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Techniques of Food Microencapsulation

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Introduction:

Microencapsulation is defined as a process in which tiny particles or droplets are surrounded by a coating, or embedded in a homogeneous or heterogeneous matrix, to give small capsules with many useful properties.Micro encapsulation, the science of capturing a core material in a shell or coating for controlled release, can provide the food industry with a distinct market advantage in all these product purchase points.Microencapsulation can provide a physical barrier between the core compound and the other components of the product. More especially, in the food field, microencapsulation is a technique by which liquid droplets, solid particles or gas compounds are entrapped into thin films of a food grade microencapsulating agent. The core may be composed of just one or several ingredients and the wall may be single or double-layered.

Microencapsulation Materials

Typically, microencapsulated products can be divided into five main categories: flavorings, vitamins and minerals, oils and fats (such as omega-3s and 6s), herbs and bioactive (such as pro-biotic bacteria) and other food ingredients (such as enzymes, leavening agents and yeast).

Shell-

A critical step in developing microencapsulated food products is determining the shell formulation that meets the desired stability and release criteria. The GRAS shell material must stabilize the core material, must not react with or deteriorate the active ingredient and should release under the specific conditions based on the product application.

Shell materials are typically film-forming, pliable, tasteless, non-hydroscopic, soluble in an aqueous media or solvent, and/or exhibit a phase transition, such as melting or gel point.

Most materials approved for food use are natural or derivatives of a natural product. They can be put into roughly six categories as follows:

- Polysaccharides/hydrocolloids, such as starch, algin/alginate, agar/agarose, pectin/polypectate and other gums.
- Proteins such as gelatin, casein, zein, soy, and albumin.
- Fats and fatty acids such as mono-, di- and triglycerides, and lauric, capric, palmitic and stearic acid and their salts.
- Cellulose derivatives such as methyl- and ethyl-cellulose and CMC.
- Hydrophilic and lipophilic waxes such as shellac, PEG (polyethylene glycol), or carnauba wax or beeswax.
- Sugar derivatives.

"Captivating" Techniques

The various microencapsulation processes allow product formulators to make capsules from less than a micrometer to several thousand micrometers in size. Each process offers specific attributes, such as high production rates, large production volume, high product yield, and different capital and operating costs. Other process variables include greater flexibility in shell material selection and differences in microcapsule morphology, particle size, and distribution.

Microencapsulation processes include-

- Physical technique
- Chemical technique

Physical methods use commercially available equipment to create and stabilize the capsules. Chemical techniques apply ionic chemistry to create the micro spheres in batch reactors.

PHYSICAL TECHNIQUE-

- Spray-Drying –

Water removal by spray-drying solutions is a common engineering practice. By decreasing water content and water activity, spray-drying is generally used in food industry to ensure:-

1. A microbiological stability of products, avoid the risk of chemical and/or biological degradations.
2. Reduce the storage and transport costs, and finally obtain a product with specific properties like instantaneous solubility for example.

The spray-drying process has been developed in connection with the manufacture of dried milk. However, when milk is spray-dried, the process can be considered as a microencapsulation one; milk fat is being the core material that is protected against oxidation by a wall material consisting of a mix of lactose and milk proteins. In this mix, the carbohydrates provide structure through glass formation whereas the proteins provide emulsification and film forming properties. Spray-drying process has been used for decades to encapsulate food ingredients such as flavors, lipids, and carotenoids. During this drying process, the evaporation of solvent, that is most often water, is rapid and the entrapment of the interest compound occurs quasi-instantaneously

Other physical techniques include the spinning disc and coextrusion processes.

- The spinning disc method-

Similar to the spray-drying process, uses an emulsion or suspension containing the food ingredient, prepared with a solution or melt of the coating material. The emulsion or suspension is fed to the disc surface and forms a thin wetted layer that, as the disc rotates, breaks up into airborne droplets from surface tension forces that induce thermodynamic instabilities. Resulting capsules are typically spherical. Because the emulsion or suspension is not extruded through orifices, this technique permits use of a higher viscosity shell material and allows higher loading of the food ingredient in the shell. The process also offers a broad range of particle sizes with a controlled distribution.

- Coextrusion encapsulation methods-

Create fibers containing the active ingredients within fluid, high-viscosity, glassy sugars and carbohydrates. These fibers can be chopped to create micro cylinders. When the viscosity is low and the surface tension of the fluid is high, these extrudates would thermodynamically break up into tiny droplets, creating microcapsules.

The typical extrusion systems use stationary nozzle coextrusion, centrifugal coextrusion, or submerged nozzle coextrusion. All these processes involve concentric nozzles, which pump the core material through the inner nozzle while the shell formulation is pumped through the annulus, allowing true “core-shell” morphologies.

As the liquid stream exits the nozzle, local disturbances, such as induced vibration or gravitational, centrifugal, or drag force, control particle size. Typical microcapsules produced by coextrusion range from 100 micrometers to 6 mm, or about the size of a human egg cell to the size of a pencil eraser.

CHEMICAL TECHNIQUE-

Of the different chemical microencapsulation processes, only phase separation, gelation, and coacervation are widely used in the food industry.

- Phase Separation-

The food ingredient, such as flavor oil, is emulsified in a polymer solution, and subsequently, an antisolvent is added to induce the precipitation of the polymer around the core.

- Coacervation-

Microcapsule shells are formed by ionic interaction between two ionic polymers, typically a polyanion (acacia gum) and a polycation (gelatin).

- Gelation-

The concept of gelation as a microencapsulation method involves using a technique such as cooling, cross linking, or a chemical reaction to form gelled micro spheres or microcapsules. For example, reacting sodium alginate with calcium chloride forms the insoluble calcium alginate.

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