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Review Article

An Overview on Microcapsules

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ABSTRACT:

The development of new functional foods requires technologies for incorporating health promoting ingredients into food without reducing their bioavailability or functionality. In many cases, microencapsulation can provide the necessary protection for these compounds. Microcapsules offer food processors a means to protect sensitive food components, ensure protection against nutritional loss, utilize sensitive ingredients, incorporate unusual or time-release mechanisms into the formulation, mask or preserve flavors/aromas and transform liquids into easy to handle solid ingredients. Various techniques cab be employed to form microcapsules, including spray drying, spray chilling or spray cooling, extrusion coating, fluidized-bed coating, liposomal entrapment, lyophilization, coacervation, centrifugal suspension separation, cocrystallization and inclusion complexation. This article describes the recent and advanced techniques of microencapsulation. Controlled release of food ingredients at the right place and the right time is a key functionality that can be provided by microencapsulation. Timely and targeted release improves the effectiveness of food additives, broadens the application range of food ingredients, and ensures optimal dosage, thereby improving the cost effectiveness for the food manufacturer.

KEY WORDS: Drug delivery systems, Microcapsules, Controlled release,Microencapsulation

INTRODUCTION

The very popular **microcapsule** is one of the most convenient ways of protection and masking reduced dissolution rate, facilitation of handling and spatial targeting of active ingredient. Microcapsules are used to overcome some of problems of conventional therapy and enhance efficacy of a given drug. Hollow microparticle composed of a solid shell surrounding a core-forming space available to permanently or temporarily entrapped substances.

Microencapsulation is defined as encasing of small particles of liquids, solids or gases by an intact shell to produce a microcapsule. Microcapsules are small sphere comprising a near uniform wall enclosing some material. The enclosed material in the microcapsule is referred to as core, internal phase or fill where as well as sometimes called a shell coating or membrane.The particle size of microcapsules is ranging from 5-500, even extended up to 2000µ depending on material, core to coat ratio and methods of preparation. Microcapsule belongs to “reservoir” system and green’s tiny capsules became known as microcapsules or microspheres. In the late 1940s an inventor named Chester Carlson enlisted the aid of Haloid company of Rochestor, Newyork, to help commercialize his new copying process, know as xerography,a dry photocopying process that used toner consisting of microencapsulated dyes.

Microcapsules consist of two important parts; they are core and coat materials. Core materials include active constituents which are either water soluble or insoluble with or without additives. Coating materials are the wall forming materials which are chemically compatible and non reactive with the core materials should provide a cohesive membrane with desired coating properties such as flexibility, solubility, permeability, strength and stability. The Microcapsules are used in novel drug delivery system to deliver the drug in an optimal amount in right period of time with minimum side effect and maximum therapeutic effect toget desired effect.

The microcapsules are divided into three types they are as follows

Mononuclear / single core, Polynuclear / multiple cores, Matrix type

Advantages

- To increase the bioavailability
- To alter the drug release
- To improve the patient's compliance
- To produce a targeted drug delivery
- To reduce the reactivity of the core in the relation to the outside environment
- To decrease evaporation rate of the core material.
- To convert liquid to solid form& to mask the core taste
- Masking of bitter taste drugs.eg: Oflaxacin.
- Conversion of liquid to pseudo solid.eg:Vit.A. palmitate
- Reduction of hygroscopicity.eg: Nacl.
- Reduction of vaporization of volatile drugs.eg: Methyl salicylate.
- Prevention of incompatibilities among drugs.eg: Aspirin and chlorapheniraminemaleate

Disadvantages

- Possible cross reaction between core and shell material.
- Difficult to achieve continuous and uniform film
- Shelf life of hygroscopic drugs is reduced.
- More production costs.
- More skill and knowledge is required.
- Microencapsulation techniques are of high.
- Different dosage forms like tablets, capsules,
- Lozenges cannot be encapsulated by single microencapsulation process.
- Coating may not be uniform this can effect release pattern of a drug in the body

Applications

- Agriculture applications
- Reduce insect populations by disrupting their mating process.
- Protects the phenomenon from oxidation and light during storage and release
- Catalysis
- Safe handling, easy recovery, reuse and disposal at an acceptable economic cost.

- Metal species such as palladium (II) acetate and osmium tetroxide have been encapsulated in polyurea microcapsules and used successfully as recoverable andreusable catalysts without significant leaching and loss of activity.

    - Food industry

- Adding ingredients to food products to improve nutritional value can compromisetheir taste, colour, texture and aroma.
- Ingredients can also react with components present in the food system, which maylimit bioavailability.

