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Editorial

Life is based on a combination of biochemistry and bioencapsulation

INTRODUCTION

A long time ago, it was nothing. Then, a big bang dispersed energy over the universe. Some of this energy compacted to form atoms, which combined to form molecules. The molecules became more and more complex, resulting in biochemistry, but life was still not there.

Somebody, let us call Him God, said, let's try a new thing. Let's put a microcapsule (membrane) around this biochemistry. Then, life started! Biological cells multiplied, and colonized the earth. They organized themselves to give pluricellular organisms, which evolved to finally become an exceptional structure of more than 10^{12} microcapsules called a human being.

Bioencapsulation essentially mimicks this very ancient process, *i.e.*

- immobilizing bioactive material ('actives'), thus avoiding its dispersion in water.
- protecting it (against pH, oxygen, etc,.
- controlling mass transfer (exchange with the surrounding).
- structuring it (change from liquid state to an apparent solid form), and
- creating new functions (such as ATP production over mitochondrial membrane).

The challenge of bioencapsulation researchers and engineers is to obtain microcapsules presenting powerful properties and functions like biological cells.

The initial microcapsule concept referred to a liquid core surrounded by a membrane; however, biocapsules may take many different forms such as solid beads, hydrogel beads, liposomes, etc. The core could be a solid, a liquid, an emulsion, or a liquid dispersion in a solid matrix. Some companies even develop small capsules integrated inside larger capsules.

There are a number of methods (and combinations of methods) for producing microcapsules. One simple approach is to classify them as shown in Table 1 based on the assumption that an encapsulation process comprises of three steps:

1. **Incorporation** of the 'actives' in the future core of the capsules; if the core is liquid, the 'actives' may be dissolved, dispersed, or emulsified in this liquid. If the core is solid (particles), the 'actives' may be incorporated by absorption during or after production of the core particles.

2. **Dispersion** of the core; either by production of air droplets or liquid dispersion (in the case of a liquid core) or by agitation of a powder and deposition of the coating material on it.

3. **Stabilisation** of the capsules; liquid droplets or particles surrounded by a liquid are stabilized by solidifying the external surface (membrane) or the core (beads) via solidification, gellation, polymerization, precipitation, drying or any other physical, physicochemical or chemical process.

Table 1: Classification of the microencapsulation methods

Encapsulation steps		Initially, the core phase is liquid (solution, melt, …)			Initially, the core is solid (particles, beads …)	
1) Incorporation		Dissolution, dispersion or emulsification of the active ingredient in the core phase			Absorption of the active ingredient during or after production of the particles	
2) Dispersion / agitation		Production of droplets in air or liquid			Particles in fluid bed or rotating pan + spray coating	Suspension of particles or beads in coating solution
		Dripping/ dropping in air or a stabilizing solution	Spraying of fine droplets in air	Emulsion / dispersion of the core in a continuous phase		
3) Stabilisation	Solidification	Prilling	Spray cooling		Spray coating	
	Drying Evaporation		Spray drying	Solvent evaporation	Spray coating	
	Gelation	Hydrogel beads	Spray chilling	Thermal gelation		
	Polymerisation			Interfacial or *in situ* polymerisation		
	Coacervation Precipitation			Simple or complex coacervation		
	Molecular interaction	Interfacial coacervation		liposome		Ionic coating

Biocapsules may be used for many purposes; specifically, in the medical domain, one could cite:

- Taste and odor masking of unflavored drug
- Protection of actives against water or oxygen during storage
- Enhancement of flow properties of powders in tablet production
- Protection of drug against gastric juice and colon delivery of medicines
- Formulation of injectable drug form with controlled release profile
- Targeting of drug to a specific body site (in cancer therapy)
- Chondrocyte immobilization for bone reconstruction
- Langerhans islet protection against immune system following implantation for treatment of diabetes.

This is only a short list of potential applications. The domain of applicability is very broad and is likely to expand in the next few years. For additional information, you may connect to the Bioencapsulation Research Group website (http://bioencapsulation.net) where you will find listed relevant books and reviews.

Denis Poncelet
President of the Bioencapsulation Research Group, and Professor, ENITIAA, Rue de la géraudière, BP82225, 44322 Nantes Cedex, France. ***Email:*** *poncelet@enitiaa-nantes.fr*