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A BRIEF REVIEW ON MUCOADHESHIVE MICROSPHERES IN DRUG DELIVERY SYSTEM

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ABSTRACT

The aim of this article is review the principles underlying the formulation and evaluation of mucoadhesive microspheres. There are many routes of mucoadhesive drug delivery system, oral route is the most ancient as well as preferred by patient being convent to take. Microspheres, noisomes, liposomes etc. Which modulates the release characteristics of the drug. Mucoadhesion has been a topic of interest in the design of novel drug delivery system to extend the residence time of the dosage form at the site of application or absorption and improve an intimate contact with the underlying absorption surface and enhance the bioavailability or therapeutic performance of drugs. The main advantage of this route for drug that are prone to their hepatic first pass metabolism. This review provides the brief knowledge about oral mucosal drug delivery by discussing briefly the structural features of mucosa, mechanism of bioadhesion, various theories of bioadhesion, general consideration in mucoadhesive polymer.

KEYWORDS: Microspheres, mucoadhesion, mucoadhesive polymer, bioadhesion.

INTRODUCTION

The term microsphere is defined as a spherical particle with size from 1 um -1000um. The microsphere are typical free flowing powder consist of synthetic polymer which are Biod E.g. radable in nature and having particle size less than 200 um. The microspheres are made from highly transparent glass can perform as much high quality optical micro cavities or micro resonators. The success of these microspheres is limited having provided intimate contact of the drug delivery system with the absorbing membranes.[1,2] The oral route of drug administration constitutes the most convenient and preferred means of drug delivery to

systemic circulation of body. However oral administration of most of the drugs in conventional dosage forms has short-term limitations due to their inability to restrain and localize the system at gastro-intestinal tract.[3]

Mucoadhesion or bioadhesion can be characterized as the state in which two material (something like one of which is biological in nature) are held together for a delayed time period and by means of interfacial force. Mucoadhesive dosage form might be intended to delayed the retention time at the site of application, giving a controlled rate of medication discharge for enhanced therapeutic outcome.[4,5] Mucoadhesive drug delivery systems have three distinct advantages when compared to conventional dosage forms. Firstly, the mucoadhesive systems, which are readily localized in the region applied to, can improve and enhance the bioavailability of drugs. Secondly, these dosage forms can facilitate the intimate contact with underlying absorption surface resulting in a better absorption. Lastly, they can prolong residence time at the site of application to permit once or twice a day dosing.[6]

Microspheres based novel drug delivery system may increase the life span of active agents and have considerable attention in controlled release and target drug to a specific body site of interested area without side effects, and it's limited owing to their short residence time at absorption site. So, various attempt have been made to increase the bioavailability as well as prolong the gastric residence time in the stomach resulted in development of bioadhesive drug delivery system (BDDS) which will provide an intimate contact with the absorbing membranes. This approach involves the use of bioadhesive polymers, which can adhere to the epithelial surface in the stomach which enhance drug absorption.[7]

Mucoadhesive drug delivery systems are available in the form of tablets, films, patches, and gels for oral, buccal, nasal, ocular, vaginal, rectal and topical routes for both systemic and local effects.[8] Mucoadhesive microspheres that are retained in the stomach would increase the drug absorption and decrease dosing frequency which provides better patient compliance as compared to conventional dosage forms.[9]

Mucoadhesive drug delivery systems includes the following.[10]

- Buccal delivery system
- Oral delivery system
- Vaginal delivery system
- Rectal delivery system

- Nasal delivery system
- Ocular delivery system

Advantages of Mucoadhesive Microspheres

1. Decreases the recurrence of daily administration and in this manner enhance the patient consistence.
2. The utilization of particular bioadhesive particles considers conceivable focusing of specific sites or tissues, for., eg,, the gastrointestinal (GI) tract.
3. Because of adhesion and intimate contact, the definition remains longer at the conveyance site enhancing API bioavailability utilizing lower API concentration for disease treatment.
4. Offers a brilliant route, for the foundational conveyance of medications with high first-pass digestion, there by offering a more noteworthy bioavailability.
5. Uniform and wide dispersion of drug all through the gastrointestinal tract which enhances the drug retention.
6. Prolonged and sustained arrival of drug and Maintenance the remedial plasma drug concentration.
7. Drugs which are unstable in the acidic condition are destroyed by basic condition of digestive tract can be directed by this course e.g. buccal, sublingual, vagina.[11-13]

Disadvantages of Mucoadhesive Microspheres Drug Delivery System

1. The release from the formulations may get modified.
2. The release rate may vary from a variety of factors like food and the rate of transit though gut, mucin turnover rate etc.
3. Differences in the release rate can be found from one dose to another.
4. Any loss of integrity in release pattern of the dosage form may lead to potential toxicity.
5. These kinds of dosage forms cannot be crushed or chewed.

