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A Review on Gastro Retentive Floating Tablets

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ABSTRACT

The development of a gastro-retentive floating drug delivery system (GRFDDS) is the focus of the current pharmaceutical situation. Over the past few decades, this system has attracted notable attention. These are the low-density systems that float on top of the stomach contents and stay afloat in the stomach for an extended amount of time without slowing down the rate at which the stomach empties. The purpose of GRFDDS is to prolong the period of delivery's residency in the stomach. Some floating drug-delivery systems (FDDS) have shown the capability to accommodate these variations without affecting drug release. The current review article explains the advantages, disadvantages, basic physiology, mechanism, polymers, Manufacturing procedures, factors, applications, and Evaluations of GRFDDS.

INTRODUCTION

Over the past 30 years, as the expense and complication involved in marketing new drug entities have increased, with concomitant recognition of the therapeutic advantages of controlled drug delivery, greater attention has focused on the development of sustained or controlled release drug delivery system. Several reasons for the attractiveness of the dosage form. It is recognized that for many diseased states, a substantial number of the therapeutic compound already exist. The effectiveness of this drug is limited by side effects of necessity to administer the compound in a clinical setting. The goal in designing sustained and controlled release is to reduce frequency of dosing or increase effectiveness of the drug by localization at site of action, reducing dose frequency, providing uniform drug delivery. The current controlled release technology had made it possible to release drugs at a constant release rate for longer periods of time ranging from days to years. However, this benefit had not satisfied a variety of important drugs that (i) are locally active in the stomach, (ii) have an absorption window in the stomach or in the upper small intestine, (iii) are unstable in the intestinal or colonic environment, or (iv) exhibit low solubilities at high pH values. These limits promoted the development of gastro-retentive drug delivery systems (GRDDS). Besides being able to continually and sustainably deliver drugs to the small intestinal absorption window, the improvements provided from GRDDS include: achieving a greater and prolonged therapeutic effect and thus reducing the frequency of administration periods, providing a more effective treatment of local stomach disorders, and minimizing both lower-tract inactivation of the drug and drug effects on the lower intestinal flora.

However, the development process is precluded by several physiological difficulties, such as an inability to restrain and localize the drug delivery system (DDS) within desired regions of the gastrointestinal (GIT) and the highly variable nature of the gastric emptying process. It can be anticipated that, depending upon the physiological state of the subject and the design of pharmaceutical formulation, the emptying process can last from a few minutes to 12 h. This variability, in turn, may lead to unpredictable bioavailability and times to achieve peak plasma levels, since the majority of drugs are preferentially absorbed in the upper part of the small intestine. Furthermore, the relatively brief GET (Gastric Emptying Time) in humans, which normally averages 2–3 h through the major absorption zone (stomach or upper part of the intestine), can result in incomplete drug release from the DDS leading to diminished efficacy of the administered dose. Thus, control of the placement of a DDS in a specific region of the GIT offers numerous advantages, especially for drugs

exhibiting an absorption window in the GIT or drugs with a stability problem. Overall, the intimate contact of the DDS with the absorbing membrane has the potential to maximize drug absorption and may also influence the rate of drug absorption. From the recent scientific and patent literatures that an increased interest in novel oral controlled release dosage forms that designed to be retained in the GIT for a prolonged and predictable period of time exists today Several approaches are currently utilized in the prolongation of the gastric residence times (GRT), including floating drug delivery systems (FDDS), low-density systems, raft systems incorporating alginate gels, bio adhesive or mucoadhesive systems, high-density systems, super porous hydrogels and magnetic systems. The FDDS is one of the most leading methodologies in gastroretentive drug formulations.

FLOATING DRUG DELIVERY SYSTEM(FDDS)

Floating drug delivery systems (FDDS) or hydro dynamically controlled systems are low-density systems that have sufficient buoyancy to float over the gastric contents and remain buoyant in the stomach without affecting the gastric emptying rate for a prolonged period. While the system is floating on the gastric contents, the drug is released slowly at the desired rate from the system. After release of drug, the residual system is emptied from the stomach. This results in an increased GRT and a better control of the fluctuations in plasma drug concentration. However, besides the minimal gastric content needed to allow the proper achievement of the buoyancy retention principle, a minimal level of floating force (F) is also required to keep the dosage form reliably buoyant on the surface of the meal. Many buoyant systems have been developed based on granules, powders, capsules, tablets, laminated films and hollow microspheres.

BASIC GIT PHYSIOLOGY: GASTRIC EMPTYING

The stomach is anatomically divided into three parts as shown in (fig-1.1).

- Fundus
- Body
- Antrum(pylorus)

