drying, which will result in closing of microorganism cells in microcapsules of several dozen micrometer size. Encapsulated microorganisms could be dispensed to biofertilizers.

In order to check suitability of the hydrogel for delivery of antagonistic microorganisms tests of viability of microorganisms (*Trichoderma atroviride*) and biodegradation of hydrogels will be performed. Biodegradation will be carried out directly in soil. Effects of degradation will be characterized with atomic force microscopy and chemical and structural analysis by spectroscopic methods. Developed in the project hydrogel should maintain high microorganisms viability and release them in target destination in controlled way.