Mucoadhesion and Mucoadhesive Dds

Mucoadhesion is defined as the interaction between a mucin surface and a synthetic or natural polymers.[14] Mucoadhesive drug delivery system are delivery system which utilizes the property of bioadhesion of certain polymer which become adhesive on hydration and can be used for targating a drug to a particular region of the body for extended periods of time.[15]

Mucous Membranes[16]

Mucus membranes are the moist surfaces lining walls of various body cavities such as the gastrointestinal (GI) and respiratory tracts. Mucus is secreted by the goblet cells. Mucus is present either as a gel layer adherent to the mucosal surface or in suspended form or as a luminal soluble. The main components of all mucus gels are mucin glycoprotein, water, lipids, and inorganic salts. The mucus serves as a protective barrier and a lubricant also (Fig. 1).

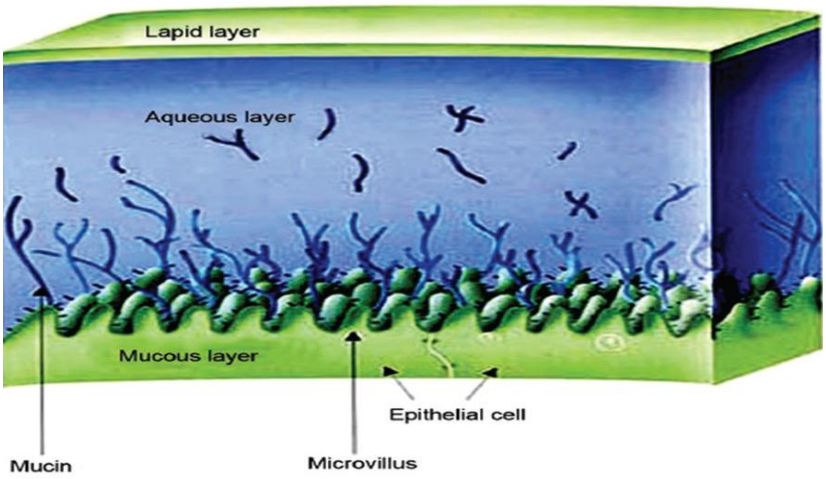

Fig. 1: Structure of mucous membrane.[17]

For adhesion to occur, molecules must bond across the interface. These bonds can arise in the following ways:

i. Ionic bonds- where two oppositely charged ions attract each other via electrostatic interaction to form a strong bond (e.g. in a salt crystal).

ii. Covalent bonds- where electrons are shared, in pairs, between the bonded atoms in order to 'fill' the orbitals in both. These are also strong bonds.

iii. Hydrogen bonds- here a hydrogen atom, when covalently bonded to electronegative atoms such as oxygen, fluorine or nitrogen, carries a slight positively charge and is therefore attracted to other electronegative atoms. The hydrogen can therefore be thought of as being shared, and the bond formed is generally weaker than ionic or covalent bonds.

iv. Van-der-Waals bonds- these are the weakest forms of interaction that arise from dipole dipole and dipole-induced dipole attractions in polar molecules, and dispersion forces with non polar substances.

v. Hydrophobic bonds- these are indirect bonds (such groups only appear to be attracted to each other) that occur when non-polar groups are present in an aqueous solution. Water

molecules adjacent to non-polar groups form hydrogen bonded structures, which lowers the system entropy. There is therefore an increase in the tendency of non-polar groups to associate with each other to minimize this effect.[18]

Limitation of Mucoadhesive Microspheres[19]

Some of the disadvantages were found to be as follows

1. The release from the formulations may get modified.
2. The release rate may vary from a variety of factors like food and the rate of transit though gut, mucin turnover rate etc.
3. Differences in the release rate can be found from one dose to another.
4. Any loss of integrity in release pattern of the dosage form may lead to potential toxicity.
5. These kinds of dosage forms cannot be crushed or chewed.

MECHANISM OF MUCOADHESION

A complete understanding of how and why certain macromolecules attach to a mucus surface is not yet Available, but a few steps involved in the process are generally accepted, at least for solid systems. Several theories have been proposed to explain the fundamental mechanism of adhesion.[20] A General Mechanism of Mucoadhesion Drug Delivery system is show in Figure 2.

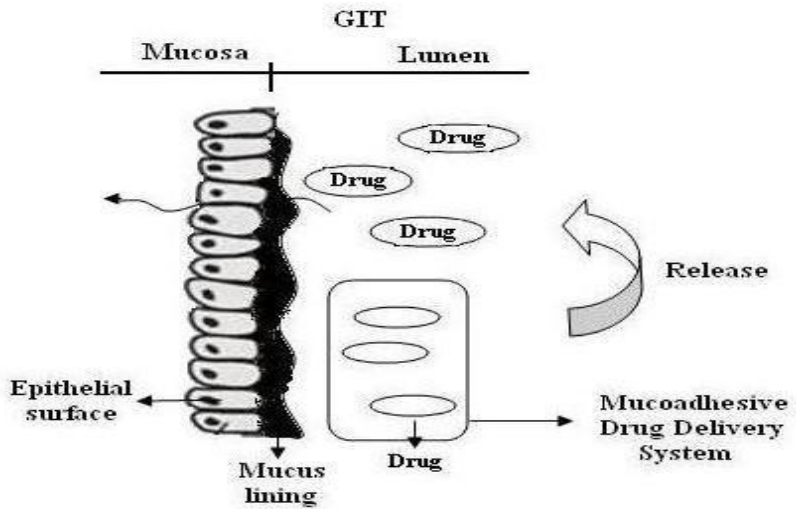

Figure 2: Mechanism of Mucoadhesion.

