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Mucoadhesive And Microspheres

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ABSTRACT
Carrier technology provides an interesting as well as an intelligent approach for the delivery of drug. It offers delivery of drug by coupling the drug to a carrier particle such as microspheres, nanoparticles, liposomes, etc. Microspheres constitute an important part of this particulate drug delivery system because of their small size and other efficient properties. Mucoadhesive microspheres provide better drug absorption as they get adhere to the mucosal surface and release drug for prolonged time. This article reviewed about the mucoadhesive microspheres, their methods of preparation and their evaluation in brief.

Keywords
Mucoadhesive microspheres, methods of preparation of mucoadhesive microspheres, evaluation of mucoadhesive microspheres

INTRODUCTION[1]

Recently the novel dosage forms which can control the release rate and target the active drug molecule to a particular site have attained a great formulation interest.
Microspheres are one of the novel drug delivery system which posses several applications and are made up of assorted polymers 1.
Microspheres are small spherical particles (typically 1 μm to 1000 μm),
sometimes referred to as microparticles. The microspheres can be made up of either natural or synthetic polymers .

Generally microspheres posses potentiality to be employed for targeted and controlled/extended release of drug, but incorporating mucoadhesive properties to microspheres will furthermore improve absorption and bioavailability of the drugs.
Mucoadhesive microspheres enhance the intimate contact with the mucus layer, and drug targeting to the absorption site by anchoring bacterial adhesions , plant lectins, antibodies etc.

Tailored mucoadhesive microspheres offers the possibilities of localized as well as controlled release of drugs by adherence to any mucosal tissue present in eye, nasal cavity, urinary, and GI tract.

Drug action can be improved by developing new drug delivery system, such as the mucoadhesive microsphere drug delivery system. These systems remain in close contact with the absorption tissue, the mucous membrane, releasing the drug at the action site leading to a bioavailability increase and both local and systemic effects.

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.

Microspheres are the carrier linked drug delivery system in which particle size is ranges from 1-1000 μm range in diameter having a core of drug and outer layers of polymer as coating material.

The success of these microspheres is limited due to their short residence time at site of absorption.
It would, therefore be advantageous to have means for providing an intimate contact of the drug delivery system with the absorbing membrane. This can be achieved by coupling bioadhesion characteristics to microspheres and developing “mucoadhesive microspheres”.

Mucoadhesive microspheres have advantages like efficient absorption and enhanced bioavailability of the drugs due to a high surface to volume ratio, a much more intimate contact with the mucus layer and specific targeting of drugs to the absorption site.

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MUCOADHESION[2]

