

Abstract

The incidence of chronic, non-communicable diseases is increasing rapidly worldwide, and among them type 2 diabetes and obesity have reached the status of 21st century epidemics. One of the main reasons for the development of these pathological conditions is improper nutrition. A diet containing an excessive supply of carbohydrates and saturated fats, with a low intake of fruits and vegetables, leads to an imbalance in homeostasis. Balanced diet rich in fruits and vegetables, which are a source of bioactive compounds, plays a key role in the prevention and treatment of metabolic diseases. There is also a noticeable trend among consumers to take care of their bodies and health through various types of diets and physical activity. Consequently, food manufacturers are forced to offer new products characterized not only by the abundance of bioactive compounds but also by an attractive form of consumption. *Chaenomeles* fruits are an example of a raw material with high processing potential, but high content of organic acids makes them unfit for direct consumption. Still, the market lacks an attractive *Chaenomeles* fruit assortment, and the available preserves are dominated by high-sugar products and/or those containing a small addition of *Chaenomeles* fruit.

Therefore, the purpose of this study was to determine and exploit the bioactive potential of *Chaenomeles* ssp. fruits in obtaining innovative, functional products with programmed health-promoting properties aimed at prevention and therapy of selected pathological conditions.

This objective was realized by determining the biological potential of compounds contained in *Chaenomeles* fruits of selected species (*C. japonica*, *C. speciosa*, *C. × superba*) and cultivars (*i*), and then developing and optimizing a drying technology based on selected methods (also combined with osmotic dehydration) (*ii*). Additionally, the technology of microencapsulation of *Chaenomeles* juice and a polyphenol extract by means of sublimation, spray, and vacuum drying was developed (*iii*).

The study proved that *Chaenomeles* fruits are an attractive raw material characterized by a rich chemical composition and potential health-promoting properties. Fifteen polyphenolic compounds, 5 carotenoids, 8 chlorophylls, all tocopherol and tocotrienol isomers were identified. In addition, *Chaenomeles* fruits contained all essential amino acids and were capable of inhibiting enzymes crucial in the prevention of type 2 diabetes (α -amylase and α -glucosidase), obesity (pancreatic lipase), neurodegenerative diseases (acetylcholinesterase and butyrylcholinesterase), and inflammation (15-lipoxygenase).

The combined drying (convective pre-drying followed by microwave-vacuum drying) yielded a dried product of the quality and content of biologically active compounds similar to the sublimation method (51.04 g of polyphenolic compounds/kg of dry matter). In addition, the osmotic dehydration of fruit juice concentrates reduced the drying time, lowered (from 47 to 77%) the organic acid content, and increased anticholinergic potential. Microencapsulation of the juice with maltodextrin as a carrier and sublimation and spray drying provided powders with the highest concentration of polyphenolic compounds, low content of 5-hydroxymethylfurfural, and high antioxidant potential. The highest retention of phenolic compounds, including flavan-3-ols, in polyphenolic extract, was measured after spray drying, while vacuum drying provided more favorable physical parameters of the resulting powders.

The chemical and technological experiments performed during the study demonstrated that *Chaenomeles* fruits are a good raw material for the production of attractive dried products. They also confirmed that the microencapsulation is an innovative way to use the fruits in the food industry due to their high concentration of bioactive compounds with antioxidant, antidiabetic, anti-obesity, and anticholinergic properties.

Keywords: sublimation drying, vacuum drying, spray drying, convection drying, microencapsulation, osmotic dehydration, bioactive compounds, antioxidant properties, type 2 diabetes, neurodegenerative diseases