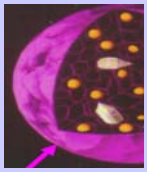
Encapsulation of plant oleosomes and oleoresins in mixed carbohydrate matrices

C. Socaciu[1,2], M.Trif[1], A.Baciu[2], T.Nicula[2], A.Nicula[2]

[1] Department of Chemistry and Biochemistry, University of Agricultural Sciences and Veterinary Medicine,.

[2] SC. PROPLANTA SRL, 400372 Cluj-Napoca,,Romania



Introduction

The natural carbohydrate networks form easily hydrocolloids which may be used as convenient matrices for lipid encapsulation. The microcapsules formed can provide good stability, high biodegradability and controlled release of encapsulated molecules. Lipophilic, functional molecules (PUFAs, antibiotics or phytochemicals) including vitamins are labile and need protection, and controlled functionality at specific target organs.

Microencapsulation is a good alternative to improve the stability of plant oils, oleoresins, oleosomes as well to keep their functionality.

The aim of this work was to monitor the stability of oil-, oleosome- and oleoresin-containing capsules in different carbohydrate matrices and characterization of their composition by FTIR (ATR) spectrometry, a versatile, non-destructive technique to evaluate the authenticity, incorporation rate and stability of molecules incorporated in capsule.

Materials and methods

Oleosomes (SBO) separated from sea buckthorn fruits. Oleoresins were extracted from Hemp (HPO) seeds collected from Cluj county (Transilvania, North of Romania). Virgin olive oil (EOV) and pumpkin oil (PKO) were provided from supermarkers.

Preparation. Different concentrations of alginate (AG 1,0%, 1,5% and 2,0% w/v), alginate-carrageenan (AG-CAR), alginate –guar gum (AG-GG) alginate –xanthan gum (AG-GG) mixtures and chitosan (CH) used to encapsulate SBO, HPO, EOV or PKO, by ionotropicaly cross-linked gelation.

Light microscopy was used to evaluate the dimensions of microcapsules.

The **FTIR spectra** were obtained with a Fourier transform spectrometer Spectrum One (PerkinElmer), equipped with the universal ATR as an internal reflection accessory . The fingerprint of matrices and microcapsules were registered between 700 and 4000 cm^{-1}.

RESULTS AND DISCUSSION

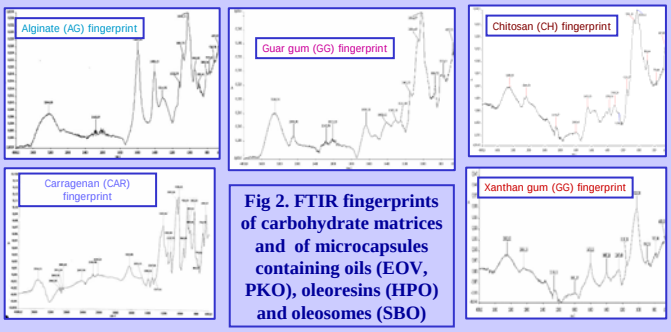
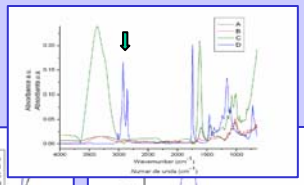
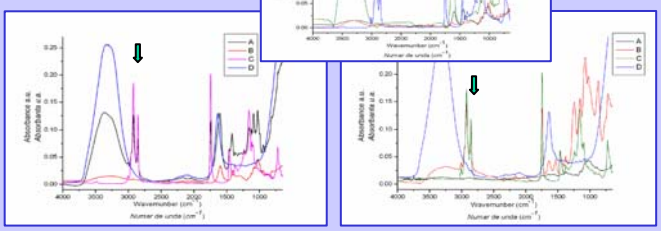


Fig 2. FTIR fingerprints of carbohydrate matrices and of microcapsules containing oils (EOV, PKO), oleoresins (HPO) and oleosomes (SBO)

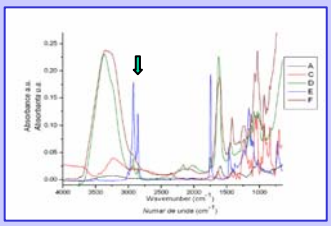


FTIR-ATR spectra of: A. AG powder; B. GG powder; C. AG-GG-HPO beads (ratio 0.5:0.5) D. HPO