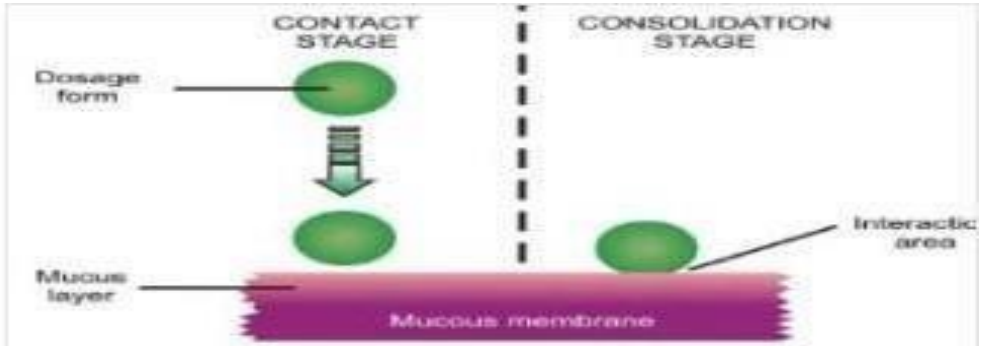


Fig. 1: The two steps of the mucoadhesion process

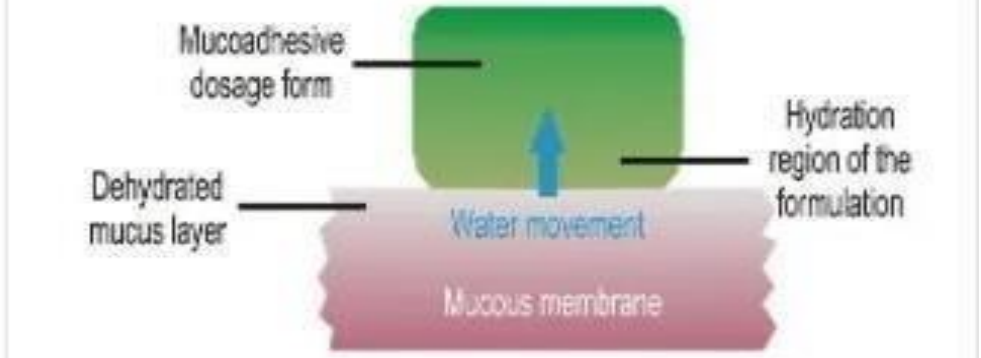
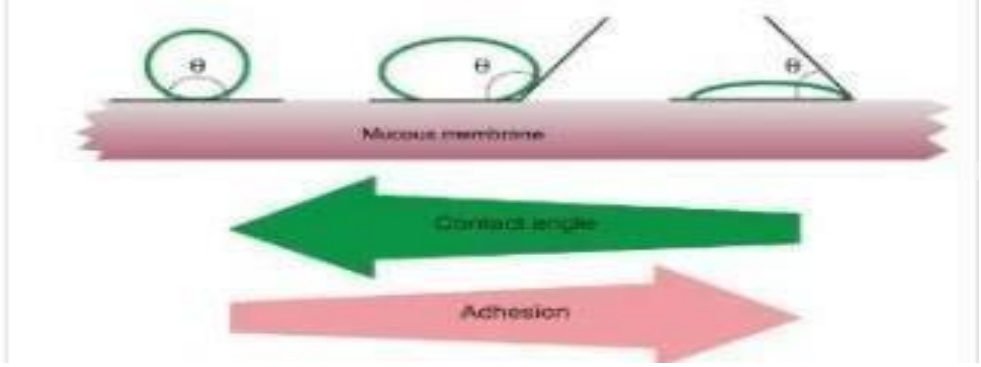


Fig. 2: Dehydration theory of mucoadhesion



MICROSPHERES[2]

Microspheres, as carrier for drug is one such approach which can be used in a sustained controlled release fashion. Microspheres are small spherical particles, with diameters in the micrometer range (typically 1 μm to 1000 μm). Microspheres are sometimes referred to as microparticles.

Dosage forms that can precisely control the release rate sand target drugs to a specific body site have created enormous impact on the formulation and development of novel drug delivery system.

The objective of controlled release drug delivery includes two important aspects namely spatial placement and temporal delivery of drug. Spatial placement relates to targeting a drug to a specific organ or tissue, while temporal delivery refers to controlling the rate of drug delivery to the target

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tissue.

Variety of devices have been used for controlled release drug delivery, biodegradable polymer microspheres are one of the most common types and hold several advantages.
Microspheres can encapsulate many types of drugs including small molecules, proteins, and nucleic acids and are easily administered through a syringe needle.
They are generally biocompatible, can provide high bioavailability, and are capable of sustained release for long periods of time.

MUCOADHESIVE MICROSPHERES[3]

Recent advances in polymer science and drug carrier technologies have promulgated the development of novel drug carriers such as mucoadhesive microspheres that have boosted the use of bioadhesion in the drug delivery.
Mucoadhesive microspheres include microparticles and microcapsules of 1 to 1000 μ*m* in diameter consisting either entirely of mucoadhesive polymer or having an outer coating with adhesive property.

Microspheres have the potential to be used for controlled as well as spatial drug delivery. Incorporating mucoadhesivenes to microspheres leads to efficient absorption and enhanced bioavailability of drug.
Specific targeting of drug to the absorption site is achieved by using homing devices (ligand) like plant lactin, bacterial adhesion etc. on the surface of the microspheres.
Mucoadhesive microspheres can be tailored to adhere to mucosal linings of GIT, thus offering the possibilities of localized as well as systemic absorption of drug in controlled manner

MUCOADHESION[4]

Various mucoadhesive dosage forms such as discs, microspheres, and tablets have been prepared and reported by several research groups. mucoadhesive drug delivery systems are used to enhance drug absorption in a site-specific manner .
Mucoadhesion is defined as the interaction between a mucin surface and a syntheticor natural polymer 10. Mucoadhesion is defined as the interaction between a mucin surface and a synthetic or natural polymer.

