Online Available at www.thepharmaresearch.info

THE PHARMA RESEARCH, A JOURNAL

The Pharma Research (T. Ph. Res.), (2010), 3; 112-116.
Published on- 15 June 2010

Review Article

ISSN 0975-8216

MICROENCAPSULATION TECHNIQUES AND ITS APPLICATION: A REVIEW

Sunderlal Tiwari, Achrish Goel, Keshri Kishore Jha, Akhil Sharma*

Affiliated to:
Department of Pharmaceutics, College of Pharmacy, Teerthanker Mahaveer University, Moradabad-244001

ABSTRACT

Micro-encapsulation is a process in which tiny particles or droplets are surrounded by a coating to give small capsules many useful properties. In a relatively simplistic form, a microcapsule is a small sphere with a uniform wall around it. The material inside the microcapsule is referred to as the core, internal phase, or fill, whereas the wall is sometimes called a shell, coating, or membrane. Most microcapsules have diameters between a few micrometers and a few millimeters. The reasons for microencapsulation are countless. In some cases, the core must be isolated from its surroundings, as in isolating vitamins from the deteriorating effects of oxygen, retarding evaporation of a volatile core, improving the handling properties of a sticky material, or isolating a reactive core from chemical attack. In other cases, the objective is not to isolate the core completely but to control the rate at which it leaves the microcapsule, as in the controlled release of drugs or pesticides. The problem may be as simple as masking the taste or odor of the core, or as complex as increasing the selectivity of an adsorption or extraction process.

Keywords: Microencapsulation, Novel Technique, Microparticulate system

*Corresponding author:
Email: xs2akhil@gmail.com

1.0 INTRODUCTION

Micro-encapsulation is a process in which tiny particles or droplets are surrounded by a coating to give small capsules many useful properties. In a relatively simplistic form, a microcapsule is a small sphere with a uniform wall around it. The material inside the microcapsule is referred to as the core, internal phase, or fill, whereas the wall is sometimes called a shell, coating, or membrane. Most microcapsules have diameters between a few micrometers and a few millimeters.

The definition has been expanded, and includes most foods. Every class of food ingredient has been encapsulated; flavors are the most common. The technique of microencapsulation depends on the physical and chemical properties of the material to be encapsulated. [1]

Many microcapsules however bear little resemblance to these simple spheres. The core may be a crystal, a jagged adsorbent particle, an emulsion, a suspension of solids, or a suspension of smaller microcapsules.

The microcapsule even may have multiple walls.

These micro-capsules have a number of benefits such as converting liquids to solids, separating reactive compounds, providing environmental protection, improved material handling properties. Active materials are then encapsulated in micron-sized capsules of barrier polymers (gelatin, plastic, wax).

Microencapsulation includes BIO-ENCAPSULATION which is more restricted to the entrapment of a biologically active substance (from DNA to entire cell or group of cells for example) generally to improve its performance &/or enhance its shelf life.

1.1 REASONS FOR ENCAPSULATION

The reasons for microencapsulation are countless. In some cases, the core must be isolated from its surroundings, as in isolating vitamins from the deteriorating effects of oxygen, retarding evaporation of a volatile core, improving the handling properties of a sticky material, or isolating a reactive core from chemical attack. In other cases, the objective is not to isolate the core completely but to control the rate at which it leaves the microcapsule, as in the controlled release of drugs or pesticides. The problem may be as simple as masking the taste or odor of the core, or as complex as increasing the selectivity of an adsorption or extraction process.

2.0 TECHNIQUES TO MANUFACTURE MICROCAPSULES

2.1 Physical methods

1) Pan coating

The pan coating process, widely used in the pharmaceutical industry, is among the oldest industrial procedures for forming small, coated particles or tablets. The particles are tumbled in a

pan or other device while the coating material is applied slowly.

The problem of bitter and obnoxious taste of drug in pediatric and geriatric formulations is a challenge to the pharmacist in the present scenario. In order to ensure patient compliance bitterness masking becomes essential. Molecule interacts with taste receptor on the tongue to give bitter, sweet or other taste sensation, when they dissolve in saliva.

