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Detail on microencapsulation

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ABSTRACT : Microencapsulation is a cycle by which very tiny particles or droplets of solid or liquid material covered or encircled with a consistent film of polymeric material. These miniature cases have various advantages, for example, changing fluids over to solids, giving natural security, isolating responsive mixes and improved material dealing with properties. In this article numerous significant strategies for microencapsulation like skillet covering, polymerization, salting out, airsuspension covering, hot-dissolve and so forth are portrayed with their licensed applications and their protected models. Microencapsulation advancements are applied in any area of industry. It very well may be found in: Cell immobilization, Beverage creation, Protection of particles from other compound, Drug delivery, Quality and safety in food, agriculture and environment sectors, pharmaceuticals, etc. Microencapsulation techniques are used to increase the duration of action and stability of the drug , as a heat delivery vehicle, in sustain release of water soluble particles, to administration of neuroactive agents.

I. INTRODUCTION :

Microencapsulation is the cycle where little beads or particles of fluid or solid material are surrounded or coated by a continous film of polymeric materials .(1) The microencapsulation technique was presented by Bungen burg de Jon and Kan, (1931), and molecule size under 200 µm (2). Microencapsulation process helps in converting the liquids to solids, changing the colloidal and surface properties, providind environmental protection, improved bioavailability and controlling the release characteristics of different coated materials(3,4,5). Microencapsulated products (microparticles or microcapsules) are small entities that have an active agent know as the core material surrounded by a shell known as the coating material oe embedded in a matrix structure . A large portion of the microparticle shells comprise of natural polymers, however waxes and lipids are additionally utilized. The microencapsulated items have a size range from 1 to 1000 µm in measurement. Economically accessible microparticles contained 10-90% w/w center. An enormous number of center materials can be embodied like live cells, adhesives, flavors, agrochemicals, proteins, pharmaceuticals(6). The scanning electron microscopy is utilized to uncover the basic highlights of microcapsules as these are to be shifted and complex. The walled model might be mononuclear or may have numerous center structure (7) and there may likewise be twofold or different concentric covering present (8). As amassed microcapsules have an extra outside divider and subsequently change fit as a fiddle and size. Despite the fact that, the microstructure of film and the inside can be distinguished by SEM of surfaces of microcapsule yet their actual quality isn't effectively portrayed quantitatively. The porosity and porousness can be determined from discharge information, densities, measurements, and center/divider proportions (9,10).

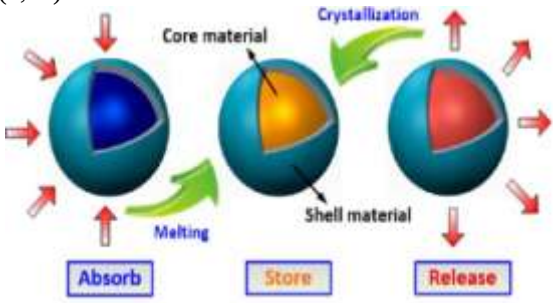

Fig.1 microencapsulation

ADVANTAGES AND DISADVANTAGES OF MICROENCAPSULATION ADVANTAGES [11,12]

1. Converts fluid into free flowing solid and pseudo strong which improves taking care of and capacity

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like Eprazinone, Clofibrate, Castor oil, Cod-liver oil and so forth

2. Diminishes unpredictability of substances like methyl salicylate, peppermint oil, flavors, perfumes etc.

3. avoid incompatibilities in drug combination like anti-inflamatory medicine and chlorpheniramine maleate, eutectic combination etc.

4. Covers upsetting taste of medication like penicillin derivatives like ampicillin, aminophylline, prednisolone, cod liver oil etc.

5. mask unpleasant or unacceptable odor of cores like castor oil , cod liver oil , methionine etc.

6. reduces gastro intestinal irritation due to irritant drugs like ferrous sulfate, potassium chloride, paracetamol, phenylbutazone, indomethacin, nitrofurantoinetc

7. reduces hygroscopicity of core like sodium chloride etc.

8. Gives sustain/prolong/delay/control drug release.

10. Improve stream properties, compaction and compressibility of the core like Vitamietc.

11. For immobilization of chemicals for improving their security and maintenance of action.

12. By this compound contrary fixings can create in single structure like Aspirin, Citric acid etc.

DISADVANTAGE [11,13]

1Very costly,

2. The procedure isn't versatile to all core materials,

3. Here and there covering might be uncompleted and discontinuous ,

4. No single technique can be applied to all core materials,

5. Due to the lacking strength and timeframe of realistic usability, Sensitive drugs can't utilized,

6. For various cores and various applications, Individual plan approach is required,

7. Covered items may have non reproducible and unstable release characters , may be too bulky,

8. limited choice of safe , approved , biocompatible and biodegradable materials

9. May harm the coat or the item because of mechanical stress like pressure, compaction, packaging, transport, handling etc.

