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STOMACH SPECIFIC FLOATING IN SITU GEL DRUG DELIVERY SYSTEM – A REVEIW ON PRIMARY AND NOVEL APPROACHES

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ABSTRACT

Conventional oral dosage forms pose low bioavailability problems due to their rapid gastric transition from stomach, especially in case of drugs which are less soluble at alkaline pH of intestine. The drugs which produce their local action in stomach get rapidly emptied and do not get enough residence time in stomach. So, frequency of dose administration in such cases is increased. To overcome this drawback and to maximize the oral absorption of these drugs, novel drug delivery systems have been developed such as floating systems, mucoadhesive, high density and expandable, since they provide controlled delivery of drugs with prolonged gastric residence time. In-situ gel provides the best way to overcome problems of immediate release and short gastro intestinal residence of liquids. The in situ gel dosage form is a liquid before administration and after it comes in contact with gastric contents due to one or more mechanisms gets converted to gel which floats on gastric contents. This achieves increased residence as well as sustained release. This approach is useful for systemic as well as local effect of drugs administered such as aluminum hydroxide and magnesium carbonate.

KEYWORDS: In Situ Gel, Sustained Release, Floating Systems, Mucoadhesive Drug Delivery Systems.

INTRODUCTION

Most of the drugs given via oral route are subjected to absorption throughout the gastrointestinal tract, with major absorption from stomach and intestine.[1,2]

Various processes occur after the drug release from the dosage form, which affect the absorption of drugs, e.g. degradation of drug by enzymatic or microbial action, precipitation etc.

Drugs which get absorbed from stomach or show local effect should spend maximum time in the stomach. This is found to be very difficult in case of conventional tablets and capsules because of gastric emptying. Gastric emptying of a particular dosage form depends on various factors like volume and composition of the meal, temperature and viscosity of the meal, pH of stomach, body posture, emotional state of the individual, diseased state, gastric motility altering drugs etc.[3]

Prolonged gastric retention of drug is required in the following conditions.[4]

- Drug is best absorbed from stomach e.g. aspirin,
- Gastric fluids facilitate and improve the disintegration and dissolution of the drug,
- Dissolution and absorption of drug is promoted by the food e.g. griseofulvin,
- Slow dissolving drugs,
- Drug show local effect within stomach. E.g. antacids.

In situ gel forming systems have been widely investigated as vehicles for sustained drug delivery. This interest has been sparked by the advantages shown by in situ forming polymeric delivery systemssuch as ease of administration and reduced frequency of administration, improved patient compliance and comfort.[5]

In situ gel formation occurs due to one or combination of different stimuli like pH change, temperature modulation and solvent exchange.[6]

Gastro retentive in situ gelling system helps to increase bioavailability of drug compared to conventional liquid dosage form. The gel formed from in situ gelling system, being lighter than gastric fluids, floats over the stomach contents or adhere to gastric mucosa due to presence of bioadhesive nature of polymer and produce gastric retention of dosage form and increase gastric residence time resulting in prolonged drug delivery in gastrointestinal tract.[7]

Gastro retentive system ensures that whole drug delivery system remains within the gastric region for longer duration of time. This improves gastric retention time for such drug in comparison to conventional dosage form and further minimum effective concentration of drug remains maintained in systemic circulation for longer duration. This also improves the solubility of drugs which are less soluble at alkaline pH of intestine and wastage of drug during the absorption process is reduced remarkably. Gastro retentive drug delivery systems prolong the dosing intervals and thus improve patient compliance. Presence of drug in solution form is the most essential requisite for a drug to get absorbed. But, if the solubility of drug is poor then the time required for drug to get dissolve within stomach would be high and transit time becomes most stringent factor, which would in turn affect the absorption of drug. So, dose of administration for such drugs should be kept at more frequent intervals in a single day. Gastro retentive drug delivery systems provide a support to reduce the frequent dosing of such drug by producing a controlled delivery within stomach for longer duration. Though, other formulations or novel dosage forms like nanoparticle, microspheres, liposome etc. can also be used for controlled release effect, but gastro retentive system are considered much better alternative for improved absorption through stomach.[8]

Benefits of Gastro retentive Drug Delivery System (GRDDS)[9,10]

The principle of GRDDS can be used for any particular medicament or class of medicament.