Mucoadhesion has been widely promoted as a way of achieving site- specific drug delivery through the incorporation of mucoadhesive hydrophilic polymers with in pharmaceutical formulations such as “microspheres” along with the active pharmaceutical ingredient (API).

It is the reliable means to deliver the drug to the target site with specificity, if modified, and to maintain the desired concentration at the site of interest without untoward effects.
Microspheres received much attention not only for prolonged release, but also for targeting of anticancer drugs to the tumour.

In future by combining various other strategies, microspheres will find the central place in novel drug delivery, particularly in diseased cell sorting, diagnostics, gene & genetic materials, safe, targeted and effective in vivo delivery and supplements as miniature versions of diseased organ and tissues in the body.

MECHANISM OF MUCOADHESION[5]

The mechanism of adhesion of certain macromolecules to the surface of a mucous tissue is not well understood yet. The mucoadhesive must spread over the substrate to initiate close contact and increase surface contact, promoting the diffusion of its chains within the mucus.
Attraction and repulsion forces arise and, for a mucoadhesive to be successful, the attraction forces must dominate. Each step can be facilitated by the nature of the dosage form and how it is administered. For example, a partially hydrated polymer can be absorbed by the substrate because of the attraction by the surface water.

The mechanism of mucoadhesion is generally divided into two steps: the contact stage and the consolidation stage. The first stage is characterized by the contact between the mucoadhesive and the mucus membrane, with spreading and swelling of the formulation, initiating its deep contact with the mucus layer.

Mucoadhesion is the attachment of the drug along with a suitable carrier to the mucosal layer. Mucoadhesion is a complex phenomenon which involves wetting, adsorption and interpenetration of polymer chains. Mucoadhesion has the following Mechanism.
Intimate contact between a mucoadhesive delivery

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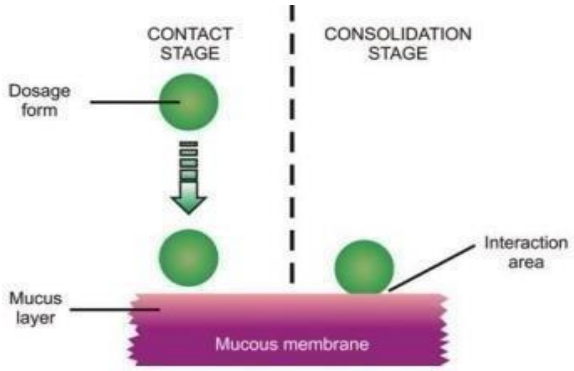
system and mucosal membrane (wetting or swelling phenomenon) . Penetration of the mucoadhesive delivery system into the tissue or into the surface of the mucous membrane.

Mechanismof Mucoadhesion Diagram Representation.

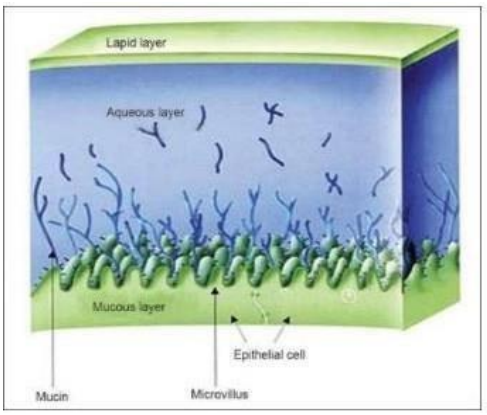


MUCUS MEMBRANES[5]

Mucus membranes are the moist surfaces lining walls of various body cavities such as the gastrointestinal 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 major components of all mucus gels are mucin glycoprotein, water, lipids, and inorganic salts. The mucus serves as a protective barrier and for lubrication also.

Structure of Mucus Membrane



THEORIES OF MUCOADHESION [6,7]

The phenomena of bioadhesion occur by a complex mechanism. Above theories have been proposed, which will explain the mechanism of bioadhesion.

