Programme title: Food Chemistry

Mode of study: full-time

Topic title: Bacterial Cellulose-Based 3D Carriers for Probiotic Yeasts: Co-Cultivation and Functional Performance in Food Applications

Supervisor: prof. Ing. Adriána Kovalčík, Ph.D.

Specialist supervisor: prof. RNDr. Ivana Márová, CSc.

Description: This doctoral thesis focuses on the development of edible three-dimensional carriers for viable probiotic yeasts based on bacterial cellulose (BC), prepared through the co-cultivation of BC-producing microorganisms and selected probiotic yeast strains. Co-cultivation enables the in situ immobilization of yeasts within the forming nanofibrillar BC network, which may enhance their stability during storage and support controlled release under simulated gastrointestinal conditions.

The objective of the study is to optimize co-cultivation parameters and to comprehensively characterize the resulting BC biofilms/hydrogels in terms of their microstructure, physicochemical properties, and the viability of immobilized yeasts, including their release behavior and storage stability.

The applied part of the research will focus on the development of a “probiotic insert” format for beverages, in which the BC hydrogel serves as a carrier with defined probiotic viability and a controlled release profile. The outcomes of this work may contribute to the development of novel probiotic food systems with high added value.

Topic title: Study of New-Type Probiotics and Their Biological Effects

Supervisor: prof. RNDr. Ivana Márová, CSc.

Specialist supervisor: Ing. Simona Dzurendová, Ph.D., Ing. Jiří Holub, Ph.D.

Description: Probiotics are live microorganisms that naturally occur in the human body and have numerous positive effects. They are most commonly bacteria which, when consumed in appropriate amounts, contribute to maintaining the user’s proper health status. Increasingly, selected yeasts are also classified as new-type probiotics, and their spectrum continues to expand. Bacteria and yeasts can form consortia and significantly influence each other as well as affect the intestinal microbiota and other systems.

The subject of the dissertation will be the study of possibilities for combining known species of probiotic bacteria with selected, less common species of probiotic yeasts cultivated in co-culture and subsequently in biofilm. The work will include testing cultivation conditions for these organisms on suitable substrates and evaluating their growth, metabolic activity, production of bacteriocins, and mutual interactions within the consortium (cultivation methods, microscopy, morphology, flow cytometry). Furthermore, the project will optimize a panel of analyses describing probiotic effects and the synergistic effects of probiotics, probiotics and postbiotics involved in consortia. As part of safety, harmlessness, and biological effect studies, a battery of cytotoxicity tests on human cell cultures with various detection types will be optimized. A detailed characterization of probiotic application forms will

be carried out, and their biological effect and stability will be tested under various model conditions and in real systems.

Topic title: Employment of molecular techniques for study and engineering of biotechnologically relevant thermophilic bacteria

Supervisor: prof. Ing. Stanislav Obruča, Ph.D.

Description: Thermophilic bacteria, particularly representatives of the genera *Aneurinibacillus* and *Caldimonas*, represent promising model systems with substantial application potential in a wide range of biotechnological processes and products. The aim of this doctoral thesis is to achieve a detailed understanding of the metabolism of these bacteria using modern molecular techniques, with a primary focus on their biotechnological applications.

Within the scope of this work, metabolic engineering tools will be developed and applied to enable targeted modification of selected metabolic pathways, with the goal of enhancing the biotechnological potential of the studied thermophilic bacteria. These approaches will be primarily employed to optimize processes such as the production of microbial polymers and the biotransformation of phenolic compounds.

An integral part of the dissertation will be the evaluation of the biotechnological performance of the engineered strains in laboratory-scale bioreactors, including detailed characterization of cultivation processes and analysis of the resulting products.

Topic title: Thermophilic microorganisms as tools for circular bioeconomy

Supervisor: prof. Ing. Stanislav Obruča, Ph.D.

Description: Rational management of raw materials, particularly their reuse and recycling, is a fundamental prerequisite for a sustainable economy. In this context, thermophilic microorganisms offer significant application potential, as they enable the valorization of a wide range of secondary raw materials, including lignocellulosic biomass as well as waste streams containing biodegradable polymeric materials.

The aim of this doctoral thesis is to investigate biotechnological strategies based on the use of selected strains of the bacterial species Caldimonas thermodepolymerans for the processing of lignocellulosic materials of agricultural and food industry origin, as well as biodegradable polyesters.

The work will include the screening of different process strategies, their detailed characterization, and subsequent optimization of selected process scenarios. The research will involve the use of mini-bioreactor systems for the optimization of cultivation conditions, including advanced cultivation modes such as continuous cultivation, followed by the transfer of the developed processes to laboratory-scale bioreactors.

An integral part of the doctoral thesis will also be a basic techno-economic analysis of the developed biotechnological processes.