1. The GRDDS are advantageous for drugs absorbed through the stomach e.g. ferrous salts and antacids.
2. The efficacy of the drugs can be increased utilizing the sustained release.
3. GRDDS provides advantages such as the delivery of drugs with narrow absorption windows in the small intestinal region.
4. The GRDDS are not restricted to medicaments, which are principally absorbed from the stomach.
5. Improvement of bioavailability: Furosemide has poor bioavailability because its absorption is restricted to upper GIT. This was improved by formulating its floating dosage form. The floating system containing furosemide exhibit 42.9% bioavailability as compared to 33.4% shown by commercial tablet and 27.5% shown by enteric coated tablet.
6. Reduction in the variability in transit performance: Floating dosage forms with sustained release characteristics are useful in reducing the variability in transit performance.
7. Reduction in plasma level fluctuations: The reduced plasma level fluctuations results from delayed gastric emptying. For example bioavailability of standard madopar was found to be 60 70%, and the difference in the bioavailability of standard and Hydrodynamically Balanced Systems formulations was due to the incomplete absorption.
8. Dosage reductions: The recommended adult oral dosage of ranitidine is 150 mg twice daily or 300 mg once daily. A conventional dose of 150 mg can inhibit gastric acid secretion up to 5 h only. If 300 mg is administered it leads to plasma fluctuations. On formulating ranitidine as floating system, the dosage has been reduced and sustained action was observed.
9. Enhancement of therapeutic efficacy: Floating systems are particularly useful for acid soluble drugs that are poorly soluble or unstable in intestinal fluids. For example bromocriptine used in the treatment of Parkinson's disease have low absorption potential that can be improved by HBS dosage form and thus its therapeutic efficacy could be enhanced.
10. Reduction in plasma level fluctuations: The reduced plasma level fluctuations results from delayed gastric emptying. For example bioavailability of standard madopar was found to be 60 70%, and the difference in the bioavailability of standard and Hydrodynamically Balanced Systems formulations was due to the incomplete absorption.

Limitations of GRDDS[11]

1. Poor stability may be seen for the drugs that may degrade by gastric acid, gastric enzymes etc.
2. Drugs which show poor solubility at acidic pH are not suitable for GRDDS.
3. Drugs that absorb throughout the GIT are poor candidates for this system.
4. Gastro irritant drugs cannot be formulated as GRDDS.
5. First pass metabolism was found to be the major limitation.

Oral in situ gel forming system also known as stomach specific or raft forming systems have provided a suitable way of providing the controlled drug delivery within stomach with enhanced gastro-retention. The tablet/capsule floating dosage forms are stable as compare to liquids but the problem with them is that they are needed to swallow as whole unit. In case of dosage adjustment these cannot be broken in halves as these are also designed for controlled release and floating ability also depends on dimensions of tablets. Elderly patients, children, some adult persons and patient with certain conditions suffer from dysphasia, so it becomes difficult for them to swallow tablet/capsule dosage forms. Also in case of dosage adjustments these floating solid dosage forms are needed to be available in different strengths. Where an environment specific gel forming solution, on conversion to gel, floats on the surface of the gastric fluids (due to less density than gastric contents). In this technique, a solution of low viscosity is used which on coming in contact with the gastric fluids, undergo change in polymeric conformation and a viscous gel of density lower than the gastric fluids is produced. This low density gel formation called as "raft" not only provide the much desired gastro retention to prolong the contact

time, but also produce the continuous and slow drug release.[12,13]

Various Approaches of GRDDS

A) Low-density systems (Floating drug delivery)
B) Expandable/Swellable systems
C) Bio/Muco-adhesive systems
D) High density systems
E) Raft forming systems