- **Electronic theory:** Involves the formation of an electric double layer at the mucoadhesive interface by the transfer of electrons between the mucoadhesive polymer and the mucin glycoprotein network. For example: Interaction between positively charged polymers chitosan and negatively charged mucosal surface which becomes adhesive on hydration and provides an intimate contact between a dosage form and absorbingtissue.

- **Wetting Theory:** States that if the contact angle of liquids on the substrate surface is lower, then there is a greater affinity for the liquid to the substrate surface. If two such substrate surfaces are brought in contact with each other in the presence of the liquid, the liquid may act as an adhesive amongst the substrate surfaces.

- **Adsorption Theory:** According to this theory, after an initial contact between two surfaces, the material adheres because of surface force acting between the atoms in two surfaces. Two types of chemical bonds resulting from these forces can be distinguished as primary chemical bonds of covalent nature and Secondary chemical bonds having many different forces of attraction likes electrostatic forces, Vander Walls forces, hydrogen and hydrophobic bonds.

- **Diffusion Theory of Mucoadhesion:** Diffusion theory describes that polymeric chains from the bioadhesive interpenetrate into glycoprotein mucin chains and reach a sufficient depth within the opposite matrix to allow formation of a semi-permanent bond 18. The process can be visualized from the point of initial contact. The existence of concentration gradients will drive the polymer chains of the bioadhesive into the mucus network and the glycoprotein mucin chains into the bioadhesive matrix until an equilibrium penetration depth is achieved.

- **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

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mucoadhesive surface.

- **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.

- **Cohesive Theory:** According to this theory the phenomena of mucoadhesion is mainly due to the intermolecular interactions amongst like-molecules.

FACTORS AFFECTING MUCOADHESION[8]

The mucoadhesion of a drug carrier system to the mucous membrane depends on the below mentioned factors.

Polymer Based Factors Molecular weight of the polymer, concentration of polymer, stereo chemistry of polymer, chain length of polymer, hydration of polymer.

Physical Factors pH at polymer substrate interface, swelling of polymer, applied strength, contact time. Physiological Factors Mucin turnover rate and diseased state.

ADVANTAGES OF MUCOADHESIVE MICROSPHERE[9.10]

- Provide constantand longer therapeutic effect.

- Reduces the frequency of daily administration and thereby improve the patient compliance.

- Improve the absorption of drug hence improve the bioavailability of drug and reduce the chances of adverse effects.

- The morphology of microspheres permits a controllable variability in degradation and drug release.

- Readily localized in the region applied to improve and enhance the bioavailability of drugs. E.g. testosterone & its esters, vasopressin, dopamine, insulin and gentamycin etc.

- Facilitate intimate contact of the formulation with underlying absorption surface. This allows modification of tissue permeability for absorption of macromolecules. e.g. peptides and proteins.

- Prolong residence time of the dosage form at the site of application and absorption to permit once or twice a day dosing.

- Offers an excellent route, for the systemic delivery of drugs with high first- pass metabolism, there by offering a greater bioavailability

- Additionally significant cost reductions may be achieved and dose-related side effects may be reduced due to API localization at the disease site.

LIMITATIONS OF MUCOADHESIVE MICROSPHERE[10]

Some of the disadvantages were found to be as follows:

- The release from the formulations may get modified

- The release rate may vary from a variety of factors like food and the rate of transit though gut, mucin turnover rate etc

- Differences in the release rate can be found from one dose to another

- Any loss of integrity in release pattern of the dosage form may lead to potential toxicity.

- These kinds of dosage forms cannot be crushed or chewed.

Materials Used In the Formulation of Mucoadhesive Microspheres[10]

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.

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- Polymers that adhere through nonspecific, noncovalent interactions that is primarily electrostatic in nature.

- Polymers that bind to specific receptorsite on tile self surface.

TYPES OF MUCOADHESIVE POLYMERS[11]

- **First generation mucoadhesive polymers:** First-generation mucoadhesive polymers may be divided into three main sub-categories, namely: Anionic polymers, Cationic polymers and non-ionic polymers. Among these anionic and cationic polymers have been exhibits the greatest mucoadhesive strength.