10. Miniature particles may not be appropriate for parenteral applications because of size limitations,

11. Need of sanitization, need of non-hypersensitive, biocompatible and biodegradable nature of the carrier etc.

Materials used for microencapsulation:-

Core material:

- It is characterized as material to be coated . The fluid center incorporate disintegrated materials while the solid corehas a place with active ingridient, excipients, stabilizers, discharge rate retardants or diluents [15,16].The core material gives adaptability and permits compelling plan and improvement of microcapsules [17,18]

Coating material:-

It very well may be characterized as layer of substance which shapes a spread over core for production of microcapsules. desired properties for coating material;

1.It should be soluble in aqueous media/solvent and also provided controlled release under specific conditions.

2. It should have properties like flexibility, strength,stability, impermeability and optical properties [14,19]

3.It should be chemical compatible

4. It should have capability to forming a film .

5. It should be pilable, dull, stable, non hygroscopic, economical and should not have high consistency [20,16].

Classification:

- Microcapsules can be classified into three categories;

1. Mononuclear/Single core.
2. Poly nuclear/Multiple core.
3. Matrix type.

Mononuclear types microcapsules contain shell around the core, which poly nuclear having many cores enclosed in the shell. In case of matrix, the core material homogeneously distributed into shell material [20,21] .

Because of the presence of extra external wall aggregated microcapsules vary in size and shape. Microstructures of both membrane are also detected by SEM. Figureshowsvarous kind of microcapsule [22]

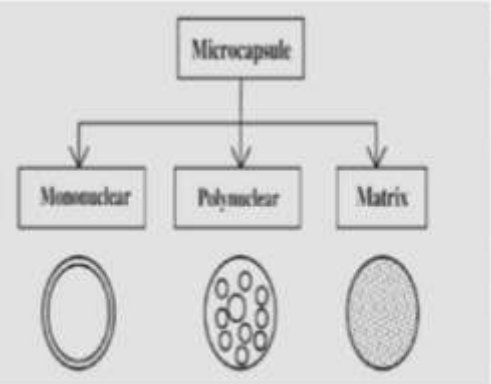

Fig.2 TYPES OF MICROCAPSULES

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Mechanism and Kinetics of Drug Release

Major mechanisms of drug release from microcapsules [23] included diffusion , dissolution , osmosis and erosion:

Diffusion

The most well-known component of drug release (core material) in which the dissolution liquid enters the shell then the core material comes into the contact with the dissolution liquid and leak out through the interstitial channels or pores [24]. The drug release depends on the rate of penetration of dissolution liquid, rate of penetration of dissolution liquid to the microcapsules and rate at which the dissolves drug escapes from the microcapsule .The kinetics of such drug release follows Higuchi's condition [25]: Q = [D/J (2A – ε CS) CS t] ½ where, Q is the amount of drug released per unit area exposed surface in time t; J is the tortuosity of the capillary system in the wall ; D is the diffusion coefficient of the solute in the solution; A is the total amount of drug per unit volume; ε is the porosity of the wall of microcapsule; CS is the solubility of the drug in permeating dissolution fluid.

Dissolution

The rewlease rate of the drug from the microcapsule depends on the dissolution rate of polymer coat, when the coat is solvent in the dissolution liquid [24]

The solubility in the dissolution liquid and thickness of coat influence the release rate [26]

Osmosis

Another technique for drug release is through osmosis. The essential requirements of osmosis is semi permeable membrane and in microcapsule polymer coat fill the need. As the cycle progress an osmotic pressure is made between the outside and within film of microcapsule which bring about arrival drug through little pores.

Erosion

Erosion of coat for the most part happen because of pH or enzymatic hydrolysis and causes drug release with certain coat materials like bee's wax, stearyl liquor and glycerylmonostearate [27]. The drug release from microcapsules has become complex as a result of extraordinary variety in actual types of microcapsules with size, shape and course of action of the core and coat materials [28,29]. The physiochemical properties of core materials like solubility,diffusibility and partition coefficient and of coating materials like variable porosity, thickness and inertness which makes difficult to modeling of drug release. However, on the basis of various studies concerning with the release characteristics , the following consideration can be made :

1.drug release rate from microcapsules follow the zero order kinetic.
2.Microcapsules of monolithic type have the t1/2 dependant release rate for the first half of the total drug release and therefor turn down exponentially.
3.Microcapsules of monolithic type containing excess of dissolved drug , the release rate are ½ dependant throughout almost the entire drug release .
4.The path traveled by drug isn't constant in monolithic capsules ; as the drug at the center travels large distance than the drug at surface. [3].