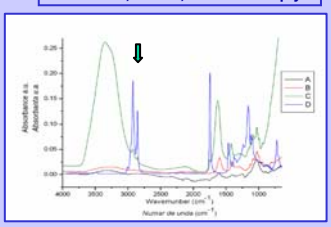


FTIR-ATR spectra of: A. AG 2% SBO B. AG powder; C. SBO; D. AG 2% empty

FTIR-ATR spectra of: A. CH powder; B. CH 2% PKO; C. PKO; D. CH 2% empty



FTIR-ATR spectra of: A. AG powder; C. *CAR* powder; D. AG-CAR-EOV beads (0.75:0.75); E. EOV; F. AG-CAR beads (0.75:0.75) empty



FTIR-ATR spectra of: A. AG powder; B. XG powder; C. AG-XG-SBO (ratio 0.75:0.75); D. SBO

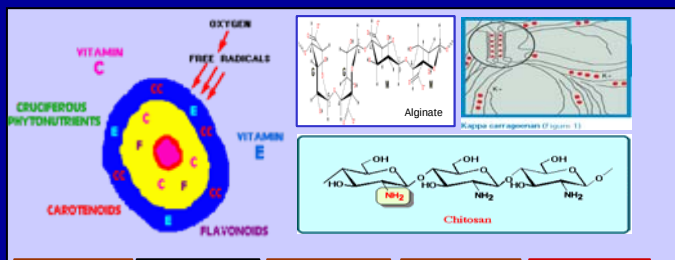


Fig 1. Different phytochemicals and their antioxidant role in capsules formed of alginate (AG), kappa carragenan and chitosan matrices. a. Oil PKO; b.emulsion of EOV prepared to be encapsulated; c and d. microscopic image of HPO and SBO oleosomes of high and small volume. e. emulsion of SBO before mioencapsulation f. Capsules obtained using AG-CAR as matrix; g.capsules obtained with AG-GG.

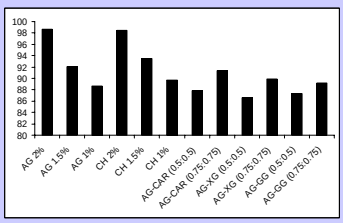


Fig.3. Comparative representation of oil encapsulation efficiency in alginate (AG- at 1, 1.5 and 2%) , chitosan (CH- at 1, 1.5 and 2%), alginate- *k*-carrageenan (AG-CAR 0.5:0.5 and 0.75:0.75), alginate-xanthan gum (AG-XG 0.5:0.5 and 0.75:0.75), alginate-guar gum (AG-GG 0.5:0.5 and 0.75:0.75)

Discussion. The encapsulation efficiency reached 98% for 2% carbohydrate concentration (highest for CH) and decreased gradually to 1%. By FTIR-ATR spectra we were able to identify the main wave numbers specific to free matrices (AG, CAR, CH, GG, XG) and to discriminate the differences which appear when the oils /oleoresin/oleosomes were free or incorporated.

The wave numbers useful for matrices discriminations were identified at 3244-3302 cm^{-1}(O-H stretch), 1400-1474 cm^{-1} (CH_2 bending), 1000-1200 cm^{-1}(C-O and C-C stretch), 924-1000 cm^{-1}(poly OH and CH_2 twist), 776-892 cm^{-1}(glycoside links).Oils specific fingerprints were identified in the regions 2800-2950 cm^{-1} and 900=1750 cm^{-1}.

Conclusion

Different oleoresins and oleosomes were encapsulated in different carbohydrate polymer matrices by ionotropically cross-linked gelation. The microcapsules had 1-5 mm diameter and the efficiency of oils encapsulation ranged from 85 to 99%. Comparing with free oils and free matrices, the capsules show specific FTIR(ATR) absorption peak shapes and intensities, dependent on the composition and stability. FTIR has been found to be a very good technique to monitor non-destructively, to fingerprint fast and reproducible the identity, authenticity and stability of different molecules incorporated in specific carbohydrate capsule.

References

Guillen, M. D. et al. (1999). J. Agric. Food. Chem. 47: 709-719

Mayur G. Sankalia et al. (2005). AAPS PharmSciTech 6:2-8

Pereira L. et al. (2003). Biomol. Eng. 20: 223-228

Socaciu C. (2007) 15th Int. Symp. Bioencapsulation, 6-8 Sept. 2007, Wien, P3-19,

Socaciu C. et al. (2007d) Int. Seabuckthorn Assoc. Conf., 12-2007,Quebec

SocaciuC., ed. (2008), *Food Colorants- Chemical and Functional Properties*. CRC Press, NY

Trif M. et al. (2007) 15th Int. Symp. Bioencapsulation, Wien, P3-07, 1-3