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MICROENCAPSULATION: A REVIEW

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ABSTRACT:

Microencapsulation is a technique by which thin coatings of wall material are formed around the substances which may be solids, liquids or even gases, enclosed in microscopic particles. Microencapsulated products (micro particles) are the small entities that have an active agent known as the core material surrounded by a shell known as the coating material or embedded into a matrix structure. Microencapsulation is an advanced food processing technology, using which any compound can be encapsulated inside a particular material, making a tiny sphere of diameter ranging from 1 µm to several 100 µm. Microencapsulation is done for protecting the sensitive compounds and hence, ensuring their safe delivery. The compound or active material which is encapsulated is called the core and the material which is used for encapsulating is called the encapsulant. Encapsulants can be either polymeric or nonpolymeric materials like cellulose, ethylene glycol, and gelatine . There are several techniques used for microencapsulation. Fluidized bed coating, spray cooling, spray drying, extrusion, and coacervation are few to be named. The selection of a particular technique depends upon the properties of the core material, encapsulant, and different properties and morphology of the capsules desired. Microencapsulation is a technology that is extensively used in foods, whether as a fortifying tool or as a mode for the development of a functional food.

KEYWORDS: microcapsule, microencapsulation , microsphere, coating material ,controlled release, core materials.

INTRODUCTION:

Microencapsulation is a process by which very tiny droplets or particles of liquid or solid material are surrounded or coated with a continuous film of polymeric material. Microencapsulation includes Bioencapsulation 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 life1. Microcapsules are finally dispersed in various dosage forms, such as hard gelatine capsules, which may be enteric coated, soft gelatine capsules, or suspensions in liquids, all of which allow dispersion of individual microcapsules on release.

Microencapsulation is an emerging technology that leads to the protection of different food components or functional constituents against various processing conditions by covering them inside a polymeric or nonpolymeric material and allowing their controlled release under particular conditions. In addition, it enhances the sensory quality by masking the unpleasant taste, aroma, and Flavors also, it increases food safety by inhibiting the growth of the microbes. Microspheres are considered as free flowing powders having biodegradable polymers. Microencapsulation process helps for controlling the release characteristics of different coated materials, converting the liquids to solids, changing the colloidal and surface properties and providing environmental protection. By delivering the agent to the target tissue in the optimal amount in the right period of time, maximum therapeutic efficacy, little toxicity and minimal side effects can be achieved. There are various approaches in delivering a therapeutic substance to the target site in a sustained controlled release fashion.

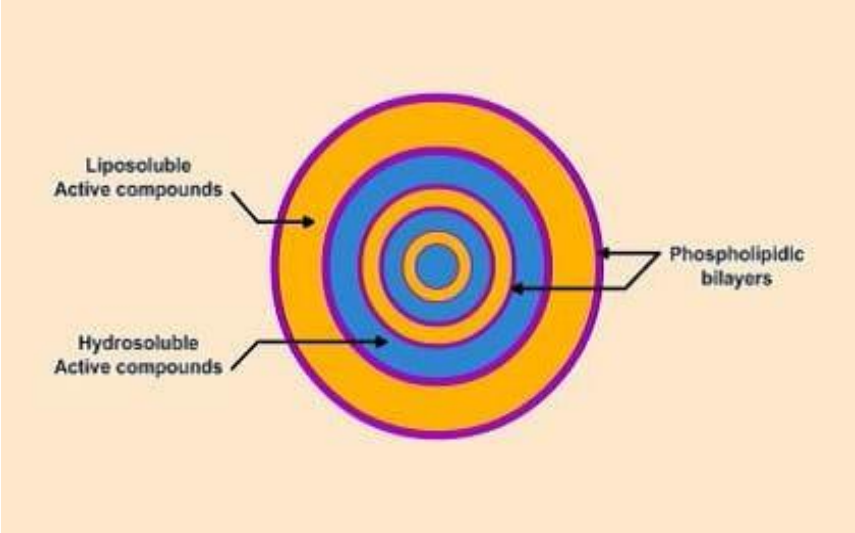

Figure 1: Microencapsulation process

REASONS FOR MICROENCAPSULATION:

- The reason for microencapsulation is found for either to be sustained or prolonged drug release.
- This technique is broadly used for masking odour and taste of many drugs.
- This technique improves patient compliance and can be used for converting liquid drugs into free flowing powder.
- The drugs which are sensitive to oxygen, light, temperature, moisture, can be stabilised by this technique.
- To reduce the drugs toxicity and GI irritation many drugs have been encapsulated including potassium chloride and ferrous sulphate.

