Metabolomics approach for the comprehensive evaluation of fermented foods. Influence of lactic fermentation on the quality of selected plant materials.

Fermented foods have been a fundamental part of human diets for thousands of years. Fermentation is a natural process where microorganisms like bacteria, yeasts, and molds convert organic compounds into alcohol or organic acids under anaerobic conditions. Fermentation enables the natural extension of the shelf life of sensitive, often seasonal vegetables and fruits, which on the one hand limits the use of synthetic food additives and, on the other hand, is also a good alternative to the import of fresh products, thus reducing the carbon footprint. Fermented products enable the diversification of the food industry assortment, offering consumers new sensory experiences (taste, texture, smell, color) while providing bioactive compounds with health-promoting properties. Additionally, in the face of the growing problem of greenhouse gas emissions related to both animal breeding and feed imports, society is encouraged to increase the consumption of food of plant origin, especially local products. Conscious dietary choices bring benefits not only for logistic, economic and ecological reasons, but also contribute to improving human health.

Traditional Polish fermented foods, such as fermented white cabbage, cucumber and red beet, undergo lactic acid fermentation, a process driven by lactic acid bacteria (LAB) that produce lactic acid from sugars, creating an acidic environment that preserves the food and contributes to its distinctive sour taste. The aim of the project is a new, in-depth look at these products that have been known in Poland for centuries through the use of modern equipment solutions. The proposed project is part of an innovative approach to food research called "foodomics", which deepens knowledge about food and nutrition through the use and integration of advanced -omics technologies. One of the areas of foodomics is metabolomics, which in this project will be used to monitor the transformation of as many small-molecule metabolites as possible and determine their impact on selected health-related biological activities in the process of spontaneous and directed fermentation of plant raw materials traditional in Poland.

The results obtained from analyzes using Ultra High Performance Liquid Chromatography (UHPLC), High Performance Thin-Layer Chromatography (HPTLC) and High Resolution Mass Spectrometry (HRMS), combined with appropriate multidimensional statistical analysis, will enable an in-depth understanding of the impact of fermentation and storage on selected quality parameters of fermented vegetables. They will allow, among other things, to answer the questions whether and how fermentation affects the health-promoting compounds contained in a given plant material, what happens to them during storage and which of them are responsible for desired or undesirable changes. This approach fits into the modern trend of food research, in which food is perceived not only as a source of essential nutrients, but also as a means of preventing the development of lifestyle diseases and supporting broadly understood health. Obtaining such information will certainly be of interest to scientists and the food industry involved in designing functional foods or developing ways to valorize plant industrial by-products in a circular economy. An important result of the project will also be the demonstration of the usefulness of food metabolomics analyzes as an effective alternative and/or complement to traditional quality assessment of fermented foods. In order to disseminate the acquired knowledge, the research results will be published in prestigious, peer-reviewed international scientific journals.