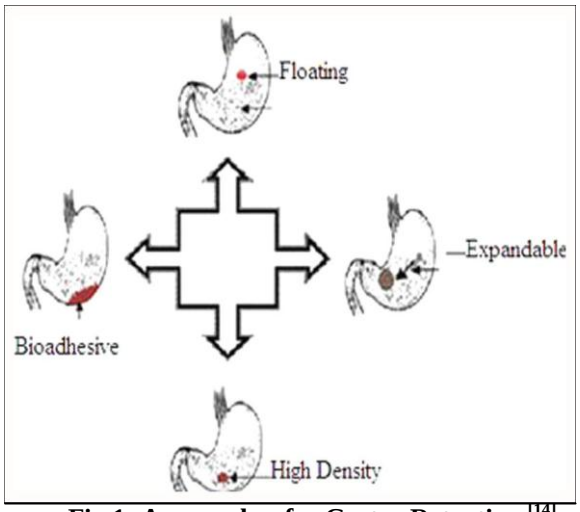

Fig 1: Approaches for Gastro Retention.[14]

A. Floating drug delivery systems (FDDS)

Floating drug delivery systems are also known as Hydrodynamically Balanced Systems FDDS is an effective technology to prolong the gastric residence time in order to improve the bioavailability of the drug. FDDS are low-density systems that have sufficient buoyancy to float over the gastric contents and remain in the stomach for a prolonged period.[15]

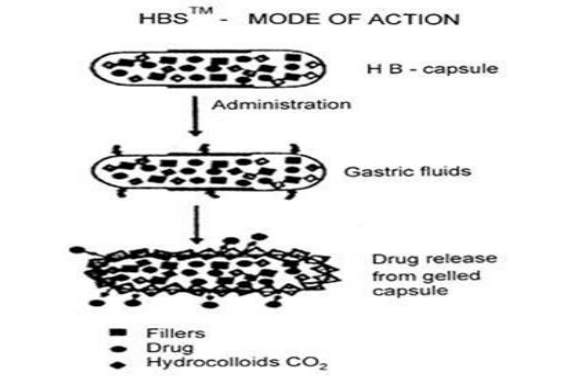

Fig 2: HBS Mode of Action.[16]

Floating drug delivery system (FDDS) have less density as compared to gastric contents so it will float over the gastric fluid due to this phenomena it will release drug without affecting gastric retention time.[17]

- By this way the desire plasma concentration is achieved and prolong the drug release.
- It has longer residential time so it improves oral bioavailability of drug.
- Drug that may be absorbed from the upper portion of stomach is suitable for thisdelivery system.

It has mainly two types of systems

- Effervescent system
- Non effervescent system

I) Effervescent systems

These buoyant delivery systems utilize matrices prepared with swellable polymers such as Methocel or polysaccharides, e.g., chitosan, and effervescent components, e.g., sodium bicarbonate and citric or tartaric acid or matrices containing chambers of liquid that gasify at body temperature. Gas can be introduced into the floating chamber by the volatilization of an organic solvent (e.g., ether or cyclo pentane) or by the carbon dioxide produced as a result of an effervescent reaction between organic acids and carbonate–bicarbonate salts. The matrices are fabricated so that upon arrival in the stomach, carbon dioxide is liberated by the acidity of the gastric contents and is entrapped in the gellified hydrocolloid. This produces an upward motion of the dosage form and maintains its buoyancy. Recently a multiple-unit type of floating pill, which generates carbon dioxide gas, has been developed.

II) Non effervescent systems

Non-effervescent floating drug delivery systems are normally prepared from gel-forming or highly swellable polysaccharides or matrix forming polymers like poly acrylate, polycarbonate, polystyrene and poly methacrylate. In one approach, intimate mixing of drug with a gel forming hydrocolloid which results in contact with gastric fluid after oral administration and maintain a relative integrity of shape and a bulk density less than unity within the gastric environment. The air trapped by the swollen polymer confers buoyancy to these dosage forms. Excipients used most commonly in these systems include hydroxyl propyl methyl cellulose (HPMC) poly acrylates, polyvinyl acetate, carbopol, sodium alginate, calcium chloride, polyethylene oxide and polycarbonates.[19]

Advantages of floating drug delivery systems

1. Floating dosage forms remains at the site for prolonged time.
2. FDDS are advantageous for drugs meant for local action in the stomach e.g. Antacids
3. Acidic substance like aspirin causes irritation on the stomach wall when come in contact with it hence; HBS/FDDS formulations may be useful for the administration of aspirin and other similar drugs.
4. The FDDS are advantageous for drugs absorbed through the stomach e.g. Ferrous salts, Antacids.
5. Controlled delivery of drugs: Minimizing the mucosal irritation due to drugs, by drug releasing slowly at controlled rate.