    - Pharmaceutical application

- Potential applications of this drug delivery system are replacement of therapeutic agents (not taken orally today like insulin), gene therapy and in use of vaccines fortreating AIDS, tumors, cancer and diabetes.

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1.4 Preparation of microcapsules

Microencapsulation techniques

PREPARATION OF MICRO CAPSULES

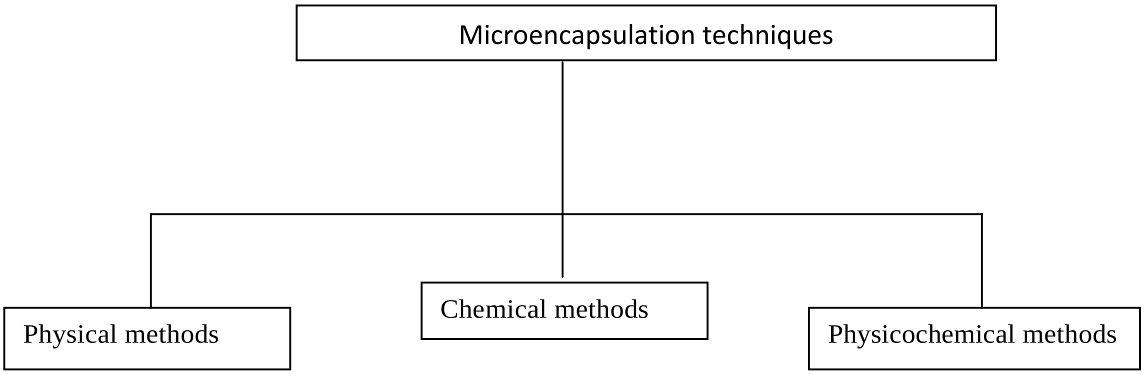


Chart no. 1 : Microencapsulation techniques

- Physical methods
  - Air suspension coating
  - pan coating
- Chemical method coating
  - Solvent evaporation method
- Physicochemical methods
  - Coacervation phase separation

Various microencapsulation techniques and the processes involved in each technique

The selection of microencapsulation method and coating materials are interdependent. Based on the coating material or method applied, the appropriate method or coating material is selected. Coating materials, which are basically film-forming materials, can be selected from a wide variety of natural or synthetic polymers, depending on the material to be coated and characteristics desired in the final microcapsules.

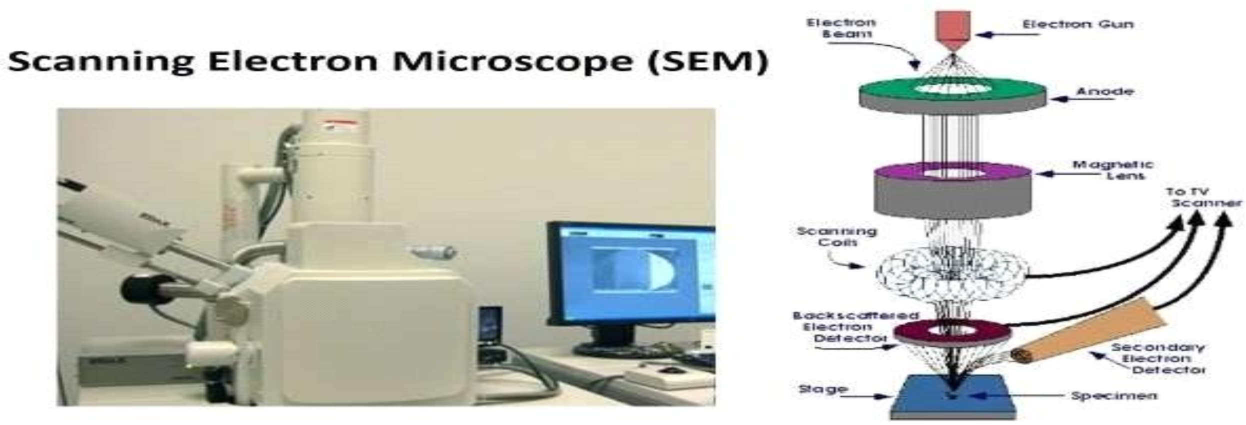
No	Microencapsulation technique	Major steps in encapsulation
1	Spray-drying	• Preparation of the dispersion • Homogenization of the dispersion
		c. Atomization of the infeed dispersion d. Dehydration of the atomized particles
2	Spray-chilling	• Preparation of the dispersion • Homogenization of the dispersion • Atomization of the infeed dispersion

