Technologies to develop active packaging

An attempt to survey existing encapsulation systems in the packaging material

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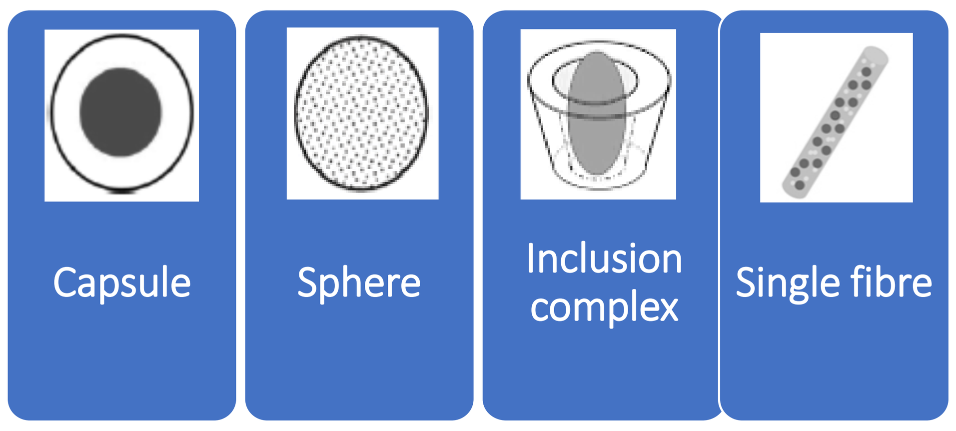
Introduction

Encapsulation is the expertise of "wrapping" solids, liquids, or gaseous materials in micro/ nanoparticles in order to protect their physicochemical characteristics and control their release rates.

The micro/nanoparticles can be roughly classified into capsules and spheres, while electrofluidodynamic processes offer the option to form nanofibers or coatings with nanobeads with high surface-to-volume ratios.



Active Components

Attempts to encapsulate flavors, antimicrobials, fragrances, coloring materials, printing inks, time-temperature indicators, into food packaging materials can be found in literature (Fig.1), aiming to improve product quality and to prolong shelf life.