6. Treatment of gastrointestinal disorders such as gastro esophageal reflux.
7. Ease of administration and better patient compliance.
8. Site-specific drug delivery.

Disadvantages of floating drug delivery systems

1. Floating systems are not feasible for those drugs that have solubility or stability problems in gastric fluids.
2. These systems also require the presence of food to delay their gastric emptying.
3. Gastric retention is influenced by many factors such as gastric motility, pH and presence of food.
4. Drugs that cause irritation and lesion to gastric mucosa are not suitable to be formulated as floating drug delivery systems.
5. Floating systems require a sufficiently high level of fluids in the stomach, so that the drug dosages form float therein and work efficiently.
6. Gastric emptying of floating forms in supine subjects may occur at random and becomes highly dependent on the diameter and size. Therefore patients should not be dosed with floating forms just before going to bed.
7. Drugs such as Nifedipin, which is well absorbed along the entire GI tract and which undergo significant first-pass metabolism, may not be suitable candidates for FDDS.[18]

B. Swelling and expanding systems

These are the dosage forms, which after swallowing, swell to an extent that prevent their exit from the pylorus.[19] As a result, the dosage form is retained for a longer period of time. These systems, since they exhibit the tendency to remain longed at the pyloric sphincter. On coming in contact with gastric fluid, the polymer imbibes water and swells. The extensive swelling of these polymers is due to the presence of physical/chemical cross-links in the hydrophilic polymer network. These cross links prevent the dissolution of the polymer and hence maintain the physical integrity of the dosage form. A balance between the extent and duration of swelling is maintained by the degree of cross-linking between the polymeric chains. A high degree of cross-linking retards the swelling ability of the system maintaining its physical integrity for prolonged period. On the other hand, a low degree of cross-linking results in the extensive swelling of the system, succeeded by the rapid dissolution of the polymer.[20]

C. Bioadhesive drug delivery systems

Bioadhesive systems are those which bind to the gastric epithelial cell surface or mucin and serve as the potential means of extending the GRT of DDS in the stomach, by increasing the duration of contact of drug with the biological membrane. The concept is based on self-protecting mechanism of GIT. Mucus secreted continuously by the specialized goblet cells located throughout the GIT plays a cyto protective role. Bio adhesion is an interfacial phenomenon in which is biological, is held together by means of interfacial forces. The attachment could between an artificial material and biological substrate, such as adhesion between a polymer and a biological membrane. In the case of polymer attached to the mucin layer of a mucosal tissue, the term mucoadhesion is used. The mucosal layer lines a number of regions of the body including the GIT, the ear, nose and eye.[20]

D. High density systems

These dosage forms have a density(3g/ml) far exceeding that of normal stomach contents(1g/ml) and thus retained in rugae of the stomach and are capable of withstanding its peristaltic movements. The density of these systems should at least be 1.004 g/ml. This is accomplished by coating the drug with heavy inert materials such as barium sulphate, zinc oxide, titanium dioxide, iron powder etc.[21]

E. Raft forming systems

On contact with Gastric fluid a gel forming solution (e.g. sodium alginate solution containing carbonates or bicarbonates) swells and forms a viscous cohesive gel containing entrapped CO2 bubbles. This forms raft layer on top of gastric fluid which releases drug slowly in stomach. Such formulation typically contains antacids such as aluminium hydroxide or calcium carbonate to reduce gastric acidity. They are often used for gastro esophageal reflux treatment as with liquid Gaviscon.[22]

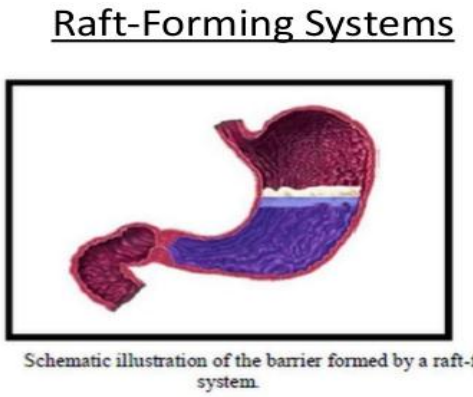

Fig 3: Raft Forming Systems.[23]

