Encapsulation in yeast - new challenge for promising applications in food technology

Pham-Hoang B. N., Waché Y.
UMR PAM, AgroSup Dijon/Univ Bourgogne, Dijon, France (hoangbaongoc.pham@yahoo.fr)

INTRODUCTION AND OBJECTIVE

Encapsulation is a technique in which an active principle will be covered by a material wall as a casing to shelter it against unfavorable environmental conditions. Depending on application purpose, this technique is carried out by spray drying, freeze drying, coacervation…with varied wall materials (Desai 2005). However, to the best of our knowledge, up to date, there is not a universal method which can resolve all of problems in food technology. For example, modified starch is a good material for oil encapsulation while it improves storage stability. But in some particular cases, for example, antioxidant encapsulation, the capsule made from modified starch provides a difficulty to resist high temperature (Paramera 2011).

Another method called "unconventional" is the use of microbial cells as capsule for coating the active compounds (Pham-Hoang 2013). Unlike common techniques mentioned above, microbial cells propose a capsule that is ready-to-use. The main step of this technique is the incorporation of foreign molecules into cell which will occur by simple diffusion. Among microbial cells, yeast envelope is considered to be a good material for system coating. The advantage of yeast capsule is a good resistance to high temperature, oxygen and light. Therefore it proposes a perfect protection for bounded components. This technique has been recently developed in food, especially for stabilization and protection of flavor molecules and easy handling of sensitive substances such as antioxidants and colorants (Dardelle 2007, Paramera 2011)

β-carotene and quercetin are popularly used as antioxidants in food and drug. However, the sensitivity to light, high temperature and oxygen makes many difficulties to maintain their functions in final products. Encapsulation in yeast is a powerful solution to resolve these problems. Nevertheless, the uptaking capacity of yeast cells depends on the physiological state of cells and also on the size and hydrophobicity of the active molecule. Loading cells with a big molecule like β-carotene or a hydrophilic one like quercetin is still poorly understood. Thus, the aim of this study is to investigate the encapsulation process for these molecules.

MATERIALS AND METHODS

The strain *Yarrowia lipolytica* W29 (ATCC20460; CLIB89) was used in this study. β-Carotene (97%) and quercetin (95%) were purchased from Sigma Aldrich. All the solvents used in this study were provided by Sigma Aldrich.

Encapsulation process

The encapsulation process is presented in Fig. 1.

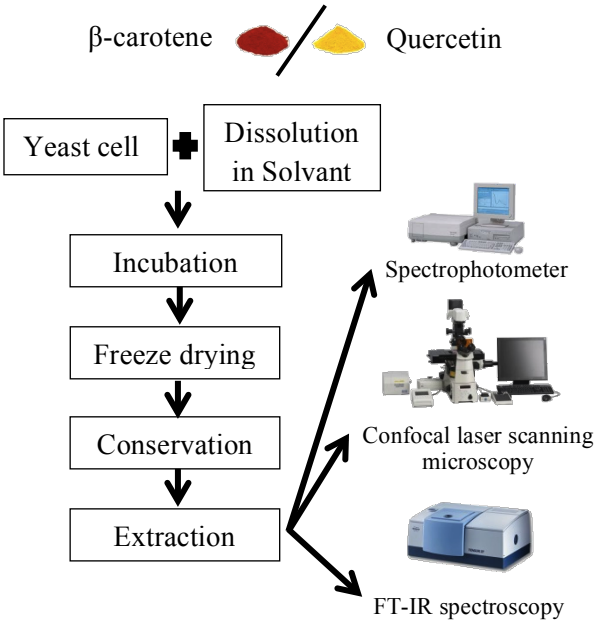


Figure 1 : Scheme presenting the experimental design of the study.

RESULTS AND DISCUSSION

Figure 2 shows the morphology of yeast cells before and after encapsulation observed by Confocal laser scanning microscopy. The cell morphology changed when submitted to solvent (chloroform) (in case of encapsulation of β-carotene). The solvent may facilitate the transfer of β-carotene through the membrane. However, the encapsulation yield obtained from this method was still low (1.5 ± 0.2 $mg.g^{-1}$ cell by dry weight). On the contrary, due to its smaller size the molecule of quercetin seemed to pass through the cell envelope more easily than β-carotene resulting in a higher encapsulation yield (197 ± 15 $mg.g^{-1}$ cell by dry weight) (Table 1).

