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Role of solids composition on α-relaxation behavior, molecular structure and stability of spray-dried xanthones encapsulation systems around glass transition

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ABSTRACT

Although the glass transition properties and encapsulation efficiency of various biopolymers have been documented, no attempts have been made to relate the α-relaxation behavior, molecular structure and stability of an encapsulation system above the glass transition. In this work, the efficiency of whey protein (W), maltodextrin (M) and their combination (MW) to encapsulate α-mangostin was assessed through the monitoring of the changes in the mechanical property and molecular structure around the glass transition using dynamic-mechanical analysis and Fourier transform infrared spectroscopy, respectively. A dramatic decrease in the storage modulus was observed in the non-encapsulation system (NE). Addition of W and M increased the temperature difference ($T_{storage} - T_{\alpha}$), resulting in a decrease in the α-mangostin degradation rate during storage. Carbonyl group (C—H) vibration of reducing sugars became smaller when W was added, while the spectra of the M and MW systems exhibited sharp peaks. This confirmed better encapsulation with W than with M.

1. Introduction

Mangosteen (*Garcinia mangostana* L.) or “Mang Khut” in Thai is a tropical fruit that has been widely consumed due to its tasty flesh. Mangosteen pericarp has also been used as a traditional medicine for treating such a symptom as diarrhea due to its xanthones, which are a class of phenolic compounds and also one of the most potent natural antioxidants (Ji et al., 2007; Zadernowski et al., 2009). Xanthones are noted to consist of α-mangostin, β-mangostin, 9-hydroxycalabaxanthone, 3-isomangostin, gartanin and 8-deoxygartanin as determined by high-performance liquid chromatography (HPLC). α-mangostin has, in particular, been reported to have the highest antioxidant activity (Ji et al., 2007; Okonogi et al., 2007). Prior to their use, however, xanthones must normally undergo thermal processing, which leads to their degradation. Suvarnakuta et al. (2011), for example, reported the losses of xanthones and their antioxidant activity in mangosteen rind during drying; methods and conditions of drying affected the changes of xanthones and their antioxidant activity. A means to increase the stability of the compounds both during processing and storage is therefore much desired. Among many possible alternatives, encapsulation via spray drying is an effective technique for entrapment of and hence protecting bioactive compounds or sensitive ingredients inside a coating material or a continuous phase (Saenz et al., 2009; Ahmed et al., 2010; Fang and Bhandari, 2010; Sansone et al., 2011).

Encapsulation is normally achieved via the use of a biopolymer that can help improve product stability by forming a solid, amorphous continuous phase (glass) surrounding a target compound to be protected. An array of biopolymers, including various proteins, maltodextrin and cyclodextrin have been used either alone or in combination with other materials to encapsulate plant extracts, aromatic additives, carotenoids and vitamins (Guzey and McClements, 2006; Gunasekaran et al., 2007; Bae and Lee, 2008;

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