Theories of Mucoadhesion[21]

Different theories are involved in the mucoadhesion which are as follows

1. The electronic theory

2. The adsorption theory
3. The wetting theory
4. The diffusion theory
5. The mechanical theory, and
6. The cohesive theory.
7. Fracture theory.

1. **Electronic theory** Electronic theory is based on the premise that both mucoadhesive and biological materials possess opposing electrical charges. Thus, when both materials come into contact, they transfer electrons leading to the building of a double electronic layer at the interface, where the attractive forces within this electronic double layer determines the mucoadhesive strength.[22] According to the adsorption theory, the mucoadhesive device adheres to the mucus by secondary chemical interactions, such as in van der Waals and hydrogen bonds, electrostatic attraction or hydrophobic interactions.[23]

2. **The Wetting Theory** This theory is applicable for liquids, postulates that the lower the contact angle of liquid on substrate surface there will be greater affinity for adhesion.

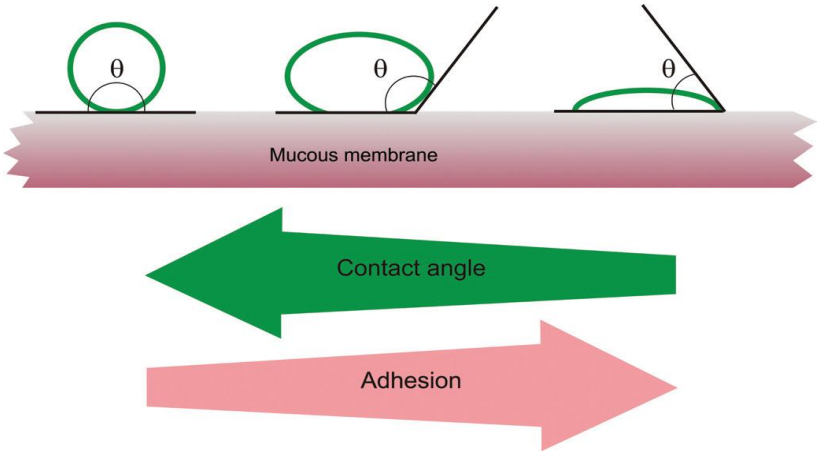

Figure 3: Schematic diagram showing influence of contact angle between device and mucous membrane on bioadhesion.

3. **The Diffusion Theory** This theory illustrates the forming of a network structure among the mucoadhesive and the mucosal surface by diffusion of the polymers chains present on the mucoadhesive surface.

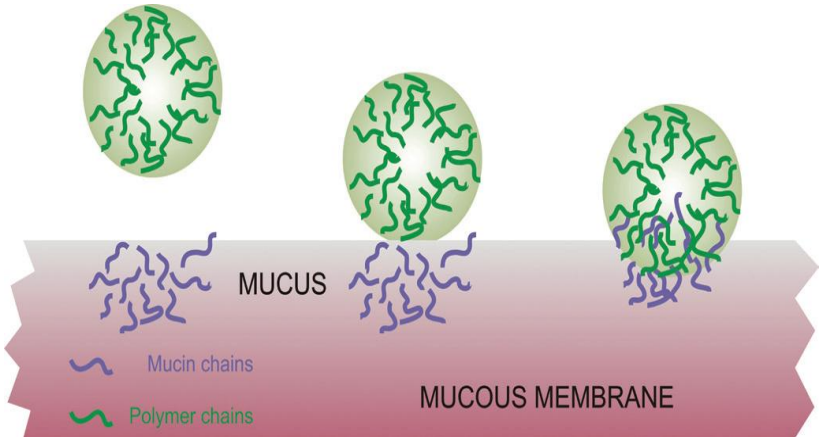

Figure 4: Secondary interactions resulting from interdiffusion of polymer chains of bioadhesive device and of mucus.