- **Anionic polymers:** Anionic polymers are the most widely employed mucoadhesive polymers within pharmaceutical formulation due to their high mucoadhesive functionality and low toxicity. These include alginates, carrageenan, poly(- acrylic acid) (PAA) and its weakly cross-linked derivatives and sodium carboxymethylcellulose (NaCMC). PAA and NaCMC possess excellent mucoadhesive characteristics due to the formation of strong hydrogen bonding interactions with mucin. Polycarbophil and carbomer (Carbopol, PAA derivatives have been studied extensively as mucoadhesive platforms for drug delivery to the GI tract.

- Carbomers are cross-linked with allyl sucrose or allylpentaerythritol, whereas polycarbophil polymers are cross-linked with divinyl glycol. Both compounds have the same acrylic backbone but vary in their cross-link density that is often tailored to suit pharmaceutical or cosmetic performance.

- **Cationic polymers:** Chitosan is a cationic polysaccharide, the most abundant polysaccharide in the world, next to cellulose . The most explored mucoadhesive polymers, chitosan is gaining increasing importance due to its good biocompatibility, biodegradability and due to their favourable toxicological .The linearity of chitosan molecules also ensures sufficient chain flexibility for interpenetration . Chitosan may provide improved drug delivery *via* mucoadhesive mechanism; it has also been shown to enhance drug absorption *via* the paracellular route through neutralization of fixed anionic sites within the tight junctions between mucosal cells.

CLASSIFICATION OF MUCOADHESIVE POLYMERS[12]

There are various mucoadhesive polymers of synthetic and natural origin, which are classified in Table below :-

A short list of mucoadhesive polymers

Synthetic polymers	Natural polymers
Hydroxy propyl methyl cellulose (HPMC) Poly(acrylic acid) polymers (carbomers, polycarbophil)	Chitosan Sodium alginate
Poly vinyl pyrrolidone (PVP) Poly vinyl alcohol (PVA)	Pectin Locust bean gum
Poly hydroxyethyl methylacrylate	Guar gum
Poly ethylene oxide	Xanthan gum
Sodium carboxy methyl cellulose (Na CMC)	Karaya gum
Hydroxyl ethyl cellulose (HEC)	Gelatin
Hydroxy propyl cellulose (HPC)	Tragacanth
Ethyl cellulose (EC)	Soluble starch

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Methyl cellulose (MC)	Lecithin

Methods Of Preparation Of Mucoadhesive Microspheres[12]

Mucoadhesive microspheres can be prepared by using different techniques like:

- Complex coacervation
- Hot melt microencapsulation
- Single emulsion technique
- Double emulsion method
- Solvent removal
- Ionotropic gelation
- Phase inversion method
- Spraydrying

- **Complex Coacervation**: Principle of this method is under suitable conditions when solutions of two hydrophilic colloids were mixed, result into a separation of liquid precipitate. In this method the coating material phase, prepared by dissolving immiscible polymer in a suitable vehicle and the core material is dispersed in a solution of the coating polymer under constant stirring. Microencapsulation was achieved by utilizing one of the methods of phase separation, that is, by changing the temperature of the polymer solution; by changing the pH of the medium, by adding a salt or an incompatible polymer or a nonsolvent to the polymer solution; by inducing a polymer polymer interaction. Generally coating is hardened by thermal cross linking or desolvation techniques, to form a self sustaining microsphere.

- **Hot Melt Microencapsulation**: Microspheres of polyanhydride copolymer of poly bis(p-carboxy phenoxy) propane anhydride with sebacic acid were firstly prepared by this method19. In this metod the polymer is firstly melted and then the solid drug particles are added to it with continuous mixing. The prepared mixture is then suspended in a non-miscible solvent like silicone oil with stirring and heated at the temperature above the melting point of the polymer with continuous stirring so as to get stabilized emulsion. The formed emulsion is cooled to solidify polymer particles followed by filtration and washing of the microspheres with petroleum ether.

- **Single Emulsion Technique**: The microspheres of natural polymers are prepared by single emulsion technique. The polymers and drug are dissolved or dispersed in aqueous medium followed by dispersion in organic medium e.g. oil, results in formation of globules, and then the dispersed globule are cross linked by either of heat or by using the chemical cross-linkers. The chemical cross-linkers used are formaldehyde, glutaraldehyde, diacid chloride etc.

