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Microencapsulation of betalains obtained from cactus fruit (*Opuntia ficus-indica*) by spray drying using cactus cladode mucilage and maltodextrin as encapsulating agents

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ABSTRACT

The microencapsulation of betalains from cactus fruit by spray drying was evaluated as a stabilization strategy for these pigments. The betalains used as active agent were extracted from purple fruits of *Opuntia ficus-indica* (BE) and encapsulated with maltodextrin and cladode mucilage MD–CM and only with MD. The microcapsulates were characterized by scanning electron microscopy (SEM), thermal analysis (TGA–DSC), tristimulus colorimetry, as well as, their humidity, water activity and dietary fiber content were also determined. The active agent content was measured by UV–Vis spectrophotometry and its composition confirmed by HPLC–ESIMS. A pigment storage stability test was performed at 18 °C and different relative humidities. The addition of CM in the formulation increased the encapsulation efficiency, diminished the moisture content, and allowed to obtain more uniform size and spherical particles, with high dietary fiber content. These microencapsulates are promising functional additive to be used as natural colorant in the food industry.

1. Introduction

Since food ingredients are on the focus of public interest, it is becoming increasingly important to meet consumers expectations for natural and healthy products. Hence, the search of new plant-derived colorants for the food industry is still necessary. However, the higher stability of synthetic colorants with respect to natural alternatives is a challenge that must be overcome. In order to meet the growing demand for natural colorants, new pigment sources are being sought. In this course, red cactus pear (*Opuntia ficus-indica*) has been suggested as a valuable source of betalains, with several technological and sensorial advantages in comparison to red beet (Moßhammer, Stintzing, & Carle, 2006).

O. ficus-indica (Cactaceae), commonly named as prickly pear or nopal cactus, develops properly either arid or semiarid lands where the population uses it as source of food and by foraging. The extracts of its cladode (modified stems) have shown hypolipidemic, hypocholesterolemic, antidiabetic, hypoglycemic, and anti-inflammatory activities. Additionally, the fruit is rich in polyphenols and betalains, compounds that are well known by their antioxidant properties (El-Mostafa et al., 2014; Osuna-Martínez, Reyes-Esparza, & Rodríguez-Fragoso, 2014). Cactus fruit is considered a crop widely distributed in America with a fast growth and low cost, what increases its potential to develop added-value food products. Cactus betalains have increasingly attracted interest as a source of water-soluble pigment preparations (Stintzing, Schieber, & Carle, 2003; Moßhammer et al., 2006). Depending upon the nature of the betalamic acid addition residue, the betalains can be divided in two groups: the purple-red betacyanins and the yellow betaxanthins. The major betacyanin found in cactus pear fruits is betanin that results from the condensation of betalamic acid with a C_5-glucosylated *cyclo*-Dopa moiety (Castellanos-Santiago & Yahia, 2008).

Spray drying is the most commonly used encapsulation technique for food products. The final product quality and powder efficiency depend on the operating conditions, such as, inlet and outlet air temperatures, feed flow rate, atomization speed or pressure,

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