3	Spray-cooling	• Preparation of the dispersion • Homogenization of the dispersion • Atomization of the infeed dispersion
4	A: Extrusion B: Centrifugation	• Preparation of molten coating solution • Dispersion of core into molten polymer • Cooling or passing of core-coat mixture through dehydrating liquid • Preparation of core solution • Preparation of coating material solution • Co-extrusion of core and coat solution throughnozzles
5	Fluidized-bed coating	• Preparation of coating solution • Fluidization of core particles. • Coating of core particles
6	Liposomal entrapment	• Micro fluidization • Ultrasonication • Reverse-phase evaporation
7	Lyophilization	• Mixing of core in a coating solution • Freeze-drying of the mixture
8	Coacervation	• Formation of a three-immiscible chemicalphases • Deposition of the coating • Solidification of the coating

Table no. 1: Various microencapsulation techniques and the processes involved in eachtechnique

INSTRUMENTS HANDLING

- **Scanning by electron microscope**



This instrument useful for determination structure of shape and outer structure of microencapsulue.

Figure 1 scanning electron microscope

- **Attenuated total reflectance FTIR spectroscopy**

This is used to determine the degradation of the polymeric matrix of the carrier system.

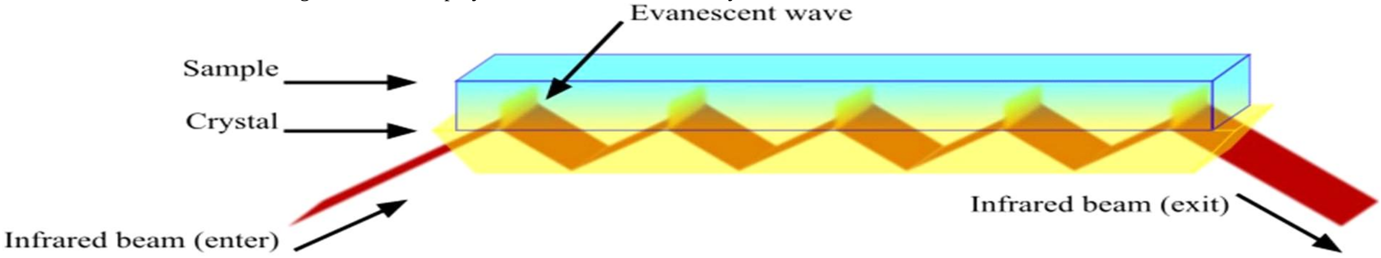


Figure 2 Attenuated total reflectance FTIR spectroscopy

- **Multivolume pycnometer**

Helium is introduced at constant pressure in the chamber and allowed to expand. This expansion results in reduction in pressure within this chamber and two different readings volume and hence the density of the microencapsule is determined.

Figure 3 multivolume pycnometer

- **Spray Dryer:**

Microencapsulation by spray drying offers advantages over conventional microencapsulation techniques by producing microcapsules via a relatively simple, continuous process. The spray drying equipment used is same as is used for the production of dry milk.

Figure 4 spray dryer in laboratory scale

- **Spray cooling:**

Spray cooling is called as 'matrix' encapsulation because the particles are more adequately described as aggregates of active ingredient particles buried in the fat matrix, while 'true' encapsulation is usually reserved for processes leading to a core/shell type of micro encapsules. Even though the process does not lead to a perfect encapsulate, the properties obtained by spray cooling/ chilling are sufficient to achieve the desired delayed release of the ingredient in the actual application.