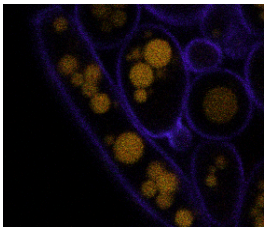
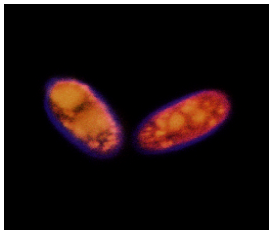
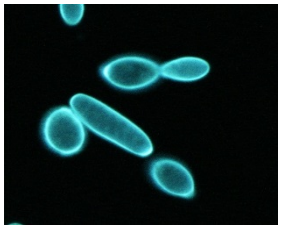
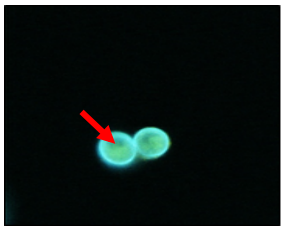
Before encapsulation	After encapsulation
β-carotene (cells dyed with calcofluor(blue) and nile red (red)	
	
Quercetin (cells dyed with calcofluor(blue). The arrow indicates quercitin (which fluoresces in yellow)	
	

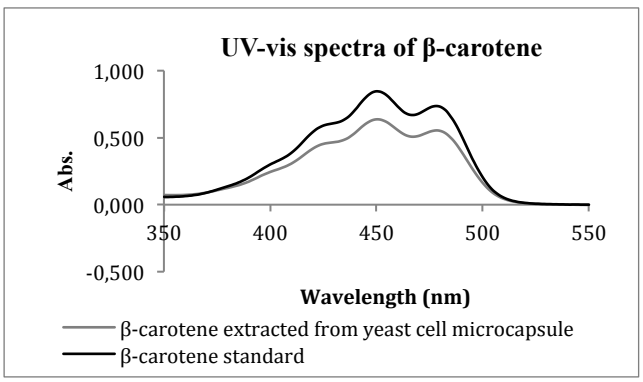
Figure 2 : Morphology of yeast cells before and after encapsulation as observed in Confocal laser scanning microscopy

Table 1: Encapsulation yield of β-carotene and quercetin in yeast

Encaspualtion yield (mg.g cell^{-1} by dry weight)	
β-carotene	Quercetin
1.5 ± 0.2	197 ± 15

The chemical property of β-carotene and quercetin after encapsulation process was investigated using UV-vis spectrophotometer.

We observed that the UV-vis spectra of standard and encapsulated β-carotene had the same shape and were consistent with the spectra described by Britton (1995) for all-trans-β-carotene. This indicates that the encapsulation process did not induce chemical changes to β-carotene and particularly, no oxidation modifications were observed (Cao-Hoang et al, 2011). A similar result showing the stability of the molecule was obtained for quercetin.



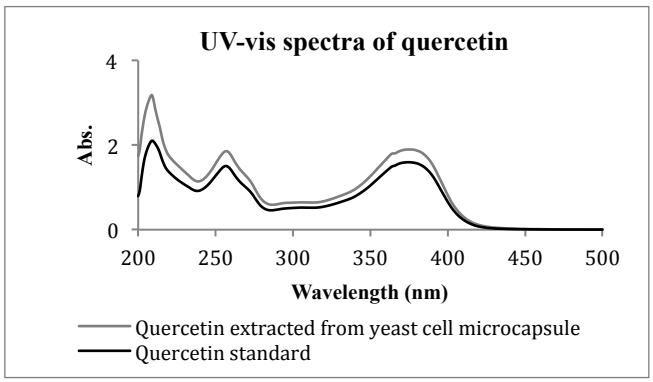


Figure 3 : UV-vis spectra of β-carotene and quercetin extracted from yeast cell microcapsule compared with standard molecule.

CONCLUSIONS

In this study, β-carotene, due to its size and poor solubility, was more difficult to encapsulate into yeast cells than quercetin. This encapsulation process exhibited a protective effect during the freeze drying step.

REFERENCES

- Cao-Hoang L. et al. (2011) *Increased in stability and change in supramolecular structure of beta-carotene through encapsulation into polylactic acid nanoparticules.* Food chemistry, 124(1):42-49.
- Britton, G. (1995) *Structure and properties of carotenoids in relation to function.* FASEB J, 9(15):1551-1558.
- Desai K. G. H. and Park H. J. (2005) *Recent developments in microencapsulation of food ingredients.* Dry Technol, 23(7):1361-1394.
- Sultana K. et al. (2000) *Encapsulation of probiotic bacteria with alginate-starch and evaluation of survival in simulated gastrointestinal conditions and in yoghurt.* Int J Food Microbiol, 62(1-2):47-55.
- Nelson G. (2002) *Application of microencapsulation in textiles.* Int J Pharm, 242(1-2):55-62.
- Shi G. et al. (2007) *Yeast-cell-based microencapsulation of chlorogenic acid as a water-soluble antioxidant.* J Food Eng, 80(4):1060-1067.
- Pham-Hoang B. N. et al. (2013) *Encapsulation in a natural, pre-formed, multi-component and complex capsule: yeast cells.* Applied Microbiol Biotechnol.
- Dardelle G. et al. (2007) *Flavour-encapsulation and flavour-release performances of a commercial yeast-based delivery system.* Food Hydrocolloid, 21(5-6):953-960.
- Paramera E. I. et al. (2011). *Stability and release properties of curcumin encapsulated in Saccharomyces cerevisiae, b-cyclodextrin and modified starch.* Food Chemistry 125: 913–922.