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Nano-phytosome as a potential food-grade delivery system

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ABSTRACT

Flavonoids have many nutritional-therapeutic and preservative features. Therefore, the aim of using them for fortifying food products could provide new horizon in developing new functional foods. However, there are several problems associated with the use of these phyto-active constituents in foods and food beverages. Nano-phytosome is one of the newest lipid based nano-carrier and fast growing attractive way of delivering botanical based nutraceuticals. Although the nano-phytosome technology has been developed for pharmaceutical applications, it could be potentially used in food products for designing novel functional foods and beverages. The current review represents physicochemical properties and potential applications of nano-phytosome as a carrier of food bioactive compounds in development of functional foods.

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1. Introduction

In the industrialized world, people need to access their nutritional requirements more easily than before. Thus, people are growingly become conscious about their health, diet habit, and how to manage their time to prepare healthy foods. Therefore, the demand for functional foods, balanced low fat diet, the more natural, safe, and healthy foods that brings specific health benefits in less time is increasing steadily (Palzer, 2009). On the other hand, lowering fatty foods in the diet make deficiency of the necessary fat soluble compounds in the body. The word "nutraceutical" was first defined as a food-based compound, which provides health promoting benefits. These compounds include fat-soluble vitamins, carotenoids, phytostrols, poly-unsaturated fatty acids (PUFAs), anthocyanins, flavonoids, and etc. (Nguemeni, Gouix, Bourourou, Heurteaux, & Blondeau, 2013). Nutraceuticals can be potentially used for enrichment of the low fat foods or producing functional foods. However, there are some problems such as their low solubility in an aqueous medium and their low stability during processing and storage (Tapas, Sakarkar, & Kakde, 2008). In this case researchers reported that nutraceuticals have less in vivo actions, poor bioavailability, and absorption due to their complex molecular structure (Bhattacharya, 2009; Pathak, 2011). Thus, using food grade nano-delivery systems for the encapsulation of nutraceuticals can be potentially a good solution for solving these problems.

The food-grade delivery system can be defined as the entrapment of a bioactive ingredient in a food grade carrier to protect and improve in controlling its release rate. Delivery systems could have various advantages in food industries as follows (Guzey & McClements, 2006; Pezeshky, Ghanbarzadeh, Hamishehkar, Moghadam, & Babazadeh, 2016; Rashidi & Khosravi-Darani, 2011; Sagalowicz & Leser, 2010; Weiss et al., 2008; Yang, Corona, Schubert, Reeder, & Henson, 2014):

- Protection of bioactive components from undesirable conditions during food processes and gastrointestinal conditions such as oxidation phenomena, pH, and enzymatic degradation;
- Improvement the solubility of bioactive ingredients in an aqueous or lipophilic mediums;
- Masking undesirable odors, flavors, and colors of some bioactive compounds generated during harsh processing and adverse storage;
- Performs as a vehicle for controlling the release rate of the antioxidants and antimicrobial compounds for elimination or decreasing oxidation and microbial pollutions phenomena in the foods during food processes and storage until reaching to the consumers;
- Improving the bioavailability of the encapsulated ingredients.
- Food-grade carriers should meet all the following requirements (McClements & Rao, 2011; Tamjidi, Shahedi, Varshosaz, & Nasirpour, 2013; Weiss et al., 2008; Weiss, Takhistov, & McClements, 2006):
- Their composition should be made up of safe and food grade components;
- They should be stable against degradation during processing and storage time.
- They should not have the adverse effects on the desired organoleptic properties of foods.

Delivery systems can be categorized in to the macro and nano-delivery systems. On the basis of nanotechnology definition, which is defined as production and manipulation of materials in the nano sized scale, nano delivery carriers have particle sizes smaller than 100 nm (Solans, Izquierdo, Nolla, Azemar, & Garcia-Celma, 2005). In the food and pharmaceutical sciences, it has been well documented that nanodelivery systems have superior functionalities than conventional microencapsulation systems. The nanodelivery systems have following advantages over macrodelivery systems (Hu, Tang, & Cui, 2004; Tariq et al., 2015; J Weiss, Gaysinsky, Davidson, & McClements, 2009; Weiss et al., 2006; Zur Mühlen, Schwarz, & Mehnert, 1998):

- Nanodelivery colloidal systems are monodisperse or partially-monodisperse solutions, which have thermodynamic and long-time kinetic stability. In contrast, macro-delivery colloidal systems are often polydisperse and contain relatively large particles (>1 μm), which cause kinetically instability and break down over time.
- Nanodelivery systems provide more surface area in comparison to macro types and could potentially enhance the solubility (in hydrophobic or hydrophilic medium) and bioavailability of the bioactive materials. The nanoparticles at sizes lower than 100 nm shows high direct absorption at the mucus.
- Nanoscale colloidal carrier systems enhance releasing rate and targeting properties of the encapsulant due to their small and uniform size.
- Smaller than visible wavelengths of nanoparticles make them optically transparent. Thus, they do not adversely influence appearance of the enriched food beverages when adding them as the nutraceutical carriers. In contrast, macro ones have white opaque appearance due to the multiple light scattering.

Up to now, various nano-delivery systems such as emulsions (i.e. micro and nano-emulsions), nanoparticles (including solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC), and lipid nanocapsules (LNC)), vesicular carriers (such as liposomes, phytosomes, and niosomes) were introduced as the potential tools for fortification of food products (Fathi, Mozafari, & Mohebbi, 2012; Pezeshky et al., 2016).

Flavonoids belongs to the secondary plant phenolic compounds, which have remarkable antioxidant, chelating, and antimicrobial properties. Hence, they could have many beneficial effects in foods and health. There are large studies indicating a protective role of these compounds. They have the capability to prevent the low density lipoprotein (LDL) oxidation, and showed special cardio-protective effects (Bhattacharya, 2009; Yang et al., 2015). Having more flavonoid contents in the old men and post-menopausal women diet reduced coronary heart disease (Vinod et al., 2010). Some other studies have demonstrated that the consumption of catechin, a major flavonoid in tea, reduces ischemic heart disease (Pawar & Bhangale, 2015). All the health benefits of the flavonoids potentially enhanced by the application of nanotechnology. Nanodelivery systems can enhance the circulation time of the encapsulant and improve the bioactive compounds retention in tumor tissues, due to the enhanced permeability and retention (EPR) effect (Maeda, 2001). Nanochemopreventive and anti-cancer effects of natural compounds such as curcumin, resveratrol, epigallocatechin-3-gallate, and other

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