4. **The Mechanical Theory** Explains the formation of an interlocked structure by the diffusion of the liquid adhesives into the micro-cracks and irregularities present on the mucoadhesive substrate resulting in mucoadhesion.[24]
5. **The Cohesive Theory** According to this theory the phenomena of mucoadhesion is mainly due to the intermolecular interactions amongst like-molecules.
6. **Fracture Theory** The fracture theory analyses the force that is required for the separation of two surfaces after adhesion. The maximum tensile strength produced during detachment can be determined by dividing the maximum force of detachment (Fm) by the total surface area (Ao), involved in the adhesion interactions.[25]

$$Sm = Fm/Ao$$

Factor Affecting Mucoadhesion.[26]

Environmental Related factor	Physiological Related factor	Polymer Related Factor
Applied Strength	Mucin turnover	Spatial conformation
pH		Degree of hydration
Selection of the model substrate surface		Molecular weight
Initial contact time		Concentration of active polymer
		Chain flexibility of polymer
		swelling

Materials Used In The Formulation of Mucoadhesve Microspheres[27]

Mucoadhesive microspheres are made up by using mucoadhesive polymers. Mucoadhesive polymers can be of either natural or synthetic in origin. Mucoadhesive polymers that adhere to the mucin-epithelial surface can be conveniently divided into three broad classes:

- Polymers that become sticky on placing them in water and achieve their mucoadhesion due to stickiness.
- Polymers that adhere through nonspecific, noncovalent interactions that is primarily electrostatic in nature.
- Polymers that bind to specific receptor site on tile self surface.

Polymers Used for Mucoadhesivedrug Delivery[28]

These polymers are classified as,

Hydrophillic polymers

Contains carboxylic group and possess excellent mucoadhesive properties. These are,

- PVP(Poly vinyl pyrrolidine)
- MC(Methyl cellulose)
- SCMC(Sodium carboxy metyhyl cellulose)
- HPC(Hydroxyl propyl cellulose)

Hydrogels

These swell when in contact with water and adhere to tne mucus membrane. these are further classified according to their charge Anionic polymers- carbopol, polyacrylates Cationic polymers- chitosan Neural/ non ionic polymers- eudragit Analogues.

Ideal Characteristics of An Mucoadhesive Polymer

1. The polymer and its degradation products should be nontoxic and nonabsorable from the GIT.
2. It should be nonirritant to the mucous membrane.
3. It should preferably form a strong noncovalent bond with the mucin-epithelial cell surfaces.
4. It should adhere quickly to most tissue and should possess some site-specificity.
5. It should allow daily incorporation to the drug and offer no hindrance to its release.
6. The polymer must not decompose on storage or during the shelf life of the dosage form.
7. The cost of polymer should not be high so that the prepared dosage form remains competitive.
8. It should allow easy incorporation of drug in to the formulations.[29]

Sr. no.	Polymer	Relative mucoadhesive force	Quality of mucoadhesion
1	CMC	193	excellent
2	Carbopol	185	excellent
3	trangacanth	154	excellent
4	Sod. alginate	126	excellent
5	HPMC	125	excellent
6	Gelatin	116	fair
7	pectin	100	poor
8	acacia	98	poor
9	providone	98	poor

METHODS OF PREPARATION OF MUCOADHESIVE MICROSPHERES

Mucoadhesive microspheres can be prepared by using different techniques like

1. **Single Emulsion Method:** The microspheres of natural polymers, i.e. those of proteins andcarbohydrates are usually prepared by this method (Fig. **4**). Thepolymers are dissolved or dispersed in an aqueous medium followedby dispersion in the non-aqueous medium e.g., oil. In thesecond step, cross linking can be achieved either by means of heator by using chemical cross linkers e.g. formaldehyde, gluteraldehyde, terephthaloyl chloride, diacid chloride, etc. Cross linking byheat is affected by adding the dispersion to previously heated oil. Heat denaturation is however, not suitable for thermolabile drugs while the chemical cross linking suffers from the disadvantage of excessive exposure of active ingredients to the cross linking chemicals.[30]

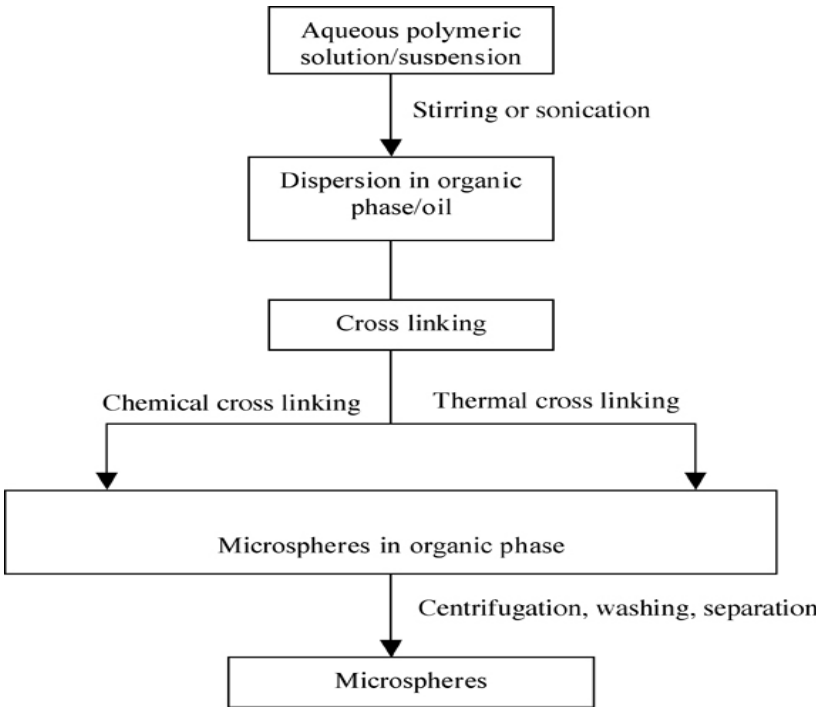

Fig. (4): Schematic representation of simple emulsion method.

