Bioavailability Estimation of Alginate/Chitosan Beads using a Simulated Human Intestinal System

Chong-Tai Kim, Chul-Jin Kim, Yong-Jin Cho, Ae-Jin Choi and Jae-Kwan Hwang, Food Nanotechnology Research Group, Korea Food Research Institute, Songnam, 463-420, Kyonggido, Korea

Plant polyphenol compounds have been considered nutritionally important recently. However, achieving successful delivery of flavonoids and phytoestrogens via the oral route is particularly difficult, due to the formiable enzymatic and transport barriers in the gastrointestinal tract. Polymer-based delivery systems that trap molecules of interest within networks have been develpoed extensively for the biomedical and pharmaceutical fields. Natural polymeric materials can be used as delivery systems of bioactive agents because of their excellent safety, biocompatibility and biodegradation. Protein hydrogels are the most convenient and widely used matrix in food application. Recently, interest in developing protein micro particles as delivery systems has grown and various kinds of animal proteins have been investigated, including gelatin, collagen, casein, albumin and whey protein in addition to plant proteins such as soy glycinin, zein and wheat gliadin. There are so far no delivery systems for foods which designed to enhance the efficiency and stability of bioactive agents. In the present study, using alginate and chitosan as polymeric delivery system, and sugar, soy protein isolate and catechin as core materials, alginate/chitosan beads were prepared by encapsulator (IE-50R Inotech, Switzerland), and then the bioavailability estimation was investigated using a simulated human intestine system (SHIS). The digestion kinetics were also investigated in comparison with a starch, soy protein isolate and catechin in the SHIS.

We designed and assembled a simulated human intestinal system which consists of stomach and small intestine. Each reactor vessel has several ports such as input and output of medium, sampling of liquid phase, pH electrode, pH control (acid and base) and thermometer. The SHIS was kept at body temperature(37℃) by pumping water into the space between the jacket and the inside walls. The stomach chamber was initially filled with gas fluids and then digested for 2 hrs. After the stomach digestion, the residuals was delivered from stomach chamber into the small intestine chamber by secreting intestinal fluid for 4 hrs, followed by secretion of 0.3M $NaHCO_3$, 0.1M $NaHCO_3$, 4% bile salt and 2% bile salt for 1, 3, 0.5 and 3.5 hrs, respectively.

In order to prepare the alginate/chitosan capsule as a delivery system of bioactive agents, the microencapsulation system was assembled with control unit, electrical and pneumatic systems

and reaction vessel. The optimal condition of operation was accomplished depending on the process parameters such as feed rate, frequency for droplet formation and electrostatic charge control.

After digestion of alginate capsules, the content of total sugar were 7.47% and 60.82% in the stomach and small intestine, respectively. However, in case of alginate/chitosan capsule and alginate/chitosan-PAE coated capsule, the total sugar were 3.12 and 4.62 % in the stomach and 43.46% and 42.09% in the small intestine, respectively. There were no difference on the degree of digestion in the alginate capsule and alginate/PEG capsule prepared with 0.1 ~ 0.3% of PEG in the stomach. In SHIS, the alginate matrix remained in a shrunken state due to conversion of sodium algnate to insoluble alginic acid, which act as a barrier to chitosan microparticles, which were then digested by intestinal fluid, followed by release of the sugar.

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