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# Applications of Microencapsulation Technique in Pharmacy

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**ABSTRACT**
Microencapsulation is a versatile technology and has emerged as a successful product of pharmaceutical sciences. This encapsulation technique involves entrapping active ingredients, drugs, or biomolecules within microscopic particles. Its multifaceted applications are transforming drug delivery, formulation and patient care. Microencapsulation can enhance drug delivery systems by ensuring controlled release, targeted delivery and improved patient compliance. Additionally, it plays a significant role in masking unpleasant tastes or odors in formulations, protecting sensitive pharmaceutical compounds from environmental factors and advancing vaccine delivery systems. Furthermore, microencapsulation extends beyond oral medication, with applications in topical formulations, dermatological products and even genetic medicine. Understanding the different applications of microencapsulation contribute to innovative drug development and enhanced patient outcomes in the dynamic field of pharmacy.

## I.INTRODUCTION

Microencapsulation is a versatile technique with a wide range of applications in the field of pharmacy. It involves enclosing tiny particles or droplets of one substance within a protective shell or coating made of another material. This protective shell can be made of polymers, lipids or other materials and it serves several purposes, depending on the specific application. The present review explores some of the key applications of microencapsulation in pharmacy.Microencapsulation is extensively used to improve drug delivery. By encapsulating drugs within microspheres or microcapsules, several advantages can be achieved, including controlled release, enhanced stability, and reduced side effects. This is particularly beneficial for drugs that have a short half-life or irritate the gastrointestinal tract.Beyond drugs, microencapsulation is utilized in cosmetics and personal care products for controlled release of active ingredients, such as vitamins, antioxidants or skin moisturizers [1].Microencapsulation plays a crucial role in the encapsulation of nutrients and nutraceuticals, ensuring their stability and controlled release in dietary supplements.

**Definition:** Microencapsulation is a process of applying relatively thin coatings onto small particles of solids or droplets of liquids.The size of the particles range from 100-5000 µm (microns). The uniqueness of microencapsulation is the smallness of the coated particles and their subsequent use or applications. Microparticles are produced by microencapsulation.

**Microparticles:**Microparticle refers to particle having the diameter in the range of 100 to 5000 micrometers (frequently around 100 – 1000 micrometers) irrespective of the precise exterior or interior structure. Microparticles are also called as micromatrices, coated pellets, beads, micro beads, coated beads, multi-unit particulate (pellet) systems (MUPS). Spansule is a capsule, enclosing microparticles, when taken orally, the drug is released slowly over an extended period of time. Microparticles are spherical, free flowing particles, containing a drug substance either dispersed or dissolved throughout the particles. Particles smaller than one micrometer (µm) are referredtoasnanoparticles [2].

**Advantages:**Have many advantages when compared from the use of single unit dosage forms [3].

1. Provide controlled release / sustained release (zero order release of drug)
2. Reduction of variation in gastric emptying time.
3. Reproducible drug release and absorption of drug due to uniform distribution in GIT
4. Reduction of gastric irritation due to spreading of the drug over the entire area.

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5. Opportunity for formulation of both oral and parenteral controlled release preparations.
6. Preparation of the final dosage form in the form of both capsule and tablet is possible.
7. The risk of dose dumping is considerably minimized

**Disadvantages:**

1. No single method of production is adoptable to all the drugs.
2. Lump formation (clumping) during the preparation.
3. Could decrease the yield of the product.
4. Chemical methods of preparation are not safe.
5. Compression into tablet may lead to cracking of the membrane of microcapsules. It might cause dose dumping of the drug. Hence reservoir systems are seldom formulated as tablets.
6. The cost of these preparations are higher when compared to matrix tablets.

## II.APPLICATIONS

1. Masking of bitter taste of drugs. Example: Acetaminophen (paracetamol)
2. Reduction of gastric irritation. Example: Aspirin, Potassium chloride.
3. Reduction of volatility (stabilization). Example: Menthol, Camphor, Methyl salicylate
4. Provide sustained release products. Example: Diclofenac sodium, Isosorbidedinitrate.
5. Stabilization against oxidation. Example: Vitamin A palmitate (retinyl palmitate)
6. Conversion of liquid to solid (stabilization). Example: Liquid crystals or flavours
7. Make permselective membrane of enzymes. Example: Urease
8. Enhancement of stability of incompatible matrix. Example: Aspirin + Chlorpheniramine maleate
9. The process can be employed to formulate enteric coated dosage forms, so that the drug will be selectively absorbed in the intestine rather than the stomach. Example: Omeprazole.
10. Reduction of hygroscopic nature of drugs. Example: Sodium chloride.
11. Bio encapsulation of cells / DNA to improve shelf life.

**Types:**Microparticlesare mainly classified into two types

1. Microspheres
2. Microcapsules.

**Microspheres:**When no distinct core and coating regions are distinguishable, the products are described as microspheres. Here the drug and polymer are present as uniform matrix present in the particle. They are also called as micromatrices [4].

**Microcapsules:**In microcapsules drug is encapsulated by a membrane. Here a clear boundary of core (drug) and coating (polymer) is present.They are also called as reservoir devices. Microcapsules are often described by other such terms as coated beads, pellets etc. Microcapsules are available in various structures [5].

## III.FORMULATION COMPONENTS

Core and coating material are the two chief components of microcapsules/microspheres **core material:**The core material is the specific material to be coated to serve the specific purpose. It is generally the active ingredient, which may be in the form of liquid droplets or solid particles.The composition of the core material can be varied as it can include other excipients.