2. **Double Emulsion Method** This method is firstly described by Ogawa Y et al. in year 1988, and is the most widely used method of microencapsulation 20. In this method an aqueous solution of drug and polymer is added to the organic phase with vigorous stirring to get primary water-in-oil emulsion. This emulsion was then poured to a large volume of water containing an emulsifier like polyvinyl alcohol or polyvinylpyrrolidone, under stirring, to get the multiple emulsions (w/o/w); and stirring was continued until most of the organic solvent evaporates, leaving solid microspheres. The microspheres are then washed and dried.[31]
3. **Hot melt microencapsulation:** This method is reported by Mathiowitz, E. and Langer, R., in 1987 for the preparation of polybis (pcarboxyphenoxy)propane anhydride polyanhydride copolymer microcapsules with sebacic acid. In this method, the solid drug particles are dispersed in melted polymer and obtained mass was sieved at less than 50 µ. Themixture is suspended in an immiscible solvent (such as silicone oil), continuously stirred and heated to 5°Cabove the melting point of the polymer. Once the emulsion was stabilized, cooled until the polymer particles aresolidified. The resulting microcapsules are washed by decantation with petroleum ether. Microcapsules adiameter of 1 to 1000 µ can be obtained and the particle size distribution can be easily controlled by changingthestirring speed. The main problem for the development of this process is to provide a suitable method for themicroencapsulation of water labile polymers, such as field anhydride. Disadvantage of this method was themoderate temperature at which the formulation is exposed.[32]
4. **Phase separation coacervation technique:-**This process is based on the principle of decreasingthe solubility of the polymer in organic phase toaffect the formation of polymer rich phase called thecoacervates. In this method, the drug particles aredispersed in a solution of the polymer and anincompatible polymer is added to the system whichmakes first polymer to phase separate and engulf thedrug particles. Addition of non-solvent results in thesolidification of polymer. Polylactic acid (PLA) microspheres have been prepared by this method byusing butadiene as incompatible polymer. Theprocess variables are very important since the rate ofachieving the coacervates determines the distribution of the polymer film, the particle size andagglomeration of the formed particles. Theagglomeration must be avoided by stirring thesuspension using a suitable speed stirrer since as theprocess of microspheres formation begins the formedpolymerize globules start to stick and form theagglomerates. Therefore the process variables

arecritical as they control the kinetic of the formedparticles since there is no defined state of equilibriumattainment.[33]

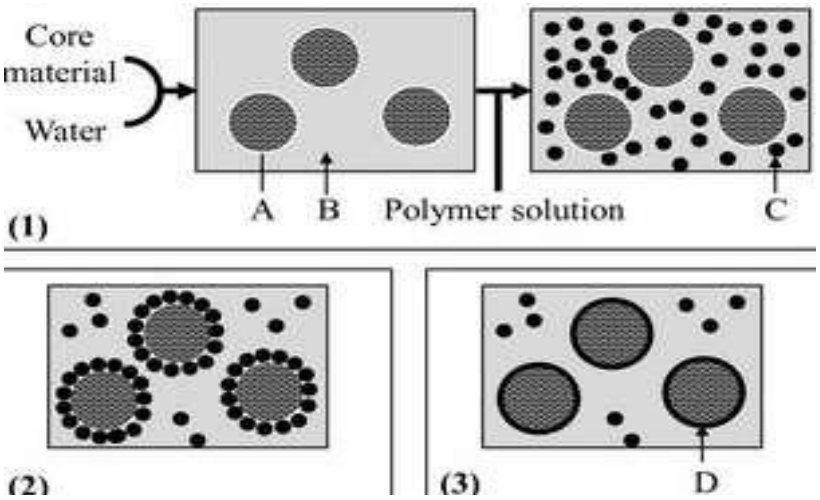

Figure 5: Scheme of microencapsulation process by coacervation.

5. **Solvent Evaporation** The processes are carried out in a liquid manufacturing vehicle. The microcapsule coating is dispersed ina volatile solvent which is immiscible with the liquid manufacturing vehicle phase. A core material to bemicroencapsulated is dissolved or dispersed in the coating polymer solution. With agitation the corematerial mixture is dispersed in the liquid manufacturing vehicle phase to obtain the appropriate sizemicrocapsule. The mixture is then heated if necessary to evaporate the solvent for the polymer of the corematerial is disperse in the polymer solution, polymer shrinks around the core. If the core material is dissolved in the coating polymer solution, matrix – type microcapsules are formed. The solvent Evaporation technique is shown in Figure 4. The core materials may be either water soluble or water insoluble materials. Solvent evaporation involves the formation of an emulsion between polymer solutionand an immiscible continuous phase whether aqueous (o/w) or non-aqueous. The comparison ofmucoadhesive microspheres of hyaluronic acid, Chitosan glutamate and a combination of the twoprepared by solvent evaporation with microcapsules of hyaluronic acid and gelating prepared by complexcoacervation were made.[34]