Differnt techniques of microencapsulation: -

Air suspension method: -

This technique includes the showering of covering material noticeable all around and suspending particles and scattering of center material in air stream. The moving air suspend the particles inside the coating chamber. The coating chamber is planned with a certain goal in mind that influence the molecule move through coating zone of chamber, where polymer arrangement coating material is applied to the moving particles [18]. This cyclic cycle is rehashed a few times relying upon the necessary thickness upon the core material. The encapsulated item is air dried. Drying rate is straightforwardly relative to temperature. The different cycle factors which influence the cycle are melting point, solvency, surface territory, thickness, dissolving point, application pace of coating material [17].

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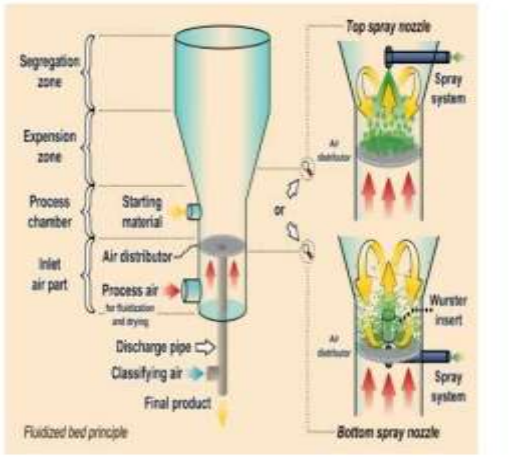

Fig.3 Air suspension method

Coacervation method:-

It is the technique wherein core material is scattered in the arrangement of coating material. The coating material can't break up or respond with covering material [17]. The molecule size depend upon scattering parameters , for example, stirrer shape, thickness, stirrer speed, surface pressure. Scope of molecule size is in the middle of 2 micrometer to 1200 micrometer [30].

Coacervation phase separation-

This technique includes three stages:- Formation of three immiscible stages:- Three stages includes fluid assembling vehicle stage, core material stage, coatingmaterial stage. In this, the core material is scatter in arrangement of coating polymer, the vehicle stage utilized as dissolvable for polymer [30]. The microcapsules are shaped by one of the techniques for stage partition coacervationi.e by change the temperature of polymer arrangement or by expansion of salt, non dissolvable, inconsistent polymer expansion or by polymer fascination [20,31]

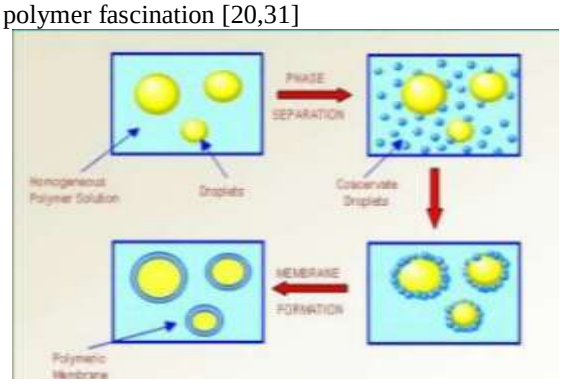

Fig.4 Coacervation phase separation

Deposition of the coating:-

In second step keeping the fluid polymer on the core material by controlled blending of coating material and core material in assembling vehicle [32]. In the event that the polymer ingested at the interface framed between the center material and fluid stage at that point coting polymer is stored on the core material. The deposition of coating material is advanced by allowance in complete free energy of system[17].

Rigidization of coating:-

It includes rigidiaztion of coating done by warm, cross connecting or dissolvation methods, to shape a self continuing microcapsules [33]. Centrifugal extrusion:-

By utilizing turning expulsion head containing concentric nozzels, fluids can be embodied. In this strategy, a fly center is secured by sheath of divider arrangement. As fly experiences the air it breaks, inferable from rayleigh precariousness, into the beads of center, every one covered with the divider arrangement [20]. The mean width of beads is inside +-10%, they arrive in a restricted ring. This cycle is well productive for shaping particles 400-2000 micrometer distance across. This cycle is just be appropriate for fluid or slurry. The creation rate can be high upto 22.5kg (50lb) of microcapsules can be delivered per nozzel every hour per head [17]. Spray drying and spray congealing:-

