CHARACTERIZATION AND ENCAPSULATION OF POLYPHENOLS AND XYLOOLIGOSACCHARIDES FROM OAT BRAN IN WHEY PROTEIN-MALTODEXTRIN COMPLEX COACERVATES

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Abstract

The trend for investigation of bioactive compounds, especially polyphenols and xylooligosaccharides (XOS) from cereals has increased in modern. These ingredients have proved to be effective for inhibiting or preventing different human ailments such as coronary, artery and cardiovascular diseases, several types of cancer due to their antiradical, antioxidant and anti-inflammatory properties. In this study, novel biotechnological approaches were suggested for the processing of grain by-products (oat bran) into functional food ingredients with antioxidant and prebiotic properties.

It is recognized that encapsulation is an effective technology in protecting the bioactive ingredients during processing and storage, and it prevents possible interaction with other food constituents. In order to obtain devices for controlled delivery of bioactive compounds, this investigation utilized whey protein as a wall material in combination with maltodextrin to form amorphous glassy matrices during the encapsulation process. The processed material was oat bran. The technology of its biotransformation was based on the ultrasound processing and enzymatic hydrolysis. The amount of protein was determined using the Kjeldahl method, carbohydrates and ash were determined according to the standard methods, XOS - using the thin layer chromatography. Extracts were examined for their scavenging effect on the diphenyl-2-picrylhydrazyl (DPPH) free-radical activity. The study of prebiotic activity was performed by cultivating *Lactobacillus acidophilus* and *Bifidobacterium bifidum* on standard nutrient media with the addition of skim milk with XOS and skim milk with a mixture of biologically active substances (XOS and polyphenols) at a temperature of (37 ± 1) ^{0}C for 72 hours. Separation and quantitative determination of extract were followed using HPLC apparatus "Stayer" (Akvilon, Russia) system column Phenomenex Luna 5u C18(2) (250 x 4.6 mm). Total phenolic content was measured by the modified Folin-Ciocalteu method. To prepare microcapsules, whey protein concentrate (WPC) and maltodextrin (MD) solutions were mixed at ratios 6 : 4, 4 : 6 and 5 : 5 by gentle magnetic stirring for 1 h, and extracts (10% w/w) was then added and mixed for 15 min. Then, mixtures were treated by ultrasonication, and 10% w/w of guar gum solution as double wall material was added to each mixture under stirring. Finally, the microcapsules were dried to produce solid or powder microcapsules. The encapsulation efficiency (EE) was determined as a ratio of encapsulated phenolic content to total phenolic content. A digestion protocol that simulates conditions of the human gastric and intestinal tract was designed to investigate the effect of the structural characteristics of capsules on release kinetics of extracts.

Obtained data indicates a high antioxidant activity of polyphenols extracts. It is established that ultrasonic treatment improves the kinetics of extraction and yield of polyphenols with an increase in antioxidant activity. The results of the study on the change in the antioxidant activity of polyphenol concentrate during storage did not reveal changes within 8 months at a temperature of 20 ± 1 ^{0}C and a relative humidity of 70 ± 5%. The study of the growth dynamics of *L. acidophilus* and *B. bifidum* confirm the presence of prebiotic properties of XOS and their selectivity. It is noted that the accumulation of biomass of prebiotic cultures occurs faster with the use of XOS and lactulose as compared to milk. In order to protect sensitive bioactive compounds the capsules were prepared with a studying their properties depending on a wall material. Thus, there were no significant changes in EE, however the highest EE of 95.28% was recorded at WPC : MD ratio of 60 : 40. The release percent of polyphenols coated in capsule during enzymatic hydrolysis *in vitro* was ranged between 70 and 83% after 2 h of digestion process.

Thus, the feasibility of biotechnology for transforming oat bran into functional ingredients has been confirmed, which will further allow them to be used in new technological solutions with bifidogenic properties. It is also proved that utilization of WPC which considers as a waste product of cheese manufacture can be beneficial for polyphenols encapsulation as a wall material.

Key words: *Polyphenols, Xylooligosaccharides, Encapsulation, Whey protein.*