Mechanism of Floating In Situ Gel

When this system floats in the gastric region, drug releases slowly at a desired rate. Floating force (F) is required to keep the dosage form reliably buoyant on the surface of the meal. In order to measure the floating force, a novel apparatus is used for the determination of resultant weight. This apparatus operates by measuring continuously the force equivalent to 'F' (as a function of time) that is required to main submerged object. The dosage form floats better if 'F' is high. This apparatus helps in optimizing FDDS with respect to stability and durability of floating forces produced in order to prevent the drawbacks of unforeseeable intragastric buoyancy capability variations.[11]

$$F = F_{buoyancy} - F_{gravity} = (D_f - D_s)\, gv$$

Where, F= total vertical force, D_f = fluid density, D_s= object density, v= volume, g= acceleration due to gravity

Various Approaches of In-Situ Gelation

There are four broadly defined mechanisms used for triggering the in situ gel formation of biomaterials:

- Physiological stimuli (e.g., temperature and pH),
- Physical changes in biomaterials (e.g., solvent exchange and swelling),
- Chemical reactions (e.g., enzymatic, chemical and photo-initiated polymerization).[24]

In Situ Formation Based on Physiological Stimuli

Thermally triggered system

The system is designed to use Poloxamer as a vehicle for ophthalmic drug delivery using in-situ gel formation property. The gelation temperature of graft copolymers can be determined by measuring the temperature at which immobility of the meniscus in each solution was first noted. The bioadhesive and thermally gelling of these graft copolymers expected to be an excellent drug carrier for the prolonged delivery to surface of the stomach. Other example of Poloxamer-407 (a polyoxyethylene polyoxypropylene block copolymer) is a polymer with a solution viscosity that increases when its temperature is raised to the eye temperature,[25,26]

Ph-Triggered System

Polyacrlic acid (Carbopol 940) is used as the gelling agent in combination with hydroxy propyl-methylcellulose (Methocel E50LV) which acted as a viscosity enhancing agent. The formulation with pH-triggered in-situ gel is therapeutically efficacious, stable, non-irritant and provided sustained release of the drug for longer period of time than conventional eye drops. Another example cellulose acetate phthalate (CAP) is a polymer undergoing coagulation when the original pH of the solution (4.5) is raised to 7.4 by the tear fluid.[27,28,29]

In Situ Formation Based on Physical Mechanism

Swelling

In situ formation may also occur when material absorbs water from surrounding environment and expand to occur desired space. One such substance is myverol 18-99 (glycerol mono-oleate), which is polar 1400 lipid that swells in water to form lyotropic liquid crystalline phase structures. It has some Bioadhesive properties and can be degraded in vivo by enzymatic action.[30]

Diffusion

This method involves the diffusion of solvent from polymer solution into surrounding tissue and results in precipitation or solidification of polymer matrix. N-methyl-pyrrolidone (NMP) has been shown to be useful solvent for such system.[30]

In situ Formation Based on Chemical Reactions

Chemical reactions that results in situ gelation may involve precipitation of inorganic solids from supersaturated ionic solutions, enzymatic processes, and photo-initiated processes.[31]

Ionic Cross Linking

Polymers may undergo phase transition in presence of various ions. Some of the polysaccharides fall into the class of ion-sensitive ones. While carrageenan forms rigid, brittle gels in reply of small amount of K^+, carrageenan forms elastic gels mainly in the presence of $Ca2^+$. Gellan gum commercially available as Gelrite® is an anionic polysaccharide that undergoes in situ gelling in the presence of mono- and divalent cations, including $Ca2^+$, $Mg2^+$, K^+ and Na^+. Gelation of the low-methoxy pectins can be caused by divalent cations, especially $Ca2^+$. Likewise, alginic acid undergoes gelation in presence of divalent/polyvalent cations e.g. $Ca2^+$ due to the interaction with glucuronic acid block in alginate.[31]