These cycles are comparative in that both include scattering the center material into the liquified coating substance and showering or bringing into center coating blend, whereby quick hardening of coating is influenced. The fundamental distinction in these two strategies is the methods by which coating cementing is cultivated. In the event of splash drying the coating cementing influenced by quick dissipation of dissolvable in which covering material is broken up though in the event of shower hardening technique the covering hardening is cultivated by thermally solidifying a liquid coating material or by bringing the center material into a non dissolvable. Expulsion of non dissolvable or dissolvable from the covered item should be possible by sorption extraction or vanishing methods [22].Few instances of food fixings which can be microencapsulated by shower drying are epitome of flavors, lipids and cartenoids. A solitary exemplifying specialist can't hold all ideal divider material properties, presently explores zeroed in on gums, proteins just as starches [34]. One of the main advance in the event

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of splash drying is the choice of atomiser which put critical impact on size of circulation of conclusive plan having dried particles [35].

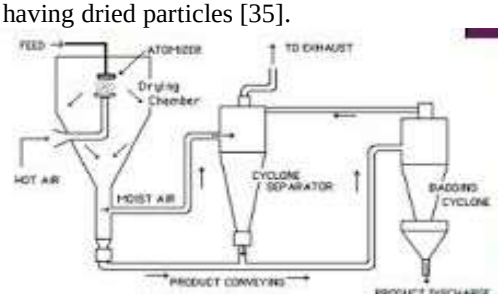

Fig.5 Spray drying and spray congealing

pan coating method

The skillet covering technique gets far and wide in drug industry. Strong particles more noteworthy than 600 microns in size are considered for successful covering and cycle have been utilized for controlled releasepreparation[22]. Medicaments are covered on different round substrates, for example, prime sugar seeds with different polymers. By and large, the covering can be applied as an answer, or as atomized shower to wanted strong core material in coating container. Coating dissolvable is eliminated by ignoring warm air coated material [36,33].

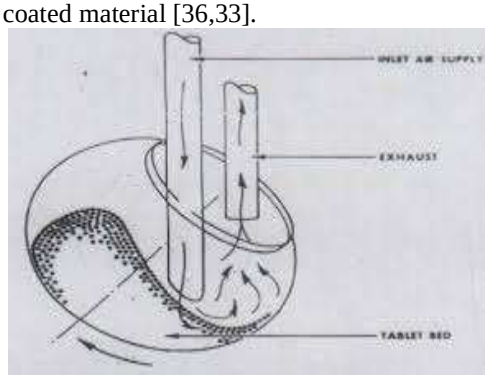

Fig.6 pan coating method

EVALUATION OF MICRO CAPSULES:

Percentage yield:

The aggregate sum of miniature cases acquired was gauged and the rate yield determined mulling over the heaviness of the medication and polymer.

Rate yield=Amount of miniature case acquired/Theoretical Amount*100

Filtering electron microscopy:

Filtering electron photomicrographs of medication stacked ethyl cellulose microcapsules were taken.A modest quantity of microcapsules was spread on gold slub and was set in the checking electron microscopy chamber. The SEM photomicrographs was taken at the increasing speed voltage of20 KV.

Particle size analysis:

For size distribution analysis, different sizes in a batch were separated by sieving by using a set of standard sieves. The amounts retained on different sieves were weighed.

Encapsulation efficiency:

Encapsulation efficiency was calculated using the formula:Encapsulation efficiency=Actual Drug Content/Theoretical Drug Content*100.[37,38,39].

Characterization of microcapsules:-

Particle size and shape:

- The most regularly utilized strategy to picture microcapsule is traditional light microscopy, checking electron microscopy (SEM). These the two methods are utilized to examine the shape and structure of microcapsule. SEM furnishes high goal as contrasted and light microscopy. It examines the microsphere surfaces additionally permits the examination of twofold walled frameworks. Confocal laser examining microscopy (CLSM) is alluded to as non dangerous representation strategy, which gives result about structures just as surface, yet in addition uncovers about inside molecule [22].

Fourier transform-infrared spectroscopy (FTIR):-

It is utilized to break down the debasement of polymeric lattice of transporter framework, and furthermore check association among polymer and medication framework.

Carr's index and hausner's ratio:-

The angle of repose was determined according to fixed funnel and cone method. The bulk density of mixed microcapsules was calculated by determining the hausner's ratio or carr's index, with the help of poured or trapped bulk densities of known weight of sample using measuring cylinder .

