DEVELOPMENT AND CHARACTERIZATION OF β-CAROTENE MICROCAPSULES COMPOSED OF STARCH AND PROTEIN EXTRACTED FROM AMARANTH

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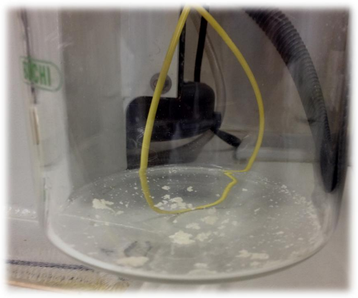
Introduction

Microcapsules may be used to transport bioactive compounds, especially probiotics, minerals, vitamins, phytosterols, fatty acids and antioxidants (Sauvant *et al*, 2012). Therefore, the choice of materials should be based on non-reactivity of the coating material with the compound to be encapsulated (Favaro-trintade, 2008). In this context, carbohydrates are frequently used as encapsulating materials due to their ability to entrap or bind the bioactive compouds, as well as their diversity and low cost. Proteins and lipids may be also used as encapsulating materials. Some studies that have explored the use of biopolymers from Amaranth grain as encapsulating materials for bioactive compounds (Aceituno-medina *et al.*, 2015) demonstrated that it is possible to encapsulate these compounds with Amaranth-based biopolymers.

The aim of this study was to evaluate the ability of starch and protein extracted from Amaranth grain (*Amaranthus cruentus* L. from Peru origin) to be used as microencapsulation materials to encapsulate a bioactive compound - β-carotene.

Methods

Morphology by epifluorescence microscopy and microstructure by scanning electron microscopy (SEM)



Mean diameter (volume%) and particle size distribution

Fourier Transform infrared spectroscopy (FTIR) and encapsulation efficiency determination

Microencapsulation by spray drying:
1:100 (biopolymer:β-carotene) in corn oil (1 %)

Results

The average size of the microcapsules made from Amaranth protein and starch were 2.22 ± 1.84 µm and 1.55 ± 1.12 µm, respectively. Their standard deviations were high, since the protein and starch microcapsules had diameters between 0.3-30 µm and 0.3-15 µm, respectively. The presence of particles of smaller size can be attributed to encapsulating material particles that failed to encapsulate β-carotene. On the other hand, the presence of larger microcapsules may be due to a possible agglomeration, observed in the morphological analysis (Figure 2), where formation of bonds between microcapsules could occurred (Tonon et al., 2010).

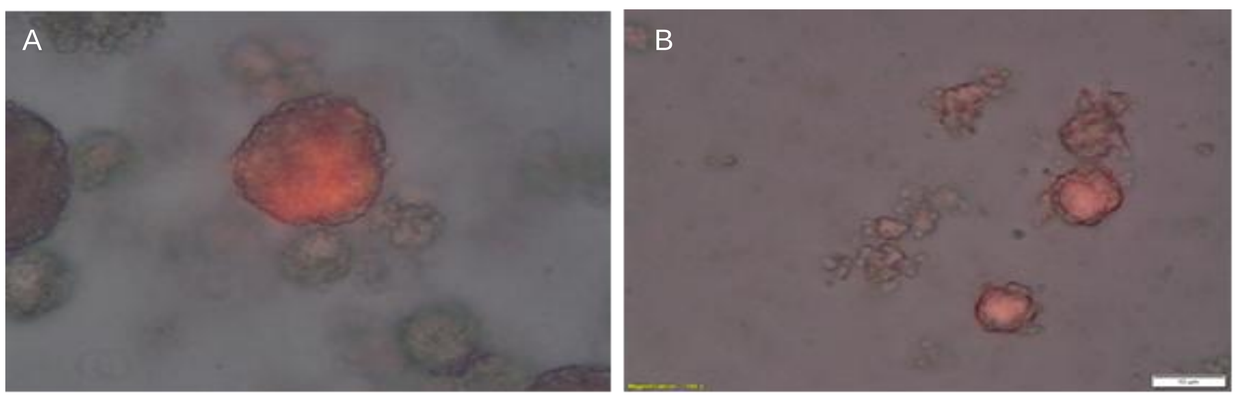


Figure 1 - Fluorescence microscopy images of the protein (A) and starch (B) microencapsules with β-carotene, obtained with a magnification of 100x.

