

Population ageing is a global issue of the 21st century, affecting numerous areas of life, including the food sector. With such a changing demographic structure, providing nutritious and visually appealing food for the elderly or patients in hospital has become a significant challenge. A technology that enables the creation of such foods is 3D printing, which allows the preparation of products with complex structures, obtained layer by layer, according to a designed digital model. The advantage of this technology is that the nutritional and sensory characteristics can be customised to meet individual consumer needs. However, most food products, including fruit, can only be printed after processing and the addition of substances improving their fluidity. Most such substances are not perceived positively by consumers (e.g. guar gum, carrageenan), require specific gelling conditions, or take a very long time to gel. The addition of proteins to fruit can improve the texture of products and, in addition, contribute to their enhanced nutritional value. However, most plant proteins are characterised by poor functional properties compared to animal proteins, so methods of modifying their properties that are also environmentally friendly should be explored. The formation of complexes with pectins and selected physical methods (ultrasound and microwave treatments) can alter the structure and improve the properties of plant proteins, and thus increase their applicability.

The aim of the project is to provide a comprehensive evaluation of the potential of using hemp protein-pectin complexes to create 3D printing pastes from fruit pomace. The effects of ultrasound and microwave treatments on selected properties of the complexes will be investigated. In addition, microwave-vacuum drying with different parameters, as well as convection drying and freeze-drying as reference methods, will be carried out to evaluate the possibility of preserving the printed material.

Hemp protein isolate or concentrate and selected citrus and/or apple pectin preparations will be used to form complexes. The complexes will be subjected to ultrasonic and microwave treatments, and their physical and chemical properties will be investigated. In parallel, fruit pomace of the desired consistency and structure will be obtained by juice pressing, homogenisation and sieving. Protein-pectin complexes with the most promising properties will be added to the processed pomace to produce a paste for 3D printing. The 3D printing process will be optimised, taking into account numerous parameters, including nozzle diameter, printing speed or infill level, and the physical and chemical properties of the printed pastes will be investigated. Selected print variants will be subjected to microwave-vacuum drying, in which temperature, pressure and microwave power will be optimised.

The research hypothesis assumes that the appropriate composition (type of pectin, protein concentration and protein/pectin ratio), environmental conditions (pH, temperature, ionic strength) and mild facilitating treatment (ultrasound, microwaves) will allow hemp protein-pectin complexes with the desired functional properties to be obtained and can be used to improve the printability of fruit pomace. The research will be a response to global issues such as the management of by-products from the food industry (pomace, pectin - fruit and vegetable industry, hemp protein - oil industry) or the growing demand for plant-based foods - both natural and nutrient-rich. The proposed research will help to understand the interactions between hemp protein and pectin subjected to selected physical treatments, which may contribute to the potential use of such complexes as alternatives to negatively perceived stabilisers used in plant-based foods. In addition, the research will provide new knowledge on the printability of fruit pomace and the possibility of using protein-pectin complexes to improve the printability of food pastes. The results of the research may also be interesting in relation to the search for solutions for the preservation of 3D printed products, which could help to increase their availability on the market in the future.

The results of the project may be relevant in the future for the design of foods with defined sensory characteristics, e.g. specific texture and structure, as well as nutritional characteristics, e.g. increased content of biologically active ingredients.