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Microencapsulation by spray drying of gallic acid with nopal mucilage (*Opuntia ficus indica*)

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ABSTRACT

The spray-drying process has been previously used to encapsulate food ingredients such as antioxidants. Thus the objective of this work was to produce microcapsules of gallic acid, a phenolic compound that acts as antioxidant, by spray drying with an aqueous extract of nopal mucilage (*Ofi*), which acted as an encapsulating agent. The rheological response and the particle size distribution of the final solutions containing gallic acid at concentrations of 6 g/100 mL were characterized along with the control sample, no gallic acid added, to elucidate the degree of encapsulation. The drying parameters to prepare the microcapsules with extract of nopal mucilage were: inlet air temperature (130 and 170 °C) and speed atomization (14,000 and 20,000 rpm). The rehydrated biopolymer showed a non-Newtonian pseudoplastic behavior. The Cross Model was used to model the rheological data. Values for "m" varied between 0.55 and 0.85, and for "time characteristic, λ", the range was between 0.0071 and 0.021 s. The mechanical spectra showed that the sample with gallic acid was stable long term (>2 days) and presented a bimodal particle size distribution. This study demonstrated the effectiveness of nopal mucilage when utilized as wall biomaterial in microencapsulation of gallic acid by the spray-drying process.

1. Introduction

Polyphenols are chemical compounds or phytochemicals with diverse biological activities due to their antioxidant capacity. Ingestion of polyphenol-rich foods should be beneficial to human health as factors associated with cardiac mortality in developed countries with particular reference to the consumption of wine (St. Leger, Cochrane, & Moore, 1979). Wine has antimicrobial and antifungal activity and may play a role in the etiology of migraine. Red wine may even protect against the common cold. Wine contains polyphenols from the flavonoid type, mostly as grape tannins (about 35 g/100 g) and anthocyanin pigments (about 20 g/100 g), not only present mostly in red rather than in white grapes (Takkouche et al., 2002), but also non-flavonoid phenolics such as stilbenes and gallic acid. Gallic acid (acid 3,4,5-tri-hydroxy-benzoic) and its derivatives are considered natural antioxidants and their effects and uses have been widely reported (Cho, Kim, Ahn, & Je, 2011; Pasanphan & Chirachanchai, 2008; Negi et al., 2005). Stabilization and application of polyphenols in foods and nutraceutical formulations can be improved by microencapsulation technologies (Sáenz, Tapia, Chávez, & Robert, 2009). Microencapsulation allows protection of bioactive compounds; *i.e.*, an active material (nucleus) is embedded in a polymer matrix (encapsulating agent or wall material) to act as a protective barrier against external or environmental factors (Ahmed, Akter, Lee, & Eun, 2010; Borgogna, Bellich, Zorzin, Lapasin, & Cesàro, 2010; Sáenz et al., 2009).

Spray drying is a common technique for producing encapsulated food materials (Sáenz et al., 2009). Good microencapsulation efficiency during spray drying is achieved when the maximum amount of core material is encapsulated inside the powder particles, succeeding in microcapsule stability, volatile losses prevention, and product shelf-life extension (Seid, Elham, Bhesh, & Yinghe, 2008). In spray drying, the operating conditions and the dryer design used depend on the characteristics of the material to be dried and the desired powder specifications (León Martínez, Méndez, & Rodríguez, 2010). Studying the effect of operating parameters

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