Chapter 24

Encapsulation of Bioactives

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24.1 Introduction

Food bioactives are physiologically active components in food or dietary supplements of plant or animal origin that have a role in health beyond basic nutrition. The addition of bioactive components to foods, particularly those foods that are consumed as part of the normal diet of target populations, offers opportunities for improving the health and well-being of consumers. The interest of the food industry in these functional foods has resulted in the development of a new generation of food products with enhanced levels of food components that have potential health benefits (Schmidl and Labuza 2000; Hilliam 2000; Heasman and Mellentin 2001; Augustin and Clarke 2004).

The delivery of bioactives through food is a major challenge. Many bioactives are prone to degradation, and thus there is a need to protect them throughout their shelf-life as both an ingredient and in fortified food products, without compromising the sensory properties of the food. In addition, the bioactivity needs to be maintained so it is available when consumed in order to have a physiological function when delivered to its particular target site within the body. All these requirements place stringent demands on using food to deliver bioactives. Often, these demands cannot be met by direct addition of a bioactive to food, as it needs to be protected prior to its release.

Microencapsulation has been used for protection and delivery of bioactives in food applications. In encapsulation, components (referred to as the core or active) are packaged within a secondary material (referred to as the wall material or the encapsulant) and delivered in small particles.

This chapter considers the issues relating to the delivery of bioactives through foods. The choice of materials for encapsulation of bioactives, the formulation of the encapsulated delivery system and the processes used for their manufacture are discussed. Examples of materials and processes used for the manufacture of encapsulated fat-soluble and water-soluble bioactives and encapsulated probiotics are given. The effectiveness of various encapsulated delivery systems for protection of bioactive ingredients and new trends in encapsulation technology are covered. The
requirements for effective encapsulation and the material states that may be used are very wide. Obvious connections can be drawn between the processes described in this chapter and the principles outlined in others (in particular Chapters 3, 5, 9, 15 and 23).

24.2 Issues Relating to Addition of Bioactives to Food

The range of food components now considered as bioactives include vitamins, minerals, functional lipids, probiotics, amino acids, peptides and proteins, phytosterols, phytochemicals and antioxidants (Wildman 2001). Their structure and function vary widely and are important considerations when adding them to food. The health aspects of bioactive ingredients and functional foods are not covered here as they are beyond the scope of this chapter.

Many bioactives are unstable. Irrespective of the form they are added to food, it is essential that they be stabilized prior to addition to food, during the food manufacturing process and throughout the food product’s shelf-life. When choosing the food vehicle for addition of a chosen bioactive, it is important to consider its solubility in the food matrix and its interactions with other ingredients in the food formulation. The incorporation of bioactives can alter flavour, odour and texture of foods. As consumers only accept food products with good sensory appeal, the successful addition of bioactives into a range of functional food products must not compromise food quality. Furthermore, as the bioactive food component is selected for its specific physiological function, it is important that it is bioavailable when the food is consumed.

24.2.1 Solubility of Bioactives

When considering the addition of a bioactive to food, it is useful to classify them as oil-soluble (e.g., polyunsaturated fatty acids, carotenes, lycopene), water-soluble (e.g., anthocyanins, proteins and peptides), or water/oil dispersible components (e.g., probiotics). Bioactives may be added directly to food if they are in a compatible format with the food matrix and provided their direct addition does not impact negatively on food quality or the bioavailability of the bioactive. When the solubility in a food matrix is limiting, its hydrophilicity/lipophilicity may be modified to enable improved incorporation. An example is the conversion of free plant sterols to fatty acid esters in order to make them more oil-soluble and readily incorporated into spreads (Deckere de and Verschuren 2000).

24.2.2 Stability of Bioactives

Bioactive ingredients are extracted from plant and animal sources and are provided to food manufacturers as liquid extracts, concentrates or powders. Generally, once the bioactive is extracted from its natural source, it is more susceptible to degradation.

It is well-known that vitamins A and D are sensitive to oxygen, light, and the presence of oxidizing agents. Long-chain polyunsaturated oils are susceptible to