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An overview of encapsulation of active compounds used in food products by drying technology

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ABSTRACT

Drying is an important process parameter for preservation of food components and it is widely applicable in food sectors. Nowadays, encapsulation by drying technology is of growing interest to provide many useful effects in food industry. Encapsulation of several drying techniques (spray drying, freeze drying, and fluidized bed coating) is a challenge to incorporate food component, antioxidant, colorant, cells and enzymes in powder form in food products. By drying, encapsulation achieves excellent properties of protection, stabilization, solubility and controlled release of the bioactive compounds. There are many reasons to apply encapsulation technology by drying, so recent developments of encapsulation are discussed in this review. Controlled release of food component at the right place at right time is a key functionality that can be provided by encapsulation. Drying improves effectiveness of food additives, broadens the application range of food ingredients, enhances shelf life of the food and lowers cost of the food products.

Contents

1. Introduction

Encapsulation is a process which entraps one substance (active agent) into another substance wall material producing particles in the nanometer (nano-encapsulation), micrometer (micro-encapsulation) or millimeter scale (Lakkis, 2007; Burgain, Gaiani, Linder & Scher, 2011). The encapsulated substance, except active agent, can be called the core, fill, active, internal or payload phase. The substance which encapsulates the active agent is called the coating, membrane, shell, capsule, carrier material, external phase,

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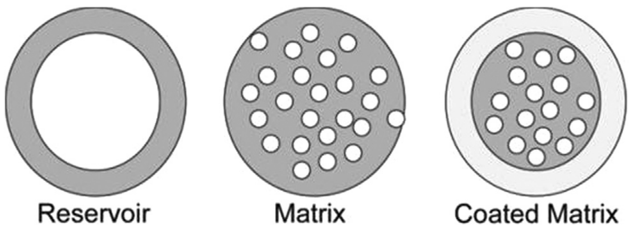

Fig. 1. Types of encapsulates (Zuidam & Nedovic, 2010).

or matrix (Wandrey, Bartkowiak & Harding, 2009; Fang & Bhandari, 2010). Encapsulation technology has been used in the food sectors to provide liquid and solid ingredients as an effective barrier against environmental parameters such as oxygen, light, free radicals etc (Desai & Park, 2005). Different types of encapsulates (reservoir, matrix and coated matrix) might be characterized (Fig. 1). (Zuidam & Nedovic, 2010) The reservoir type has a layer around the core material (also called capsule). The matrix type has the active agent dispersed over the carrier material and can be also found on the surface. A combination of reservoir type and matrix type gives a third encapsulate called coated matrix, in which the active agent is a capsule covered by an additional layer (Lakkis, 2007). Bioactive compounds can be improved by encapsulation technique which entraps a sensitive ingredient inside a coating material (Saenz, Tapia, Chavez & Robert, 2009). Bioactive components are different in molecular weight, polarity, solubility, etc. which implies different encapsulation approaches have to be applied in order to meet the specific physicochemical and molecular requirements (Augustin & Hemar, 2009; Kailasapathy, 2002). The encapsulation is applicable in agriculture, food, pharma, biotechnology and textile industry. As far as food industry is concerned, encapsulated products have found many applications as to coat colorants, flavors, vitamins, and other sensitive food ingredients in order to increase their shelf life (Dziezak, 1988; Shahidi & Han, 1993). Encapsulation involves wide area with encapsulating material, wall material, process and property and functionality and properties of encapsulated systems.

2. Why food industry applies encapsulation

The food industry applies microencapsulation process for several reasons (Gouin, 2004):

(1) Encapsulation can protect the core material from degradation by reducing its reactivity to its outside environment (e.g., heat, moisture, air, and light),
(2) Vaporization or transfer rate of the core material to the outside environment is decreases, retarded,
(3) The physical characteristics of the original material can be modified and made easier to handle,
(4) The product can be tailor-made to either release slowly over time or at a certain point, (i.e., to control the release of the core materials till the right stimulus),
(5) The flavor of the core material can be masked,
(6) The core material can be diluted when only very small amounts are required, yet still achieve a uniform dispersion in the host material,
(7) It can be employed to separate components within a mixture that would otherwise react with one another.

3. Coating material characteristics

The correct choice of the wall material is very important because it influences the encapsulation efficiency and stability of the microcapsule. The ideal wall material should have the following characteristics (Desai & Park, 2005):

1. Good rheological property at high concentration and easy work ability.
2. Ability to disperse or emulsify the active material and stabilize the emulsion produced.
3. Chemical non reactivity with the active core materials to be encapsulated during processing.
4. Ability to seal and hold the active material within its structure during processing or storage.
5. Ability to completely release the solvent or other materials used during the process of encapsulation under drying or other desolventization conditions.
6. Ability for providing maximum protection to the active material against environmental conditions (e.g., oxygen, heat, light, and humidity).
7. Solubility of the solvent should be acceptable to the food industry (e.g., water, and ethanol).

4. Encapsulation procedure

There are many techniques available for encapsulation of food compounds. Many encapsulation procedures have been proposed but none of them can be considered as a universally applicable procedure for bioactive food components. This is caused by the fact that individual bioactive food components have their own characteristic molecular structure (Augustin & Hemar, 2009). Since encapsulating compounds are very often in a liquid form, many technologies are based on drying. Different techniques like spray drying, spray-bed-drying, fluid-bed coating and freeze drying are available to encapsulate active agents (Gibbs, Kermasha, Alli &

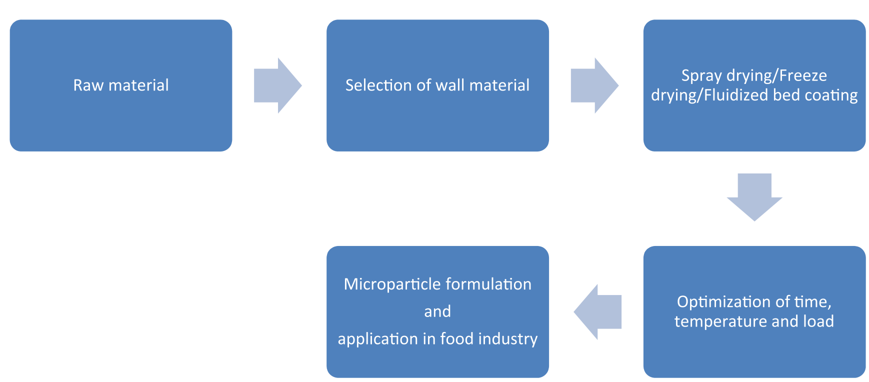

Fig. 2. A simplified encapsulation process by drying technology.