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Emerging Technologies in Microencapsulation of Fish Oil

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Abstract

Generally encapsulation will develop an impermeable barrier to oxygen diffusion, thus it has been widely used to protect fish oil from oxidation. It also used in the controlled release of ingredients to improve the functionality of food additives and expanding the application range of food ingredients. Several methods have been used to encapsulate fish oil, but spray drying is the most common method. Electro spraying for ultrathin coating, spray granulation and fluid bed film coating, encapsulation using ultrasonic atomizer are the emerging methods for encapsulation of fish oil.

Introduction

In general, the major drawback in processing of healthy oils for food applications is related to the sensitivity of oils to oxidation. Many factors induce rapid oxidative deterioration of food products that contain oils, including light, heat, and oxygen. One of the most effective methods to retard fish oil oxidation is by microencapsulation. Microencapsulation techniques are of three classes: physical processes such as spray drying, spray chilling/ coating, extrusion or fluidised bed coating; chemical processes such as molecular inclusion or interfacial polymerisation; and physicochemical techniques such as single- or multi-core coacervation and liposome encapsulation. In recent years, microencapsulation has increasingly become an important technology for the delivery of numerous nutraceuticals and flavour ingredients into food matrix. Microencapsulation can protect polyunsaturated fatty acids (PUFA) from light and heat damage, and suppress or retard their oxidation, so as to be applied in food manufacturing to obtain functional food products.

Electro Spraying for Ultrathin Coating

Electro spraying is one of the novel techniques applied in the area of food manufacturing and nutraceuticals, which improves the overall quality of food products. Electro spraying is a drying technique based on the electro hydrodynamic processing of polymer melts, solutions, or dispersions (Sergio *et al.,* 2010). This technique allows the production of dried nano- and micro particles by subjecting a polymeric fluid to a high-voltage electric field, without the need of applying high temperatures. The major advantage of this method is the feasibility of operating in mild conditions and using all food-grade materials. In this method, the production of powdery and easy-to-handle products is in a one-step process with high encapsulation efficiencies. In this process tiny particle sizes can be achieved and there

is a possibility of tailoring the size and morphology of the obtained encapsulation structures by adjusting the processing conditions.

When electro spraying technique was used to microencapsulate DHA in ultrathin films of zein prolamine, nanometer sized capsules were formed and the induction period of encapsulated oil was increased, showing improved oxidative stability.

It is a useful tool that supports food technology and nutraceuticals *via* nanoencapsulating the bioactive ingredients resulting in their controlled release and making them resistant against unfavorable external conditions. Variants of this technique, such as coaxial electro spraying enable higher encapsulation efficiency of the compounds using polymer matrix for protecting the bioactive compounds.

Electro Spraying Assisted by Pressurized Gas

This technology is based on the combination of high electric voltage with pneumatic spray, which allows the formation of microcapsules at room temperature conditions to yield a high-throughput encapsulation process. It also provides high encapsulation efficiency. This technique shows a great deal of potential to encapsulate nutraceuticals and other bioactives that are sensitive to thermal degradation and/or oxidation. It is a promising innovative high-throughput electrospraying-based methodology for the encapsulation of bioactives and, therefore, the DHA-enriched fish oil containing microcapsules can be industrially applied to develop the formulation of novel fortified food products.

Encapsulation using Ultrasonic Atomizer

Ultrasonic atomizers employ ultra-sound energy to atomize fluids and provide smaller droplets with relatively narrow size distribution. Encapsulation of fish oil using an ultrasonic atomizer provides small particle size and good emulsion stability in a combined wall material matrix (Klaypradit and Huang, 2008). Ultrasonic atomizer-based atomization technology has some potential for the microencapsulation of omega-3 oils, but payload is relatively low. When three-fluid pressure nozzle and two-fluid ultrasonic nozzle used, oil and the aqueous solution containing wall material flow in separate channels and do not mix until they meet at the tip of the nozzle. The application of these nozzles avoids the need for the emulsion preparation step prior to drying, thus prevents the oxidation that can occur during emulsification. The droplet size distribution is dependent on the underlying mechanism governing generation of droplets, which can be properly controlled. Overall, ultrasound-assisted atomization can improve the process performance significantly. Ultrasonic atomization is an effective approach to get products with controlled size distribution.

Spray Granulation and Fluid Bed Film Coating

In this method, to enhance the stability of fish oil, spray granulation and fluid bed coating were used in combination for microencapsulation (Anwar *et al.,* 2010). In this technology, the fish oil microcapsules are produced in two successive steps. Firstly, fish oil is emulsified and sprays dried to produce granules. Secondly, the granules are coated.

With this method, particles having different shapes and sizes are moved around in the fluidized bed and simultaneously sprayed with a liquid. The aqueous or organic solution evaporates and the solids it contains form the coating layer. A typical particle size is 100 micrometers up to 3 millimeters.

The casing can be used as a protective layer to increase shelf life or storage stability as well as to make the particles functional - for instance, to mask odors or tastes or to release specific active substances.

Spray granulation is a good method for producing fish oil powder and to protect it from oxidation because of the “onion skin” structure of granules produced in this process. The coating and granulation of solid particles in a fluidized bed is a process which converts pumpable and atomizable liquids (solutions, slurries, melts) into granular solids in one step by means of drying. The solution to be processed is sprayed onto a fluidized bed. Particle growth can take place either *via* surface layering or agglomeration. In the case of surface layering the atomized droplets deposit a thin layer of liquid onto the seed particles. The solvent is then evaporated by the hot fluidizing, leaving behind the dissolved material on the surface.

Conclusion

Fish oil is the richest dietary source of long-chain omega-3 polyunsaturated fatty acids (PUFA). Stabilization of omega-3 PUFA against oxidation is an important task in food processing. Microencapsulation is one of the important methods to retard this oxidation of fish oil. Many methods are used to encapsulate fish oil, and the above mentioned techniques are used as an alternative for the encapsulation of sensitive bioactive agents with promising applications in the food sector and they have minimal impact on the textural characteristics of the product, indicating that this is a promising technology for food industry.

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