- **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.

- **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 . The obtained microspheres were then subjected for vacuum drying.

- **Ionotropic Gelation**: This method was developed by Lim F and Moss RD
22. Using this method Microspheres are formed by dissolving the gel-type polymers, such as alginate, in an aqueous solution followed by suspending the active ingredient in the mixture and extruding the solution through needle to produce micro droplets which fall into a hardening solution containing calcium chloride under stirring at low speed. Divalent calcium ions present in the hardening solution crosslink the polymer, forming gelled microspheres.

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- **Phase Inversion Method**: The method involves addition of drug into dilute polymeric solution, in methylene chloride; and resultant mixture is poured into an unstirred bath of strong non-solvent, petroleum ether, in a ratio of 1: 100. Microspheres produced are then clarified, washed with petroleum ether and air dried.

- **Spray Drying**: This method involves dissolving/dispersing of the drug into the polymer solution which is then spray dried. By this method the size of microspheres can be controlled by manipulating the rate of spraying, feeding rate of polymer drug solution, nozzle size, and the drying temperature.

IDEALCHARACTERISTICS OF MUCOADHESIVE POLYMER[13]

- The polymer and its degradation products should be nontoxic and should be nonabsorbable fromthe GI tract.

- It should be nonirritant to the mucus membrane.

- It should preferably form a strong noncovalent bond with the mucin– epithelial cell surfaces.

- It should adhere quickly to mosttissue and should possess somesite specificity.

- It should allow easy incorporation of the drug and should offer no hindrance to its release.

- The polymers must notdecomposeon storageorduring the shelf life of the dosageform.

- The cost of the polymer should not be high so that the prepared dosage form remains competitive.

EVALUATION OF MUCOADHESIVE MICROSPHERES[14]

The microspheres are evaluated for the following parameters.

1. **Particle Size and Shape**: Light microscopy (LM) and scanning electron microscopy (SEM) both can be used to determine the size, shape and outer structure of microspheres.

2. **Surface Characterization of The Mucoadhesive Microspheres:** Data from the scanning electron microscopy, scanning tunneling microscopy and the electron microscopy provides insight to the surface morphology of microspheres and the morphological changes produced through degradation of polymer. Changes in the surface morphology occurring through degradation of polymer can be studied by incubating the microspheres in the phosphate buffer saline at different intervals of time. It was found that microspheres with the coarser surface improve the adhesion through stronger mechanical interactions, while smooth surface of the microspheres leads to weak mucoadhesive properties.

3. **Surface Charge Study**: From photon correlation spectroscopy data the surface charge (zeta potential) of the mucoadhesive microspheres can be determined. The surface charge can be determined by relating measured electrophoretic mobility into zeta potential with in-built software based on the Helmholtz– Smoluchowski equation 30. Zeta potential is an indicator of particle surface charge, which can be used to predict and control the adhesive strength, stability, and the mechanisms of mucoadhesion. Process of mucoadhesion involves interactions between the mucus and mucoadhesive polymers, and is influenced by their structure including their charge. Measurement of zeta potential of microspheres and mucus helps to predict electrostatic interactions during mucoadhesion.

4. **Entrapment Efficiency:** The entrapment efficiency of the microspheres or the percent entrapment can be determined by keeping the microspheres into the buffer solution and allowing lysing. The lysate obtained is filtered or centrifuged and then subjected for determination of active constituents as per monograph requirement. The percent entrapment efficiency is calculated using following equation.

% Entrapment = Actual content/Theoretical content x 100

5. **Swelling Index:** Swelling index illustrate the ability of the mucoadhesive microspheres to get swelled at the absorbing surface by absorbing fluids available at the site of absorption,which is a primary requirement for initiation of mucoadhesion32. The percent swelling value can be determined using following equation.

Percent swelling = DT - D0 / D0 × 100 Where,

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D0 = weight of dried microspheres DT = weight of swelled microspheres

6. In- Vitro Release Study: Standard IP/BP/USP dissolution apparatus is used to study in-vitro release profile in the dissolution media that is similar to the fluid present at the absorption site as per monograph, using rotating basket or paddle type dissolution apparatus.