Enzymatic Cross-Linking

In situ formation catalyzed by natural enzymes has not been investigated widely but seems to have some advantages over chemical and photochemical approaches. For example, an enzymatic process operates efficiently under physiologic conditions without need for potentially harmful chemicals such as monomers and initiators.[29] Intelligent stimuli-responsive delivery systems using hydrogels that can release insulin have been investigated. Cationic pH-sensitive polymers containing immobilized insulin and glucose oxidase can swell in response to blood glucose level releasing the entrapped insulin in a pulsatile fashion. Adjusting the amount of enzyme also provides a convenient mechanism for controlling the rate of gel formation, which allows the mixtures to be injected before gel formation.

Photo-Polymerization

Photo-polymerization is commonly used for in situ formation of biomaterials. A solution of monomers or reactive macromer and initiator can be injected into a tissues site and the application of electromagnetic radiation used to form gel. Acrylate or similar polymerizable functional groups are typically used as the polymerizable groups on the individual monomers and macromers because they rapidly undergo photo polymerization in the presence of suitable photo initiator. Typically long wavelength ultraviolet and visible wavelengths are used. Short wavelength ultraviolet is not used often because it has limited penetration of tissue and biologically harmful. A ketone, such as 2, 2-dimethoxy-2-phenyl acetophenone, is often used as the initiator for ultraviolet photo polymerization, whereas camphorquinone and ethyl eosin initiators are often used in visible light systems. The photo-reactions provide rapid polymerization rates at physiological temperature. Furthermore, the systems are easily placed in complex shaped volumes leading to an implant formation.

Polymers Frequently Used for In situ Gelling for Gastro Retentive Reasons

Sodium alginate[32,35]

Sodium alginate is a widely used polymer of natural origin. Chemically, it is alginic acid salt, consisting of –L-glucuronic acid and -D-mannuronic acid residues connected by 1,4-glycosidic linkages. Solution of alginates in water form firm gels in presence of di-or trivalent ions (e.g. calcium and magnesium ions). Alginate salts, specifically, sodium alginate is mostly used for preparation of gel forming solution, for delivery of the drugs and proteins. Alginate salts are considered most favourable because of biodegradable and non toxic nature, with additional bio-adhesive property.

Pectin

These are plant origin anionic polysaccharides isolated from the cell wall of most plants and basically consist of (1-4)-D-galacturonic acid residues. Pectin undergoes gel formation in presence of divalent ions (e.g.Ca^{+2}) which causes cross galacturonic acid units (ionic cross linking) in the presence of the H ions (pH dependent gelling).[36]

Gellan gum

Gellan gum (FDA approved) is secreted by the Sphingomonas elodea (Pseudomonas elodea) and chemically is anionic deacetylated polysaccharide with repeating tetra saccharide units composed of -D-glucuronic acid (1 unit), -L-rhamnose (1 unit) and -D-glucuronic acid (2 units) residues. Gellan gum undergoes gel formation due to change in temperature or due to presence of cations (e.g. Na, K ,Ca),[37,38,39]

Xyloglucan

It is a plant based polysaccharide obtained from seeds of tamarind. Chemically, this polysaccharide composed of a chain of (1-4)-D-glucan having (1-6)-D xylose units as branches which have partial (1-2)-D-galactoxylose substitution. Xyloglucan, itself, does not undergo gel formation but dilute solutions partly degraded by galactosidase exhibit gelling properties on heating (temperature dependent gel formation). Besides the use in oral drug delivery, it is also being used for ocular and rectal drug delivery. Xyloglucan has shown a very low gelation time of up to few minutes.[36]

Evaluation of In Situ Gelling System

Clarity

The clarity of formulated solutions can be determined by visual inspection under black and white background[40]

Viscosity

The viscosity and rheological properties of the polymeric formulations, either in solution or in gel made with artificial tissue fluid (depending upon the route of administrations) were determined with different viscometer.[25]

Sol-Gel Transition Temperature and Gelling Time

For in situ gel forming systems, the sol-gel transition temperature and pH should be determined. Gelling time is the time required for first detection of gelation of in situ gelling system.[25]