CORE MATERIALS:

The core material, defined as the specific material to be coated, can be liquid or solid in nature. The composition of the core material can be varied, as the liquid core can include dispersed and/or dissolved materials. The solid core be active constituents, stabilizers, diluents, excipients, and release-rate retardants or accelerators. A substance may be microencapsulated for a number of reasons. Examples may include protection of reactive material from their environment, safe and convenient handling of the materials which are otherwise toxic or noxious, taste masking, means for controlled or modified release properties means of handling liquids as solids, preparation of free flow powders and in modification of physical properties of the drug.

COATING MATERIALS:

The coating material or the wall material used in microencapsulation should be such that it is able to form a cohesive film on the core, stabilize it, and provide strength to the capsules. The coating material should be capable of forming a film that is cohesive with the core material; be chemically compatible and nonreactive with the core material; and provide the desired coating properties, such as strength, flexibility, impermeability, optical properties, and stability.

COATING MATERIAL PROPERTIES:

- Non-hygroscopic, no high viscosity, economical.
- The coating can be flexible, brittle, hard, thin etc.
- Stabilizes core material.
- Inert towards active ingredients.
- Stable film-forming, tasteless.

EXAMPLES OF COATING MATERIAL:

TYPE	EXAMPLES
Water soluble resins	Gelatine, Gum Arabic, Starch, Polyvinylpyrrolidone, Carboxymethylcellulose, Hydroxyethyl cellulose, Methylcellulose, Arabinogalactan, Polyvinyl alcohol, Polyacrylic acid.
Water insoluble resins	Ethyl cellulose, Polyethylene, Polymethacrylate, Polyamide (Nylon), Poly (Ethylene-Vinyl acetate), Cellulose nitrate, Silicones.
Waxes and lipids	Paraffin, Carnauba, Spermaceti, Beeswax, Stearic acid, Stearyl alcohol, Glyceryl stearates .
Enteric resins	Shellac, Cellulose acetate phthalate, Zein.

TECHNIQUES TO MANUFACTURE MICROCAPSULES:

1.PHYSICAL METHODS:

1.1 Air-suspension coating

Air-suspension coating of particles by solutions or melts gives better control and flexibility. The particles are coated while suspended in an upward-moving air stream. They are supported by a perforated plate having different patterns of holes inside and outside a cylindrical insert. Just sufficient air is permitted to rise through the outer annular space to fluidize the settling particles. Air suspension coating (Wurster) consists of the dispersing of solid, particulate core materials in a supporting air stream and the spray coating on the air suspended particles. At the top, as the air stream diverges and slows, they settle back onto the outer bed and move downward to repeat the cycle. The particles pass through the inner cylinder many times in a few minutes methods.

1.2 Coacervation-phase separation

The microencapsulation by coacervation-phase separation generally consists of three steps carried out under continuous agitation: (a) formation of three immiscible chemical phases, (b) deposition of coating, and (c) Rigidization of the coating. The coacervation-phase separation has been classified into two categories, simple coacervation and complex coacervation. The former implies addition of a strongly hydrophilic substance to a solution of colloid. This added substance causes two phases to be formed. The complex coacervation is principally a pH dependant process. The acidic or basic nature of the system is manipulated to produce microcapsules. Above a certain critical pH value, the system depending upon its acidic or basic nature may produce microcapsules. Below that pH value they will not be formed. Usually, complex coacervation deals with the system containing more than one colloid.

