Bioavailability and Impact on Gut Microbiota of Microencapsulated Bioesters of Linseed Oil Enriched with Oil Derived from Food Industry By-Products – *In Vitro* Studies

Civilization diseases are globally and commonly occurring conditions whose development and spread are caused by civilizational changes (urbanization, environmental pollution, stressful work, and living environments) and human behaviors (improper diet, low physical activity). It is estimated that civilization diseases are responsible for over 80% of deaths worldwide. Changes in dietary habits, such as increased consumption of high-fat and processed food products, have led to imbalances in the proper omega-6 to omega-3 fatty acid ratio, which is cited as one of the main causes of diet-related diseases. Linseed oil is one of the most valuable sources of polyunsaturated fatty acids from the omega-3 family, particularly alpha-linolenic acid. However, linseed, in addition to its nutrient and bioactive content, also contains antinutritional substances. Another problematic aspect of linseed oil is that it is chemically unstable, sensitive to light and atmospheric oxygen, limiting its application possibilities. Therefore, alternative sources of omega-3 fatty acids, such as ethyl esters of linseed oil, are being sought.

Another issue we face is food waste. According to European circular economy policy, sustainable development goals, and the "zero" or "less" waste concept, proper waste management is one of the main challenges facing the food industry. Thus, utilizing by-products, such as pomegranate seeds, is extremely important. Numerous scientific studies have shown potential health benefits associated with the consumption of pomegranate seed oil, particularly due to the presence of punicic acid, which exhibits strong anti-inflammatory, antioxidant, and anticancer properties. However, oils rich in polyunsaturated fatty acids are chemically unstable, prone to losing their nutritional and bioactive values, necessitating processes like microencapsulation to potentially mitigate these changes. Microencapsulation is a process of creating a functional barrier between the core (active substance) and the wall material (encapsulating agent), aimed at preserving the biological, functional, and physicochemical properties of the core materials. To date, plant polysaccharides (gum arabic, maltodextrin, cellulose, chitosan), microbial origin polysaccharides (xanthan gum), as well as plant (from corn, wheat, legume seeds) and animal proteins (gelatin, albumin, beta-lactoglobulin) have been widely used for microencapsulation of biologically active substances. An interesting protein that has not yet been used for this purpose is potato protein, showing potential for use as a wall material in microcapsules. An innovative solution would be to use polysaccharides with additional functionality, such as prebiotic effects, like inulin or nutriose.

The project's aim is to assess the bioavailability and impact on gut microbiota of microencapsulated mixtures of linseed oil bioesters and pomegranate seed oil stabilized with innovative protein-polysaccharide complexes. It is assumed that the obtained preparation will be characterized by increased bioavailability, chemical stability, and health-promoting properties. The project consists of four research tasks. The first will involve the preparation and determination of the physicochemical properties of the microcapsule core material, i.e., a mixture of ethyl esters of linseed oil and pomegranate seed oil. The second stage will involve the preparation of an emulsion stabilized with protein-polysaccharide complexes and the determination of their physicochemical properties. In the next stage, these emulsions will be converted into microcapsules using the spray-drying method. In the final stage, the prepared microcapsules will be examined for bioavailability and their impact on gut microbiota.

The presented project may contribute to progress in the field of food technology by introducing new solutions in the area of wall materials used in the microencapsulation process, effectively utilizing waste raw materials, and improving the bioavailability of bioactive components. Moreover, determining the bioavailability and impact on gut microbiota of the created microcapsules could form the basis for developing dietary supplements and functional foods.