Carr’s Index = [Tapped Density-Bulk Density/Tapped Density] ×100

Hausner's ratio (HR)=ρT/ρB where ρT is tapped density and ρB is bulk density [17].

Bulk density:-

Weigh accurate microcapsules and then transfer to 100ml cylinder to obtain apparent volumes of between 50 and 100ml.

Bulk Density (ρρ)= [Weight of Microcapsules(g) (M) / Bulk Volume (ml)(V)]

where, M = mass of the powder, Vo = volume of the powder

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Isoelectric point:-

The miniature electrophoresis is a mechanical assembly which is utilized to gauge electrophoretic portability of microsphere by which isoelectric point can undoubtedly be determined. The versatility is connected with surface contained charge, ionisable conduct or particle assimilation nature of microcapsules [22].

Determination of drug loading, encapsulation efficiency and microcapsule yield:-

The medication content was controlled by extraction of 20mg example of microcapsules with methanol . Following filtration and weakening with methanol, the resultant fixation was checked by UV spectrophotometry. %loading = weight of medication/weight of microcapsules %Encapsulation efficiency= [%Actual drug content/%theoretical drug content] ×100 %Yield=M/M0 ×100 M = Weight of microcapsules M0 = Total anticipated load of medication and polymer [17,18].

Contact angle:-

The point of contact is determined to decide the wetting property of microcapsule. With the assistance of this strategy we can undoubtedly think about the idea of microcapsules regarding hydrophilicity and hydrophobicity. This is estimated at strong/air/water surface by putting a bead in round cell mounted over the target of upset magnifying instrument. It is estimated at 200c inside a moment of decay of microcapsules [22].

In vitro drug release studies:

- It can be completed in different ph conditions like ph 1.2 and ph 7.4 utilizing USP pivoting crate and oar device. The example ought to be taken out after specific time stretches and is supplanted by same medium. The delivery profile is decide utilizing the plot of sum delivered capacity of time [22].

MARKETED PRODUCT :

SR. NO.	BRAND NAME	GENERIC NAME	CATEGORY OF DRUG
1.	Lupin	Cefadroxil	Antibiotic
2.	Zorprin CR	Aspirin	Anti-arthritic
3.	Glipizide SR	Glucotrol	Anti diabetic

Applications of Microencapsulation

Some of the applications of microencapsulation are illustrated as below:

1.Microencapsulation can be utilized to plan enteric-covered measurement structures, so the medicament can be specifically invested in the digestive system as opposed to the stomach.

2. It tends to be utilized to veil the flavor of harsh medications.

3. From the mechanical perspective, microencapsulation has been utilized to help in the expansion of slick prescriptions to tableted dose structure. This has been utilized to defeat issues intrinsic in creating tablets from cheap granulations. This was refined through improved stream properties. For instance, the nonflowable multicomponent strong combination of niacin, riboflavin, thiamine hydrochloride, and iron phosphate might be embodied and pack legitimately into tablets.

4. It has been utilized to shield drugs from ecological dangers, for example, dampness, light, oxygen or warmth. Microencapsulation doesn't yet give an ideal boundary to materials, which corrupt within the sight of oxygen, dampness or warmth, anyway an incredible level of security against these variables can be given. For instance, nutrient An and K have been demonstrated to be shielded from dampness and oxygen through microencapsulation.

5.he divisions of inconsistent substances, for instance, drug eutectics have been accomplished by exemplification. The solidness upgrade of inconsistent Aspirin-Chlorpheniramine maleate blend can be refined by microencapsulating the two of them prior to blending.

6. Microencapsulation can be utilized to diminish the unpredictability. A typified unstable substance can be put away for longer occasions without considerable vanishing.

7.Microencapsulation has additionally been utilized to diminish possible threat of treatment of poisonous or toxic substances. The harmfulness happened because of treatment of fumigants, herbicides, bug sprays and pesticides have been favorably diminished after microencapsulation.

8. The hygroscopic properties of many center materials might be diminished by microencapsulation.

9.Many medications have been microencapsulated to diminish gastric disturbance.

10.In the creation of multilayered tablets for controlled arrival of the medicament contained in average layers of tableted particles [40].

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II. CONCLUSION :

Micro encapsulation formulation have many advantages over normal formulations. With this formulations ,less frequent drug administration is possible , lower plasma peak concentration can be obtained to avoid adverse effects , ensures time controlled pulsatile release of bioactive compounds has been developed . microencapsulation products increase the stability , bioavailability , and dissolution of the drug properties .this is also useful in the other fields like biotechnology for the cell immobilization , in food industry , in drug delivery etc.

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