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Coating effect on alginate beads containing seabuckthorn juice during exposure to extraction solvent and gastric conditions

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INTRODUCTION AND OBJECTIVES

Microencapsulation is a leading method to store and preserve valuable compounds as well to release them under controlled conditions (Poncelet 2006). To improve the survival of functional molecules is proposed the application of coating on the microcapsules (Chavarri 2010). The nutritional and medicinal value of sea-buckthorn berries (SB) is largely known worldwide, being rich source of antioxidants and protective molecules with significant impact in medicine and nutrition (Singh 2006).

The aim of the study was to encapsulate SB juice in alginate and coating the beads by alginate, chitosan, and polyvinyl alcohol (PVA) in order to improve the delivery of functional elements during exposure to extraction solvent (ES) and simulated gastric conditions (SGJ).

MATERIALS AND METHODS

Sea buckthorn juice. Microencapsulation procedure
Sea buckthorn juice (SBJ) was obtained from smashed and centrifugatet sea buckthorn berries, collected from Cluj, Romania. The juice was stored at 4°C. Aliquots SBJ were incorporated in sodium alginate 2% (w/v) to a final concentration 10% (v/v) and encapsulated by cross-linked gelation. To obtain the beads (ASB) we used Multinozzle Biotech Encapsulator (EncapBioSistems Inc.), 750 and 350 µm nozzle.

Coating procedures
Alginate beads (ASB) (1g), were immersed in alginate solution 0.17% (w/v) and stirred at 200 rpm for 30 min using an orbital shaker (ASBA). Same operations were done with PVA 0.17% (w/v) (ASBPVA). Medium molecular weight chitosan solution 0.1% (w/v) was made. The 1.2 pH was adjusted to with HCl. Alginate beads (1g) were immersed in chitosan solution and stirred at 200 rpm for 30 min using an orbital shaker (ASBC).
All beads were separated from the solutions and left before use 15 min at room conditions.

Four different coated and uncoated beads were obtained: uncoated alginate beads (ASB), 0.17% alginate coated 2% alginate beads (ASBA), 0.1% chitosan coated 2% alginate beads (ASBC), 0.17% PVA coated 2% alginate beads (ASBPVA).

Delivery assay, determination of the carotenoids release. Encapsulation rate of SB in beads
All beads were extracted in 10 ml ES (methanol: etilic alcohol: petroleum ether 1:1:1) for 15 minute to ultrasounds, respectively to simulated SGJ according to Chavarri 2010 method for 30, 60 and 90 min (Brinques 2010). UV-VIS Spectrometry was used to determinate carotenoids release from each type of beads.

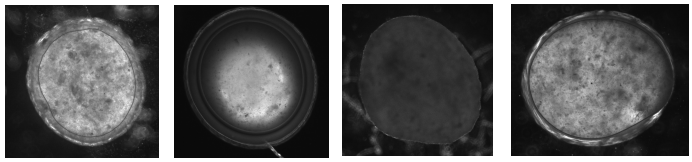
Spectrofotometric measurement
In order to determinate encapsulation rate and coating effect we used a Jasco V 530 spectrophotometer to determinate carotenoid contents. All data were processed with specific software (Shimadzu LCSolution and Spectra Manager for Windows 95/NT). The results were calculated using the absorption values (A) at 450 nm according to the formula:

$$\text{Carotenoids mg} = A \times V \times dil / M \times 250$$

A= absorbance (λ max= 450 nm), V= volume of the sample (ml), dil= dilution, M= weight of carotenoids in the sample (g), 250= $A^{1\%}_{1cm}$ (specific absorbance of colored carotenoids).

RESULTS AND DISCUSSION

Microscopic characterization of beads uncoated (ASB) and coated (ASBA, ASBC, ASBPVA).



ASB ASBA ASBC ASBPVA

Figure 1: Optical microscope (10X) images of the uncoated and coated beads

The best coating was observed for ASBA and ASBPVA.

Release rate of carotenoids from beads

Table 1 : Mean values (µg/g) of carotenoids in ES and in SGJ

Type of beads	Carotenoids (µg/g) at 450 nm in ES		Carotenoids (µg/g) in SGJ		
	15 (min)		30 (min)	60 (min)	90 (min)
	1.5 (mm)	0.7 (mm)			
Control	24.12		54.57	79.17	53.73
ASB	18.39	23.31	3.16	35.51	39.30
ASBA	10.26	15.46	5.89	3.40	0.19
ASBC	10.53	12.81	81.58	40.92	53.19
ASBPVA	10.68	12.69	60.86	3.18	0.65

*Control contains alginate (2% w/v) and SBJ (10%). SBJ carotenoid content (µg/g) was determined after 15 min in ES and 30, 60 and 90 min in SGJ.

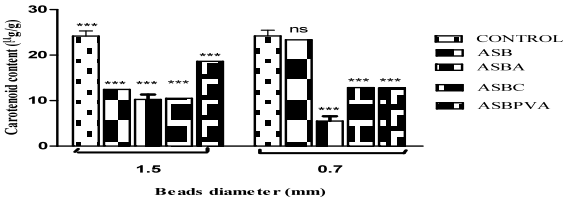


Figure 2 : Release of carotenoids in ES after 15 min from four different types of beads

The coating of alginate beads proved to be effective in these order: ASBA, ASBC and ASBPVA for the treatment at 95% confidence. ASBA proved to have the most effective coating effect at 0.7 mm bead diameter.

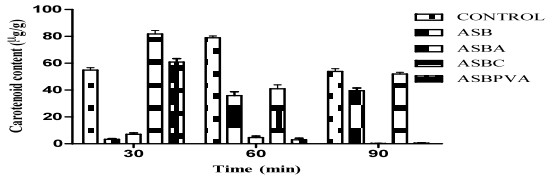


Figure 3 : Release of carotenoids in SGJ after 30, 60 and 90 min from four different types of beads

For the SGJ release the alginate coating proved to be the most effective, especially after 60 min.

CONCLUSIONS

Sea buckthorm juice was successfully encapsulated by ionotropically cross-linked gelation of sodium alginate and sea buckthorn juice.

Coating of the obtained alginate beads has been shown to have different efficiency. The alginate coating proved to be the most effective in SE and also in SGJ.

The size of the beads proved to influence the release rate of carotenoids, except for the alginate coated microcapsules where the amount of carotenoids released was higher for the 0.7 mm beads.

Spectrophotometry can be successfully used to determine the different release rates of carotenoids in ES and in SGJ from the uncoated and coated beads.

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