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Editorial

The Possibility of the Encapsulation of Multiple Bioactive Nutrients Based on Milk Proteins

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Bioactive nutrients including vitamins, polyphenols, polyunsaturated fatty acids, and probiotics offer benefits beyond basic nutrition of functional foods [1]. However, hydrophobic and amphiphilic nutrients are general not soluble in water. Moreover, under food processing, storage and gastrointestinal tract, many bioactive nutrients are sensitive to environmental factors, resulting in oxidation, degradation, aggregation and accordingly loss of bioactivity. These limit the application of bioactive nutrients in food industry but can be overcome by using encapsulation technology [2,3]. Edible carrier systems, which could be classified into emulsion-based carriers and non-lipid carriers,should be generally recognized as safe and compatible with food matrix, have high payloads of bioactive nutrients, improve physical and chemical stability of bioactive nutrients, and be able to trigger release in response to specific changes in environmental conditions [4].

Administering different bioactive components simultaneously appears to produce synergistic effects that enhance the expected health benefits. For example, mixtures of lycopene with vitamin E, vitamin C and β-carotene had greater free radical scavenging capacity than the sum of the individual bioactive nutrient [5]. Moreover, there appear to be interesting market opportunities for functional foods fortified with multiple bioactive components, with each which can offer different health benefits [6,7]. These provide motivation to develop carrier systems that can encapsulate a plurality of bioactive components simultaneously [8,9].

Milk proteins contain 82% caseins and 18% whey proteins mainly including β-lactoglobulin and α-lactalbumin [10]. These proteins have been widely used as carrier materials because of their ability to form emulsions and gels and to interact with bioactive nutrients and polysaccharides [11,12]. Stable emulsions and spray-dried microcapsules have been prepared and used as encapsulation systems by milk proteins or their combination with polysaccharides [13,14]. Emulsion-loaded β-lactoglobulin gels were also prepared based on the protein emulsification and cold-set gelation and used for protection of α-tocopherol during gastrointestinal tract [15]. Although the carrier system to encapsulate single bioactive nutrients have been widely reported based on milk proteins, a few reports are on simultaneous encapsulation of multiple bioactive nutrients, especially of the nutrients with different insolubility.

Milk proteins could interact with many bioactive nutrients to form complexes, which is important for the encapsulation of bioactive nutrients with non-lipid carriers [16]. Caseins, belonging to intrinsically unstructured proteins, could interact with vitamins and polyphenols via hydrophilic and hydrophobic contacts [17,18]. β-lactoglobulin, a small globular protein containing a primary site in the internal cavity of β-barrel and several external sites for ligand-binding, displays affinity for fatty acids, vitamins, and polyphenols. Complexation with these milk proteins could improve hydro-solubility and stability of bioactive nutrients. Recently, it was found that β-lactoglobulin could interact with hydrophobic α-tocopherol, amphiphilic resveratrol and hydrophilic folic acid to form protein-multi-ligand complexes [19]. This suggests the possibility of developing milk protein-based non-lipid carriers for simultaneous encapsulation of bioactive nutrients with different solubility.

Due to amphiphilic nature, milk proteins can adsorb oil-in-water interface to produce oil-in-water emulsions [20]. In general, bioactive components are encapsulated in the inner phase of an emulsion-based carrier [16]. Milk protein emulsions have been used to encapsulate various hydrophobic nutrients, such as β-carotene and α-tocopherol [14,21]. In double water-oil-water emulsions, lipid-soluble vitamin E and water-soluble vitamin B_2 were dissolved respectively into the inner oil and aqueous phases and whey protein isolate combination with low methoxyl pectin or κ-carrageenan in the outer aqueous phase improved encapsulation efficiency and the controlled release [22]. Recently, it was found that hydrophobic α-tocopherol and amphiphilic resveratrol could be simultaneously encapsulated in whey protein isolate stabilized oil-in-water emulsions by binding the polyphenol to protein membrane at oil-water interface [14]. It is thus possible to develop the carriers based on milk proteins stabilized emulsions for simultaneous encapsulation of bioactive nutrients with different solubility.

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