

The management of by-products and waste from the agri-food industry in accordance with the idea of sustainable development is a serious challenge today. About 5-7 million tons of apple pomace is produced per year. Rational management requires treating this waste as a valuable raw material that can be reused or processed. Therefore apple pomace should be considered as an extremely valuable source of health promoting chemicals with antioxidant, immunomodulating, chemopreventive, anti-aging, antimicrobial or prebiotic properties which may be used as food nutrients, diet supplements or drugs. Broad and not fully understood mechanism of biological activity apple constituents is responsible for their multi-dimensional spectrum of health-promoting effects. Phenolic compounds and pectin are the main health promoting constituents of apple pomace. Phenolic compounds are believed to be mainly responsible for its antioxidant properties. Unfortunately many of them have poor bioavailability from the gastrointestinal tract and skin penetration ability which is mainly caused by their low aqueous solubility, poor stability, lipophilicity and difficulty crossing membranes. This limits the application of plant extracts and their constituents. The encapsulation technology emerges as a promising technology for overcome this problems. Depending on the carrier material and method of synthesis, encapsulation may provide several advantages to the capsuled molecules and the final product including: enhanced solubility, prolonged shelf-life, reduced toxicity or side-effects, sustained release, improved dispersibility, bioavailability, texture/flavor, targeted delivery, mixing of incompatible ingredients. Nanoparticles (NPs) can be produced using pure phenolic compounds (as a single molecule) or with extracts rich in different phenolic compounds obtained during extraction of biomass. Binding the core with phenolic compounds allows for the protection of bioactive compounds from severe conditions of light, heat, and oxygen, in addition to serving as a carrier for control and release of the active compound. Therefore in this study several non-toxic, biodegradable, biocompatible, considered as safe food additive, natural nanocarriers (liposomes, cyclodextrin, pectin, chitosan) and different formulation methods was chosen to prepare extract-loaded and polyphenol-loaded NPs. We suppose, that the obtained nanoformulations will have higher antioxidant, regenerative and prebiotic properties comparing with the initial extracts or single phenolic compounds. We suppose that the synergistic or additive effects between nanocarriers and phenolic compounds may additionally increase the biological activity of NPs.

The overall idea of the project is an application of modern green extraction methods and nanotechniques for comprehensive management of by-products and waste from food industry (apple pomace) in accordance with the idea of sustainable development via: (1) application of different modern green extraction techniques to obtain apple pomace extracts of high concentration of bioactive compounds and high biological activity, (2) optimization of fabrication of apple extract-loaded nanoparticles and phenolic-loaded nanoparticles using different coating materials; (3) comprehensive structural, physico-chemical, biological (antioxidant, antibacterial, probiotic, cytotoxic, cytoprotective) studies on nanoformulations and apple pomace extract.

A comprehensive multistage researches that will be conducted in parallel will maximize the use of the by-product from agri-food industry by creating effective methodology for its processing as part of the 3R strategy (*Reduce, Reuse, Recycle*). The possibility of managing waste by making better use of its resources and switching to more sustainable patterns of production and consumption are certainly plans for the future for all of us.