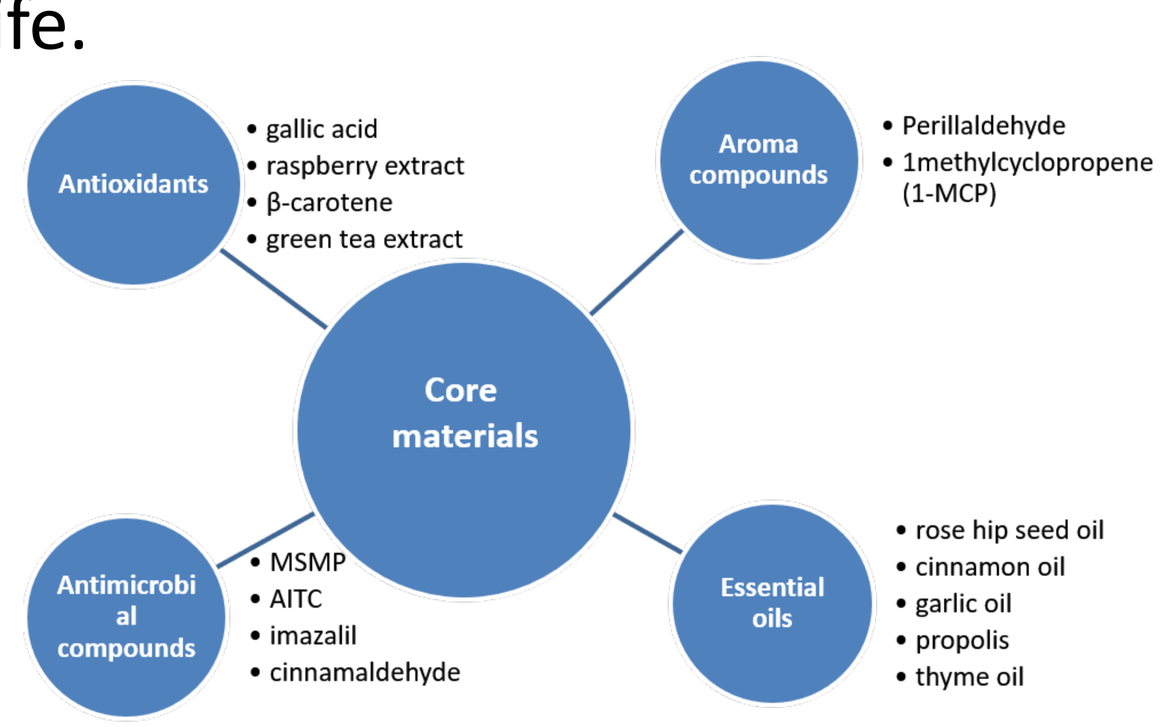


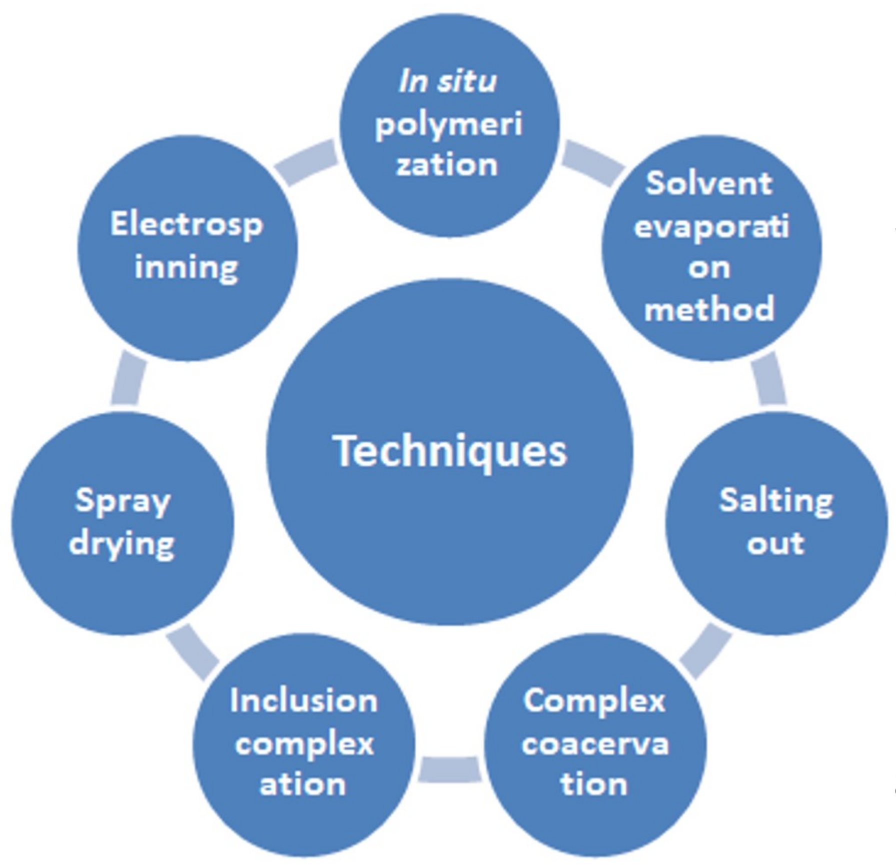
Figure 1. Core materials used in active packaging

Encapsulation Techniques

Loaded micro/nanoparticles can be synthesized either from monomers (*in situ* polymerization) or from a preformed polymer (synthetic or natural material).

In the first case, monomers are polymerized to form mainly capsule topology *via* **emulsion** and **interfacial techniques**.

In the second case, **solvent evaporation** and **complex coacervation** have been reported as appropriate techniques to prepare antioxidant, antimicrobial, antifungal and insect-repeller films *via* encapsulating vegetable essential oils.



Inclusion complexation consists of associating the active agent with a cavity-based material, e.g. cyclodextrins (CDs). Food-packaging bag manufactured using CD with ethylene-tetra cyclo-3-dodecane copolymer and hinokitol, showed no odor and good antifungal properties.

Figure 2. Encapsulation techniques applied in active packaging

Regarding encapsulation of antimicrobial compounds (nisin, pediocin, lysozyme) *via* **liposomes**, different formulations of lipids have given significant results for inhibiting *Listerial spp.* in dairy and meat food matrix. **Spray drying** is the most extensively used micro encapsulation technique in the food industry (flavor, vitamins, lipids, etc.), but limited application in packaging.

On the other hand, encapsulation of food materials *via* **electrospinning** has demonstrated serious advantages in active food packaging applications

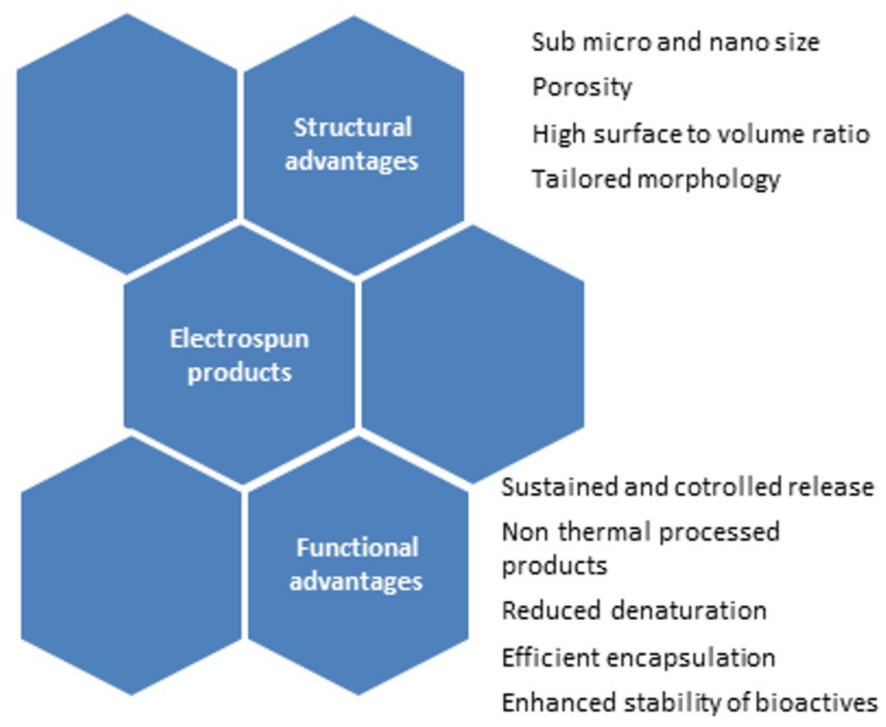


Figure 3. Electrospinning advantages

Conclusions

Among the numerous encapsulation techniques found in literature, **inclusion complexation with cyclodextrins and electrospinning** are the predominant ones for the development of new packaging materials with promising results.

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