1.3 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 with respect to microencapsulation, solid particles greater than 600 microns in size are generally considered essential for effective coating. In practice, the coating is applied as a solution, or as an atomized spray, to the desired solid core material in the coating pans. Usually, to remove the coating solvent, warm air is passed over the coated materials as the coatings are being applied in the coating pans. In some cases, final solvent removal is accomplished in a drying oven.

1.4 Spray drying

Spray drying serves as a microencapsulation technique when an active material is dissolved or suspended in a melt or polymer solution and becomes trapped in the dried particle. The main advantages is the ability to handle labile materials because of the short contact time in the dryer, in addition, the operation is economical. Spray drying and spray congealing processes are similar in that both involve dispersing the core material in a liquefied coating substance and spraying or introducing the core coating mixture into

some environmental condition, whereby relatively rapid solidification of the coating is affected. The principal difference between the two methods is coating solidification. Coating solidification in the case of spray drying is affected by rapid evaporation of a solvent in which the coating material is dissolved whereas in spray congealing it is accomplished by thermally congealing a molten coating material or by solidifying a dissolved coating by introducing the coating core material mixture into a nonsolvent.

2.CHEMICAL METHODS:

2.1 Solvent evaporation

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 dispersed in the polymer solution, polymer shrinks around the core. In the case in which core material is dissolved in the coating polymer solution, a matrix - type microcapsule is formed. e.g. Evaluation of Sucrose Esters as Alternative Surfactants in Microencapsulation of Proteins by the Solvent Evaporation Method.

2.2 Interfacial polymerization

In interfacial polymerization, a monomer is made to be polymerized at the interface of two immiscible substances. If the internal phase is a liquid, it is possible to disperse or solubilize the monomer in this phase and emulsify the mixture in the external phase until the desired particle size is reached. At this point a cross-linking agent may be added to the external phase. Since there is usually some migration of the monomer from the internal to external phase, and since it is preferred that the cross-linking agent does not transfer to the internal phase, the bulk of any polymerization will take place at the interface.

RELEASE MECHANISM

1. Degradation controlled monolithic system : -

The drug is dissolved in matrix and is distributed uniformly throughout. The drug is strongly attached to the matrix and is released on degradation of the matrix. The diffusion of the drug is slow as compared with degradation of the matrix.

2. Diffusion controlled monolithic system : -

Here the active agent is released by diffusion prior to or concurrent with the degradation of the polymer matrix. Rate of release also depend upon where the polymer degrades by homogeneous or heterogeneous mechanism.

3. Diffusion controlled reservoir system : -

Here the active agent is encapsulated by a rate controlling membrane through which the agent diffuses, and the membrane erodes only after its delivery is completed. In this case, drug release is unaffected by the degradation of the matrix.

4. Erosion : -

Erosion of the coat due to pH and enzymatic hydrolysis causes drug release with certain coat material like glyceryl mono stearate, beeswax and stearyl alcohol etc.

APPLICATIONS:

1. Beverage production.
2. Soil inoculation.
3. Protection of liquid crystals.
4. Protection of molecules from other compounds.
5. Quality and safety in food.
6. Cell immobilization.
7. It is used to protect drugs from environmental hazards such as humidity, light, oxygen or heat.
8. The separation of incompatible substances.
9. Microencapsulation can be used to decrease the volatility.

10. Microencapsulation has also been used to decrease potential danger of handling of toxic or noxious substances.

CONCLUSION:

Microencapsulation means packaging an active ingredient inside a capsule ranging in size from one micron to several millimetres. The capsule protects the active ingredient from its surrounding environment until an appropriate time. Microspheres and microcapsules are established as unique carrier systems for many pharmaceuticals and can be tailored to adhere to targeted tissue systems. Hence, micro-capsules and microspheres can be used not only for controlled release but also for targeted delivery of drugs to a specific site in the body. Therefore, the development of safe and efficient particular systems will require, in the future, in depth investigations of both the biological and technological aspects of these systems.

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