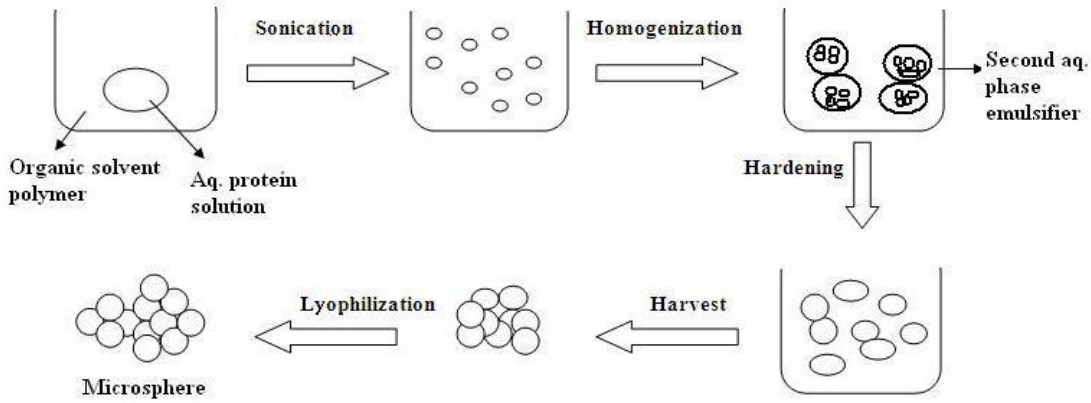

Figure 6: Solvent evaporation method for preparation of microsphere.

6. **Solvent Removal** This is a non-aqueous method of microencapsulation and is most suitable for water labile polymers such as the polyanhydrides. The method involves dissolving the polymer into volatile organic solvent and the drug is dispersed or dissolved in it, this solution is then suspended in the silicone oil containing span 85 and methylene chloride under stirring, then petroleum ether is added and stirred until solvent is extracted into the oil solution.[35] The obtained microspheres are then subjected for vacuum drying.
7. **Ionic gelation technique Procedure:** Sodium alginate and the mucoadhesive polymer are dispersed in purified water (50 ml) to form a Homo geneous polymer mixture. Drug is added tothe polymer matrix and mixed thoroughly to formsmooth viscous dispersion. Resulting dispersion isthen sprayed into calcium chloride (10% w/v) solution by continuous stirring. Produced dropletsare retained in the calcium chloride solution for 15minutes to complete the curing reaction and toproduce rigid spherical microspheres. The resultingmicrospheres are collected by decantation, andthe thus separated is washed repeatedly withpurified water to remove excess calcium impuritydeposited on the surface of microspheres andthen dried at 45°C for 12 hrs.[36]
8. **Spray Drying** In Spray Drying the polymer is first dissolved in asuitable volatile organic solvent such asdichloromethane, Acetone, etc. The drug in the solidform is then dispersed in the polymer solution underhigh-speed homogenization. This dispersion is thenatomized in a stream of hot air. The atomizationleads to the formation of the small droplets or thefine mist from which the solvent evaporateinstantaneously leading the formation of themicrospheres in a size range 1-100µm. Microparticles are separated from the hot air by means ofthe cyclone separator while the trace of solvent isremoved by vacuum drying. One of the majoradvantages of processis feasibility of operation underaseptic conditions. This process is rapid and thisleads to the formation of porous micro particles.[37]

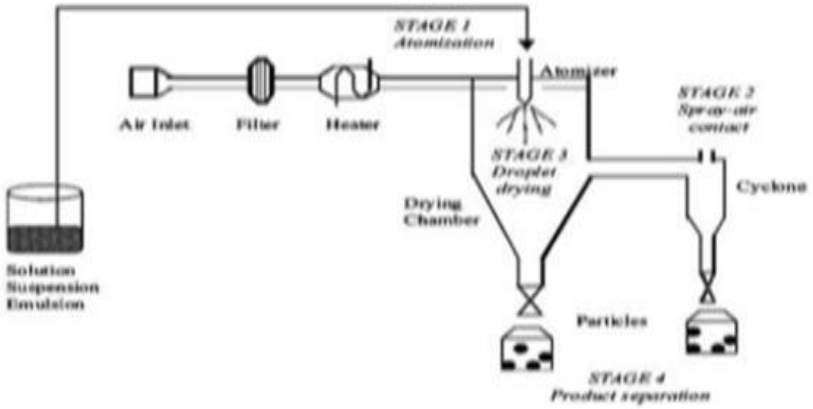

Figure 7: **Spray Drying Technique.**

9. **multiple emulsion polymerizationtechnique** Multiple emulsion method involves formation of (o/w) Primary emulsion (non aqueous drug solutionin polymer solution) and then addition of primaryemulsion to external oily phase to form o/w/oemulsion followed by either addition of cross linkingagent (glutaraldehyde) and evaporation of organicsolvent. This method of preparation is ideal forincorporating poorly aqueous soluble drug, thusenhancing its bioavailability. The microspherespreparedby multiple emulsion technique make thepoorly aqueous soluble drug such as ketorolactromethamine more bioavailable.[38]