Gel-Strength

A specified amount of gel is prepared in a beaker, from the sol form. This gel containing beaker is raised at a certain rate, so pushing a probe of rheometer slowly through the gel. The changes in the load on the probe can be measured as a function of depth of immersion of the probe below the gel surface.[11]

Fourier Transform Infra-Red Spectroscopy (FTIR) and Thermal Analysis (TA)

Fourier transform infra-red spectroscopy is performed to study compatibility if ingredients. Differential scanning calorimetry is used to observe if there are any changes in thermograms as compared with the pure ingredients used thus indicating the interactions.[41]

In-Vitro Drug Release Studies

The drug release studies are carried out by using the plastic dialysis cell. The cell is made up of two half cells, donor compartment and a receptor compartment. Both half cells are separated with the help of cellulose membrane. The sol form of the formulation is placed in the donor compartment. The assembled cell is then shaken horizontally in an incubator. The total volume of the receptor solution can be removed at intervals and replaced with the fresh media. This receptor solution is analyzed for the drug release using analytical technique.

Determination of Drug Content

Accurately, 10 ml of in-situ gel from different batches (equivalent to 20 mg of drug) were measured and transferred to 100 ml of volumetric flask. To this 50-70 ml of 0.1 N HCl was added and sonicated for 30 min. Volume was adjusted to 100 ml. Complete dispersion of contents were ensured, visually and filtered using Whatman Filter Paper. From this solution, 10 ml of sample was withdrawn and diluted to 100 ml with 0.1 N HCl. Contents of drug was determined spectrophotometrically using double beam UV-Visible spectrophotometer.[18]

Ph Measurement

The pH was measured in each of the solution of sodium alginate based In situ solutions, using a calibrated digital pH meter at 27°C.[39]

In-Vitro Floating Ability

The in-vitro floating study was carried out using 900 ml of 0.1N HCl, (pH 1.2) .The medium temperature was kept at 37^0C. Ten milliliter formulation was introduced into the dissolution vessel containing medium without much disturbance. The time the formulation took to emerge on the medium surface (floating lag time) and the

time the formulation constantly floated on surface of the dissolution medium (duration of floating) were noted.[40]

Measurement of Water Uptake by the Gel

The water uptakes by the gel of the selected formulations of sodium alginate were determined by a simple method. In this study the in situ gel formed in 40 ml of 0.1 N HCl (pH 1.2) was used. From each formulation the gel portion from the 0.1 N HCl was separated and the excess HCl solution was blotted out with a tissue paper. The initial weight of the gel taken was weighed and to this gel 10 ml of distilled water was added and after every 30 minutes of the interval water was decanted and the weight of the gel was recorded and the difference in the weight was calculated and reported.[20]

Advantages of Floating In Situ Gel over other GRDDS

a. Improved floating property when compared to floating tablets.
b. Increase in bioavailability with reduction in dosage frequency.
c. Production cost is low.
d. Method of preparation is easy when compared to other FDDS.[11]

Limitations of Floating In Situ Gel Forming Gastro Retentive Drug Delivery System:

a. In situ gel forming systems are more susceptible to stability problems due to chemical degradation or microbial degradation.
b. Change in pH may lead to degradation.

Marketed Products[42]

Liquid Gaviscon - Al-hydroxide (95mg), Mg carbonate (385mg)
Topalkan - Al-Mg antacid
Conviron - Ferrous sulphate[43]

CONCLUSION

Dosages form with prolonged gastric retention and its compatibility with stomach physiology is the real challenge. So in order to achieve gastric retention various approaches have been done from several years. Out of which floating in situ drug delivery system is the most promising technique which undergo sol to gel transition in acidic medium of stomach and provide site specific release for longer duration of time by floating on the surface of gastric fluid, due to which its contact time with gastric mucosa is increased. This results in less frequent dosing and improves patient compliance. Finally, FDDSs will be used as carriers of drugs with the "absorption window". In situ gelling system becomes helpful as an alternative of oral solid dosage form with an advantage of liquid dosage form. Sustained release formulation can be prepared in liquid form using in situ gelling approach. Several biodegradable polymer are used for this formulation. In situ floating gel has a good biocompatibility, bioavailability ad stability. So, it becomes more reliable over conventional dosage form.

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