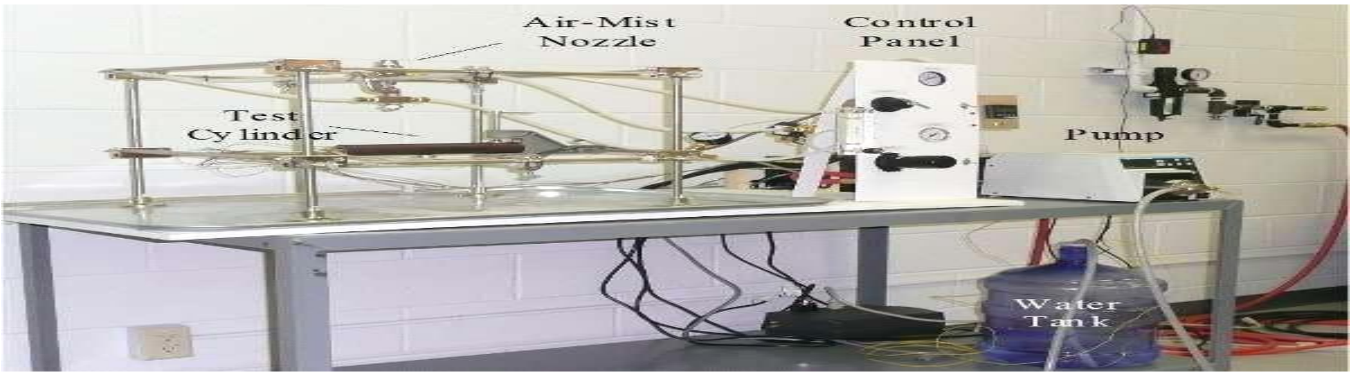


Figure 5 Multiphase spray cooling technology in industry

- **Fluidized Bed Coating:**

Fluidized bed technology is one of the few advanced technologies capable of coating particles with any kind of shell material like polysaccharides, proteins, emulsifiers, fats, complex formulations, enteric coating, powder coatings, yeast cell extract, etc.

Figure 6 Fluidised bed coater

- **Lyophilization**

Lyophilization, or freeze-drying, is a process used for the dehydration of almost all heat sensitive materials and aromas. It has been used to encapsulate water-soluble essences and natural aromas as well as drugs. Except for the long dehydration period required freeze-drying is a simple technique, which is particularly suitable for the encapsulation of aromatic materials.

Figure 7 Lyophilization instrument

FUTURE ASPECTS

As described in this paper, microencapsulation is a biomedical technology with remarkable therapeutic potential for a wide range of diseases. The process of microencapsulation can be used in designing therapeutic formulations of microbial cells, mammalian cells, drugs, and other molecular pharmaceutics. In addition to the presented applications, other applications are also promising.Given the importance of microencapsulation in various disease applications the technology needs to be further enhanced. One aspect that seems critical is targeted delivery using triggered release of the encapsulated contents due to external trigger factors. Other uses

of microencapsulation that seem promising are the use of this technology in developing disease models, such as models of tumors for developing pharmaceutical formulations.

It is also clear that, for each microcapsule formulation, the types and physical and chemical properties of the microcapsules must be optimized. Optimization may involve a number of variables, including the type of microencapsulation process, the encapsulation materials used, and the therapeutic loading capacity. Keeping these characteristics in mind, it is also evident that the future success of microencapsulation must look at the optimization of the methods behind the fabrication of microcapsules. Specifically, characteristics such as permeability, mechanical stability, cell viability, controlled release, targeted delivery, drug stability, and shelf-life of the product, including larger-scale industrial production in therapeutically acceptable production environments, need to be optimized for each intended application.

Global Microcapsules Drug Delivery Market Opportunity Outlook 2022 report highlights:

- Characterization & Engineering Technology of Microcapsules
- Applicability of Microcapsules in Drug Delivery
- Global Market Perspectives of Microcapsules
- Global Microcapsule Market Dynamics Future Indication of Microcapsules
- Indispensable Advent of Microcapsules
- Trajectory of Microencapsulation
- Why & wherefores for Microencapsulation
- Characterization of Microcapsules
- Composition of Microcapsules
- Parameters Influencing Microcapsules
- Engineering Technology of Microcapsules
- Physical Manufacturing Technologies

- Physicochemical & Chemical Technologies
- Applicability of Microcapsules
- Microcapsules in Pharmaceuticals
- Microcapsules in Nutraceuticals
- Delivering Controlled Drug Delivery
- Microcapsules: Controlled Drug Delivery
- Microcapsules: Drug Delivery Projects
- Microcapsules Escalating Regeneration
- Perception of Artificial Cell Therapeutics
- Micro capsulated Artificial Cell Carriers
- Microcapsules Broadening Transplantation
- Microcapsules Overcoming Barriers
- Microcapsules in Liver Transplantation
- Microcapsules Managing Diabetes
- Islets of Pancreas: Bioengineering Approach
- Artificial Pancreas: Medical Device
- Microcapsules in Pathobiology
- Delivery of Live Bacteria
- Microcapsules for Probiotics
- Microcapsules in Oncological World
- Microcapsulated Anticancer Targeted Carriage
- Microcapsules towards Theranostics
- Major Microcapsulated Cancer Projects
- Microcapsules for Central Nervous System
- Crossing Blood Brain Barrier
- Microcapsules Dealing with Brain Tumors
- Microcapsules Improving Cardiovascular Health
- Embedding Therapies to Cardiovascular System

- Applications Using Microcapsules
- Global Market Perspectives of Microcapsules
- Current Market Insights of Microcapsules
- Microcapsules Market by Industrial Application
- Global Market of Encapsulating Materials
- Market Trends in Biopolymeric Market
- Upcoming Market Trends of Smart Polymers
- Global Microcapsule Market Dynamics
- Accelerative Parameters
- Challenges to Overcome
- Future Indication of Microcapsules
- Competitive Landscape

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