7. 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. The % mucoadhesion is calculated by the following equation.

% Mucoadhesion= Wa-W1/Wax 100

Where,
Wa is the weight of microspheres applied W1 is the weight of microspheres leachedout

APPLICATIONS OF MUCOADHESIVE MICROSPHERES[15]

- Mucoadhesive microsphere is one potential strategy for prolonging GRT. Mucoadhesive microspheres interact with mucous of GIT and are considered to be localized or trapped at the adhesive site by retaining a dosage form at the site of action, or systemic delivery by retaining a formulation in intimate contact with the absorption site which may result in prolonged gastric residence time as well as improvement in intimacy of contact with underlying absorptive membrane to achieve better therapeutic performance of drugs.
- Vaccine delivery for treatment of diseases like hepatitis, influenza, pertusis, ricin toxoid, diphtheria, birth control. Microsphere in vaccine delivery have a specific advantage like improved antigenicity by adjuvant action, modulation of antigen release, stabilization of antigen.
- Mucoadhesive microspheres as a novel carrier system to improve drug delivery by various routes of administration like buccal, oral, nasal, ocular, vaginal and rectal, either for systemic or for local effects.
- Mucoadhesive microspheres are used as targeted drug delivery system for various diseases. Mucoadhesive microspheres are involved in various clinical as well as pharmaceutical aspects.

Sr.no	Drug used	Indication	Polymer used	Result
1	Nifidipine	Anti-hypertensive	HPMC, Carbapol	Mucoadhesive microspheres of nifidipine showed goodcontrolled release properties and polymer used showed good entrapment efficiency
2	Ramipril	Hypertension Myocardial-infraction	Chitosan, Ethylcellulose	Mucoadhsive microspheric preparation of Ramipril prolonged the Gastrointestinal residence time and slow release of drug
3	Repaglinide	Antidiabetic	EudragitRS 100chitosan	It has been concluded that drug loaded mucoadhesive microspheres are suitable delivery systems for Repaglinide
4	Cephalexin	Treatment of respiratory tract infection	Sodium alginate, Guargum	Improved bioavailability of cephalexin anddecrease the frequency of dosage form administration

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5	Simvastatin	Hypolipidemic	Carbopol 940P, sodium CMC	Mucoadhesive microspheres of simvastratin were prepared and drug release was diffusion controlled
6	Rantidine hydrochloride	Gastroretentive	Chitosan and sodiumcarboxy methyl Celluloe	Mucoadhesive microspheres of rantidine hydrochloride were prepared
7	Amoxicillin	Anti-helicobactor pylori for gastric and duodenal ulcer	Carboxyvinyl polymer	Amoxicillin administration in the form of amoxicillin mucoadhesive microspheres more effectively cleared H.pylori than in the form of suspention.
8	Propanolol hydrochloride	hypertension	Sodium carboxy methyl cellulose, carbopol 934P, HPMC	It has been concluded that mucoadhesive microspheres can successfully design for sustain delivery of propanolol hydrochloride and improve patient compliance
9	Glipizide	Anti diabetic	Sodium alginate	By using sodium alginate mucoadhesive microspheres of glipizide should increase thelength of stay of glipizide for the treatment of diabetes

CONCLUSION

- Novel drug delivery systems based Mucoadhesive polymers have achieved a great interest in recent years in the field of modern pharmaceutical formulations.

- Mucoadhesive microspheres have been proved as a promising tool in delivery of drugs to a particular site in controlled or sustained manner, as they deliver the drug to a particular site for longer duration, the absorption of drug increased and hence, the bioavailability of the drug get increased.

- Therefore, it can be say that in future also mucoadhesive microspheres will play an important role in the development of new pharmaceuticals employing more advanced techniques and materials.

- Variety of opportunities offered by microspheres like protection and masking, reduction in dissolution rate, spatial targeting of the active ingredient.

- This approach facilitates reduce drug concentration at the site other than target organ or tissue, delivery of small quantities of potent drugs and protection of labile compounds before and after administration. Microspheres are ideal targeting drug delivery system with high safety profile.

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