**Coating material:** The coating material (polymer) should be capable of forming a thin film, which is cohesive with the core material. The coating material depends on the application and method of microencapsulation. The coating material may contain different additives such as film formers (polymer), plasticizer, surfactants and fillers dissolved or dispersed in a solvent system. It should be chemically compatible, non-reactive with the core material, and provide the desired film properties like strength, flexibility and stability [6].

Coating materials are classified as

**Water soluble:**Methyl cellulose (MC), polyvinylpyrrolidone (PVP), HEC, gelatin, gum Arabic, sodium alginate

**Water insoluble**: Ethyl cellulose (EC), polyethylene, polymethacrylate, chitosan, CA

**Waxes and lipid**s: Beeswax, carnauba wax, paraffin wax, stearic acid

**Enteric resins:** Shellac, cellulose acetate phthalate, zein

**Methods of microencapsulation**

Broadly classified as follows

**Type a / Chemical process** Example: Coacervation phase separation, interfacialpolymerization, in-situ polymerization, solvent evaporation.

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**Type b /Mechanical process** Example: Air suspension coating, spray drying and spray congealing method, pan coating, multi orifice centrifugation.

The physico- chemical properties of the drug and intended use of the product are deciding factors to select the microencapsulation method [7]. Numerous methods available are:

1. Coacervation phase separation
2. Air suspension coating
3. Multiorifice centrifugal process
4. Pan coating
5. Spray drying and spray congealing
6. Solvent evaporation
7. Polymerization

## IV.COACERVATION PHASE SEPARATION

The term coacervation is derived from the latin word acervus, which means a heap or aggregation. It is a physical phenomemon which often takes place in aqueous solution of highly hydrated polymers. It is defined as the spontaneous separation of a continuous one phase aqueous solution of a polymer into two aqueous phases, one having a relatively high polymer concentration (polymer rich phase) and the other relatively low concentration (polymer poor phase). Coacervation is the term used to describe the separation of polymer solution into polymer rich and polymer poor phases when the polymer is desolvated. The polymer rich layer is also called as coacervate layer and polymer low layer is also called as equilibrium fluid [8].

Accounting for different phase separation mechanisms, coacervation was sub divided into simple and complex coacervation. Simple coacervationgenerally use one colloid (polymer) which is precipitated out by salts or non-solvents or by increase or decrease in temperature. Complex coacervation involves two or more colloids (polymers) and salting out is carried out by interaction of oppositely charged polymers.

Various factors like pH, temperature, solubility etc. play an important role in the preparation of microspheres by coacervation. Coacervation is generally observed in binary or ternary systems, in either aqueous or organic liquids. Coaceravtion process broadly involves 3 steps carried out under continous agitation. They are

1. Formation of three immiscible chemical phases
2. Diposition of the coating on core material
3. Rigidization of the coating

**Step 1**: The three immisicible chemical phases are

1. A liquid manufacturing vehicle phase
2. A core material phase.
3. A coating material phase.

To form the three phases the core material is dispersed in a solution of the coating polymer, which is emulsified in a liquid manufacturing vehicle [9]. The coating material phase is formed by utilizing one of the methods of phase separation like, temperature change, non-solvent addition, salt addition etc.

**Step 2**: It consist of depositing the liquid polymer coating upon the core material. This is accomplished by controlled physical mixing of the material in the liquid manufacturing vehicle. Deposition of the liquid polymer coating around the core material occurs if the polymer is adsorbed at the interface formed between the core material and the liquid vehicle phase. This adsorption phenomenon is a prerequisite to effective coating. The continued deposition of the coating material is promoted by a reduction in the total free interfacial energy of the system, brought about by the decrease of the coating material surface area during coalescence of the liquid polymer droplets.

**Step 3:** Rigidization of coating is essential to impart stability and protection from drug leaching from microspheres. It is achieved by thermal, crosslinking, desolvation or by salting out methods. Glutaraldehyde or formaldehyde are used for chemical crosslinking. The physical means include application of heat or use of solvent that can extract or remove remaining traces of solvent from coated microspheres.

**Examples:**

1. Temperature change
2. Incompatible polymer addition
3. Nonsolvent addition
4. Salt addition
5. Polymer-polymer interaction

Air suspension coating is also called as fluidized bed coating. Fluidization is achieved in a columnar chamber by the upward flow of drying air. Multi-orifice centrifugation method is a unique modification of the simple extrusion technique of producing microcapsules [10]. This process is primarily employed to prepare microcapsules of

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liquids. Solid particles greater than 600 microns in size are generally considered essential for effective coating in pan coating method. In this method, medicaments are usually coated onto various spherical substrates such as non-pareil seeds. Spray drying and spray congealing methods have been used for many years as microencapsulation techniques. Solvent evaporation is carried out in a liquid manufacturing vehicle. Polymerization is a relatively new microencapsulation method used to form protective coatings in situ. The interfacial polycondensation has been applied to the microencapsulation of various liquids [11].

## V.CONCLUSION

There arevarious methods of microencapsulation. Depending on the application and physico-chemical properties of the drug the method is selected. This intricate and versatile technique has unveiled a new dimension in the realm of drug formulation and delivery, offering precise control over drug release, enhanced stability, and targeted therapeutic outcomes.The technology continues to evolve, offering innovative solutions for drug formulation, delivery and other pharmaceutical challenges. It plays a crucial role in improving the efficacy, safety, and patient experience associated with pharmaceutical products.

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