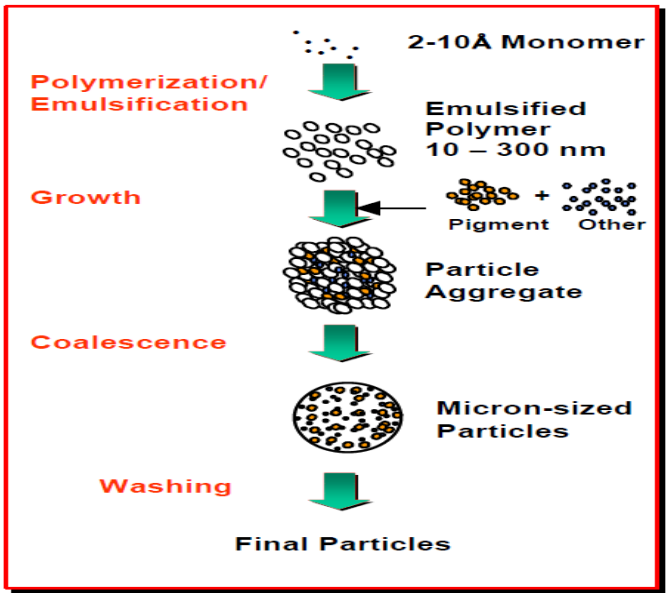

Figure 8:-multiple emulsion polymerization technique.

EVALUTION

Interaction Study By TLC/ FTIR

- **IR spectroscopic studies:** The IR spectra of the free drug and the microspheres are recorded.
- **Thin layer chromatographic studies:** The drug stability in the prepared microspheres can be tested by the TLC method.
- **UV-FTTR (Fourier transform infra red):** The drug polymer interaction and also degradation of drug while processing for microencapsulation can be determined by FTIR.[39]
- **Particle Size:** particle size can be determined by optical microscopy method.[40]
- **Surface Morphology:** The surface morphology can be determined by scanning electron microscopy(SEM) like shape and size.[41]
- **Density:** The density of the microspheres can be determined by using a multi volume pychnometer.
- **Entrapment Efficiency:** The percent entrapment efficiency is calculated using following equation: %Entrapment = Actualcontent/Theoretical content x 100.[42]
- **Swelling Index:** The percent swelling value can be determined using following equation. Percent swelling = DT - D0 / D0 × 100 Where, D0 = weight of dried microspheresDT = weight of swelled microspheres.[43]
- **Bulk density:** The bulk density is estimated by the ratio of microsphere weight to the final volume of the tapped microsphere bed.
- **Angle of contact:** The angle of contact is measured to determine the wetting property of a micro particulate carrier. It determines the nature of microspheres in terms of hydrophilicity or hydrophobicity.[44]
- ***In vitro* drug release studies:** In-vitro release studies can be performed according to USP XXII type 2 dissolution apparatus at suitable pH conditions. The drug content in the sample can be analysed by spectrophotometrically at specific wavelength (nm).[45]
- ***Ex-Vivo* Mucoadhesion Study:** The mucoadhesive property of the microspheres is evaluated on goat's intestinal mucosa by using phosphate buffer, as per monograph. Weighed microspheres are spread onto wet rinsed tissue specimen and immediately thereafter the slides are hung onto the arm of a USP tablet disintegrating test machine with suitable support at 370C. The weight of microspheres leached out at different intervals is measured.[46]

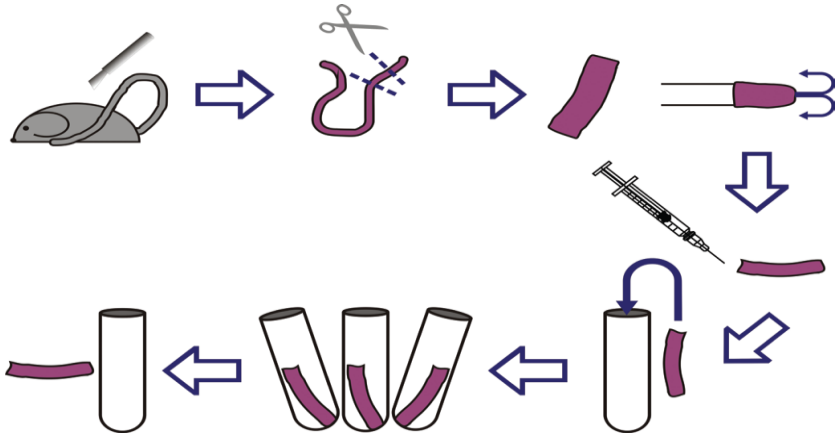

Figure 9: Everted gut sac procedure.[47]