2) Multiple Emulsions

A novel technique for taste masking of drugs employing multiple emulsions has been prepared by dissolving drug in the inner aqueous phase of w/o/w emulsion under conditions of good shelf stability. The formulation is designed to release the drug through the oil phase in the presence of gastrointestinal fluid.[3,4]

3) Prodrugs

A prodrug is a chemically modified inert drug precursor, which upon biotransformation liberates the pharmacologically active parent drug. Examples of drug with improved taste are given below.[2]

Table no.1: Prodrugs with improved taste

Sr. no.	Parent drug	Prodrug with improved taste
1	Chloramphenicol	Palmitate ester
2	Clindamycin	Palmitate ester
3	Triamcinolone	Diacetate ester

4) Mass extrusion method (Dispersion coating)

This technology involves softening the active blend using the solvent mixture of water-soluble polyethylene glycol, using methanol and expulsion of softened mass through the extruder or syringe to get a cylinder of the product into even segments using heated blade to form tablets. The dried cylinder can also be used to coat granules of bitter tasting drugs and thereby masking their bitter taste.[5]

5) Air-suspension coating

Microencapsulation by air suspension techniques is generally ascribed to the inventions of Professor Dale E. Wurster, basically the Wurster process consists of the dispersing of solid, particulate core materials in a supporting air stream and the spray coating of the air suspended particles.

6) Coacervation-Phase separation

Microencapsulation by coacervation-phase separation process consists of three steps carried out under continuous agitation;

1) Formation of three immiscible chemical phases
2) Deposition of coating
3) Rigidization of coating

Step 1 of the process is the formation of three immiscible chemical phases; a liquid manufacturing vehicle phase, a core material

phase and a coating material phase. To form the three phases, the core material is dispersed in a solution of the coating polymer, the solvent for the polymer being the liquid manufacturing vehicle phase.

Step 2 of the process consists of depositing the liquid polymer coating upon the core material. This is accomplished by controlled, physical mixing of the coating material and the core material in the manufacturing vehicle. Deposition of the liquid polymer coating around the core material occurs if the polymer is absorbed at the interface formed between the core material and the liquid vehicle phase, and this adsorption phenomenon is a prerequisite to the effective coating.

Step 3 of the process involves rigidizing the coating, usually by thermal, cross linking, or desolvation techniques to form a self sustaining microcapsule[6.]

7) Solvent Evaporation

This technique has been used to produce the microcapsules. The processes are carried out in a liquid manufacturing vehicle. The microcapsule coating is dissolved in a volatile solvent, which is immiscible with the liquid manufacturing vehicle phase. A core material to be microencapsulated is dissolved or dispersed in the coating polymer solution. With agitation, the core coating material mixture is dispersed in the liquid manufacturing vehicle phase to obtain the appropriate size microcapsule. The mixture is then heated (if necessary) to evaporate the solvent for the polymer. In the case in which the core material is dissolved in the coating polymer solution, a matrix-type microcapsule is formed. Once all the solvent for the polymer is evaporated, the liquid vehicle temperature is reduced to ambient temperature with continued agitation. At this stage the microcapsules can be used in suspension form, coated on to substrates or isolated as powders[6.]

8) Polymerization

A relatively new microencapsulation method utilizes polymerization technique to form protective microcapsules coating in situ. The method involves the reaction of monomeric units located at the interface existing between a core material substance and a continuous phase in which the core material is dispersed. The continuous or core material supporting phase is usually a liquid or gas and therefore the polymerization reactions occurs at a liquid-liquid, liquid-gas, solid-liquid, or solid gas interphase [6].

In Interfacial polymerization, the two reactants in a polycondensation meet at an interface and react

rapidly. The basis of this method is the classical Schotten-Baumann reaction between an acid chloride and a compound containing an active hydrogen atom, such as an amine or alcohol, polyesters, polyurea, polyurethane. Under the right conditions, thin flexible walls form rapidly at the interface. A solution of the pesticide and a diacid chloride are emulsified in water and an aqueous solution containing an amine and a polyfunctional isocyanate is added. Base is present to neutralize the acid formed during the reaction. Condensed polymer walls form instantaneously at the interface of the emulsion droplets.

9) In-situ polymerization

In a few microencapsulation processes, the direct polymerization of a single monomer is carried out on the particle surface. In one process, e.g. Cellulose fibers are encapsulated in polyethylene while immersed in dry toluene. Usual deposition rates are about 0.5µm/min. Coating thickness ranges 0.2–75 µm (0.0079–2.95 mils). The coating is uniform, even over sharp projections.

3.0 APPLICATIONS OF MICROENCAPSULATION

The applications of micro-encapsulation are numerous. The ones mentioned below are some of the most common ones.

- Carbon less papers
- Scratch-n-sniff
- Flavors and essences
- Pesticides and herbicides
- Pharmaceuticals
- Textiles
- Adhesives
- Visual indicators
- Thermochromic dyes
- Phase change materials
- temperature release (controlled release)

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