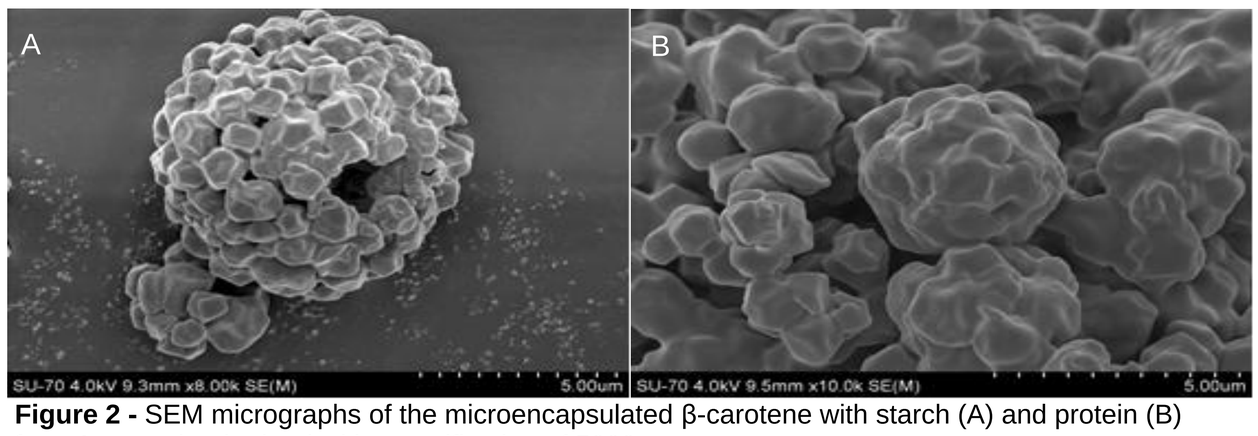


Figure 2 - SEM micrographs of the microencapsulated β-carotene with starch (A) and protein (B) from Amaranth, obtained with magnification of 5000x.

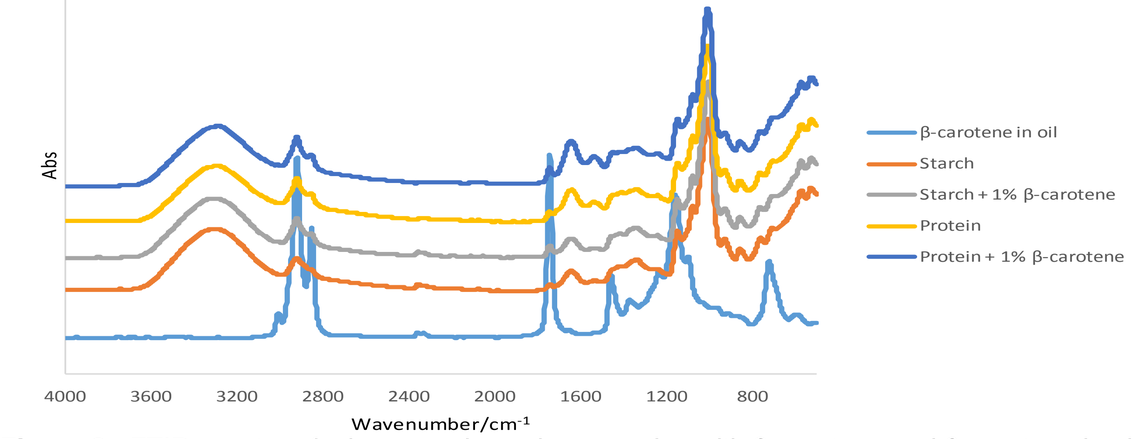


Figure 3 - FTIR spectra of microcapsules, microcapsules with β-carotene and β-carotene in oil.

β-carotene was entrapped inside the protein and starch microcapsules as evident from Figure 1. The microcapsules showed good sphericity, absence of cavities (or cracks) and surface irregularities on some particles that may explain the encapsulation capacity for β-carotene (Figure 2) (Leimann, 2016).

The β-carotene encapsulation efficiency was 71.29% ± 0.01 for the starch microcapsules and 69.32% ± 0.02 for the protein microcapsules.

The FTIR results (Figure 3) did not demonstrate the characteristic peak of β-carotene, found at peaks 3027, 2948-2818, 1615, 1560 and 1440 nm, because of its low concentration or because no chemical binding was established between β-carotene and starch or protein.

Conclusions

In this study, it was observed that the Amaranth biopolymers are capable of forming microcapsules with proper structure by spray-drying. This microcapsules showed to be a good alternative to encapsulate β-carotene, once the encapsulation efficiency was around 70%.

Therefore, it was demonstrated that *Amaranthus cruentus* L. compounds have great potential for the production of high quality products such as capsules and systems with novel interesting features and functionalities.

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