APPLICATION OF MICROSPHERES

Some of the applications of microspheres aredescribed in detail as following

1. Controlled and sustained release dosage forms.
2. Microsphere can be used to prepare enteric-coateddosage forms, so that the medicament will beselectively absorbed in the intestine rather than thestomach.
3. It has been used to protect drugs fromenvironmental hazards such as humidity, light, oxygen or heat. Microsphere does not yet provide aperfect barrier for materials, which degrade in thepresence of oxygen, moisture or heat, however agreat degree of protection against these elements canbe provided. For example, vitamin A and K have beenshown to be protected from moisture and oxygenthrough microsphere.
4. The separations of incompatible substances, forexample, pharmaceutical eutectics have been
5. Achieved by encapsulation. This is a case where directcontact of materials brings about liquid formation. The stability enhancement of incompatible aspirinchlorpheniraminemaleate mixture is accomplishedby microencapsulating both of them before mixing.
6. Microsphere can be used to decrease the volatility. An encapsulated volatile substance can be stored forlonger times without substantial evaporation.
7. Microsphere has also been used to decreasepotential danger of handling of toxic or noxious
8. Substances. The toxicity occurred due to handling offumigants, herbicides, insecticides and pesticideshave been advantageously decreased aftermicroencapsulation.
9. The hygroscopic properties of many core materialsmay be reduced by microsphere.
10. Many drugs have been microencapsulated toreduce gastric irritation.[48]

11. Microsphere method has also been proposed toprepare intrauterine contraceptive device.
12. Therapeutic magnetic microspheres are used todeliver chemotherapeutic agent to liver tumour.
13. Drugs like proteins and peptides can also be targetedthrough this system. Mucoadhesive microspheresexhibit a prolonged residence time at the site ofapplication and causes intimate contact with theabsorption site and produces better therapeuticaction.
14. Radioactive microspheres are used for imaging ofliver, spleen, bone marrow, lung etc and evenimaging of thrombus in deep vein thrombosis can bedone.[49]

Application of microspheres in pharmaceuticalindustry[50,51,52]

Transdermal drug delivery

Polymer has good film-forming properties. The drug release from the devices is affected by the membrane thickness and cross-linking of the film. Eg. Chitosan, Alginate, PLGA.

Buccal drug delivery

Polymer is an excellent polymer to be used for buccal delivery because it has muco/bioadhesive properties and can act as an absorption enhancer. Chitosan, Sodium alginate.

Nasal drug delivery Polymer based drug delivery systems, such as microspheres, liposomes and gels have been demonstrate to have good bioadhesive characteristics and swell easily when in contact with the nasal mucosa increasing the bioavailability and residence time of the drugs to the nasal route. Eg. Starch, Dextran, Albumin, Chitosan+ Gelatin.

Gastrointestinal drug delivery

Polymer granules having internal cavities prepared by de acidification when added to acidic and neutral media are found buoyant and provided a controlled release of the drug. eg. Eudragit, Ethyl cellulose+Carbopol BSA, Gelatin.

Oral drug delivery

The ability of microspheres containing polymer to form films permit its use in the formulation of film dosage forms, as an alternative to pharmaceutical tablets. The pH sensitivity, coupled with the reactivity of the primary amine groups, make microspheres more suitable for oral drug delivery applications. Eg. Chitosan, Gelatin.

Targeting by using microparticulate carriers Pellets are prepared with polymer by using the extrusion/ spheronization technology. Eg. Chitosan, Microcrystalline cellulose.

Ophthalmic Drug Delivery: Microspheres developed using polymer exhibits favorable biological behavior such as bioadhesion, permeability- enhancing properties, and interesting physico- chemical characteristics, which make it a unique material for the design of ocular drug delivery vehicles. Eg. Chitosan, Alginate, Gelatin

Intratumoral and local drug delivery In order to deliver paclitaxel at the tumor site in therapeutically relevant concentration, polymer films are fabricated. Mixture of drug has promising potential for use in controlled delivery in the oral cavity. Eg. Gelatin, PLGA, Chitosan and PCL.

Gene delivery Microspheres could be a useful oral gene carrier because of its adhesive and transport properties in the GI tract. Eg. Chitosan Gelatin, viral vectors, cationic liposomes, polycation complexes.

Colonic drug delivery Polymer has been used for the specific delivery of insulin to the colon. Eg. Chitosan.

CONCLUSION

Studies on mucoadhesive system have focused on a broad array of aspects. It is growth area whose goal is the development of the new devices and more "Intelligent" polymers as well as the creations of new methodologies that can better elucidate the mucoadhesion phenomenon.

The mucoadhesive microspheres can be used not only for the controlled release but also for enhancing bioavailability, for targeted delivery of the drugs to specific sites in the body.

Mucoadhesive microspheres will ensure the maintaince of effective plasma concentration over prolonged period of time by extending the release of drug. These carrier system will also increase the residence time of the drug in gastrointestinal tract.

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