



Delivery systems based on O/W emulsions: effect of bioactive incorporation, ratio and phase composition

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Abstract

Nutraceutical products, such as β -carotene, have physical-chemical or physiological limitations that reduce their bioavailability, and it is interesting to incorporate this active into emulsified matrices. In this context, this work aimed to study the incorporation of β -carotene into O/W emulsions with different kinds of dispersed phase and volumetric fractions.

Key words:

Encapsulation, β -carotene, kinetic stability.

Introduction

Emulsions are protective systems with high potential for the encapsulation of hydrophobic bioactive compounds, such as β -carotene. Oil-in-water (O/W) emulsions are widely used in the food industry to increase stability and delivery of the actives. The main challenge in the application of emulsions is their thermodynamic instability. As a consequence, there has been considerable interest in understanding the relationship between the emulsion compositions and their physicochemical stability. Over the recent years, the effects of type and concentration of emulsifiers, homogenization methods and process conditions have been subject of research. However, to date, there are few data on the effects of bioactive addition and its interaction with the other ingredients of the emulsion, besides the variation of the volumetric fraction and nature of the dispersed phase. Therefore, the objective of this work was to produce O/W emulsions containing β -carotene, with oil phase composed of sunflower oil (SO) or palm oil (PO) varying oil volume fraction between 20 and 60%.

Results and Discussion

Emulsions were prepared by incorporating the oil phase into the aqueous phase (Tween 80 solution - T80) using rotor-stator, Ultra Turrax T10 (IKA, Germany). Then, the emulsions were sonicated (ULTRONIQUE, Brazil) with a 30% amplitude of 750 Watts maximum power for 2 min in order to decrease droplet size. The concentration of T80 in the final emulsion was 2% (w/w) and the β -carotene concentration in the oil was 0.02% (w/w). Emulsions were evaluated for color, rheology, microscopy and kinetic stability. Fresh emulsions presented a monomodal size distribution and small droplet diameter (1.50-2.26 μm). The droplet diameter (D_{32}) increased with the disperse phase fraction increase, due to the increase in viscosity during homogenization. The higher viscosity made difficult to incorporate the oil and breakup the droplets, contributing to the formation of droplets of bigger sizes. Systems with PO showed lower values of D_{32} than those with SO. This could be related to the composition of fatty acids and the viscosity of each oil. The PO has a viscosity of 25 mPa.s and a higher content of palmitic saturated fatty acid (16:0). SO is mostly formed by the fatty acid of longest and unsaturated chain, the linoleic (18:2), and it has higher viscosity (49.8 mPa.s). The addition of β -carotene promoted an increase of D_{32} . β -carotene is a relatively high molecular weight hydrophobic molecule (536.87 g/mol) that

remains almost entirely within the drop of oil¹. Therefore, D_{32} may have increased to incorporate the long carbon chain of the bioactive. The viscosity increased with the O/W ratio increase, due to the intensification of the hydrodynamic interaction between the drops. The systems with PO had higher viscosity due to the smaller D_{32} , which implies a larger interfacial area and, therefore, a higher drop-drop interaction. Emulsions with lower D_{32} may be more stable to the creaming process. However, the emulsions with higher O/W fraction presented smaller variation in the BS curves after 7 days (Figure 1). The high stability of the systems with 60% of oil may be related to the difficulty of droplet movement, caused by the higher viscosity. The color variations (ΔE_{ab}) in the emulsions with PO were lower, indicating a higher β -carotene stability in these systems.

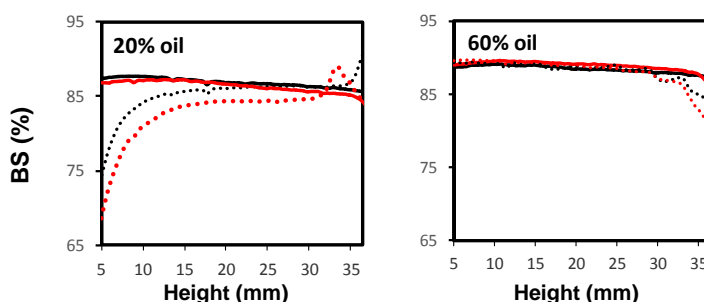


Figure 1. Backscattering graphics of palm oil emulsions. Solid lines: fresh emulsions. Dashed lines: emulsions after 7 days of storage. Black lines: emulsions without active and red lines: emulsions with β -carotene.

Conclusions

The addition of β -carotene caused a small increase in the D_{32} of the emulsions, which influenced the kinetic stability of the systems with 20% of oil. Emulsions with higher O/W ratio presented high stability, independent of the incorporation of active, due to the packaging of the drops. In general, emulsions prepared with PO showed better characteristics of delivery systems, such as lower droplet size, higher viscosity and stability and less color change after 7 days of storage.

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¹ Roohinejad, S.; Oey, I.; Wen, J.; Lee, S. J.; Everett, D. W. e Burritt, D. J. *Food Chemistry*, 2015, 174, 270-278.