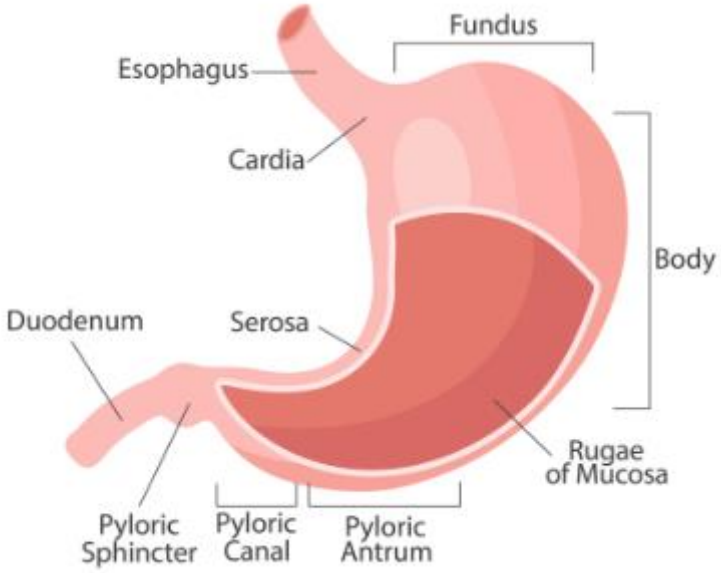

Fig 1.1: Anatomy of stomach

The proximal stomach, made up of the fundus and the body regions, serves as a reservoir for ingested materials while the distal regions (antrum) is the major site of mixing motions, acting as a pump to accomplish gastric emptying. Gastric emptying occurs during fasting as well as fed states. The pattern of motility is distinct in two steps. During the fasting state, an inter-digestive series of electric events takes place, which cycle both through the stomach and intestine every 2-3 hours. This is called as inter-digestive myoelectric cycle or migrating myoelectric cycle (mmc), which is further divided into 4 phases. (Fig 1.2)

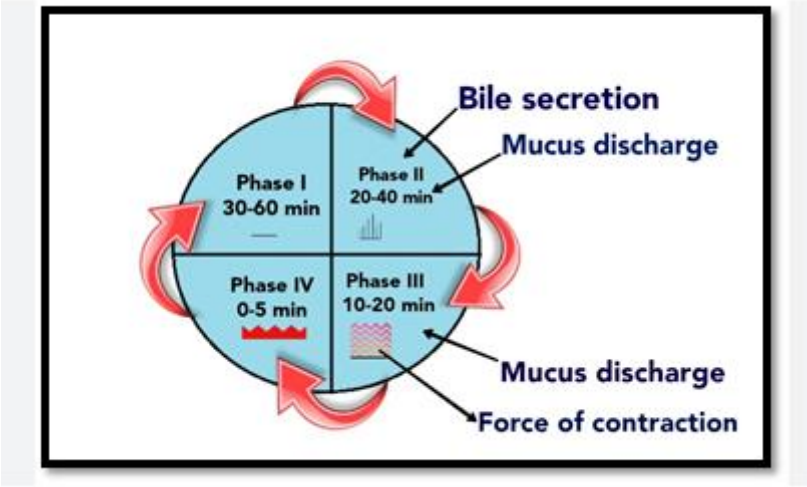

Fig-1.2 Motility pattern of GIT in fasted state

1. PHASE-I: (basal phase) lasts from 30-60min with rare contractions.

2. PHASE-II: (pre-burst phase) lasts for 20-40min with the intermittent action potential and contractions as the phase progresses, the intensity and the frequency also increase gradually.

3. PHASE-III: (burst phase) lasts for 10-20min it includes intense and regular contractions for short period. It is due to this wave that all the undigested material is swept out of the stomach to small intestine.

4. PHASE-IV: lasts for 0-5 min and occurs between phase 3 and 1 of two consecutive cycles.

Table 1.1 Gastrointestinal dimensions

Region	Surface area m^2	Length M	Transit time	
			Fluid	Digestible solid
GI tract	200	-	-	-
Stomach	0.1-0.2	-	50min	8h
Small intestine	100	3.0	2-6 h	4-9 h
Large intestine	0.5-1.0	1.5	2-6 h	2 h-3 days

ADVANTAGES

- The principle of HBS can be used for any medicament or class of medicament.
- The HBS formulations are not restricted to medicaments, which are principally absorbed from the stomach. Since it has been found that these are equally efficacious with medicaments which are absorbed from the intestine.
- The HBS are advantageous for drugs absorbed through the stomach e.g. ferrous salts and for drugs meant for local action in the stomach and treatment of peptic ulcer disease.
- The efficacy of the medicaments administered utilizing the sustained release principle of HBS has been found to be independent of the site of absorption of the medicaments.
- When there is vigorous intestinal movement and a short transit time as might occur in certain types of diarrhoea, poor absorption is expected under such circumstances it may be

advantageous to keep the drug in a floating condition in stomach to get a relatively better response.

- Gastric retention will provide advantages such as the delivery of drugs with narrow absorption windows in the small intestinal region.

- Many drugs categorized as once-a-day delivery have been demonstrated to have suboptimal absorption due to dependence on the transit time of the dosage form, making traditional extended-release development challenging. Therefore, a system designed for longer gastric retention will extend the time within which drug absorption can occur in the small intestine.

DISADVANTAGES

- They are not suitable candidates for drugs with stability or solubility problems in stomach.

- FDDS requires sufficiently high level of fluid in the stomach so that the system can float and thus enough water (200-250 ml) of water to be taken together with FDDS.

- Drugs having irritant effects on gastric mucosa are not suitable candidates for FDDS.

- Drugs which are absorbed along the entire GIT and which undergo first pass metabolism may not be desired e.g. Nifedipine.

MECHANISM OF FLOATING SYSTEMS:

Various attempts have been made to retain the dosage form in the stomach as a way of increasing the retention time. These attempts include introducing floating dosage forms (gas-generating systems and swelling or expanding systems), mucoadhesive systems, high-density systems, modified shape systems, gastric-emptying delaying devices and co-administration of gastric-emptying delaying drugs. Among these, the floating dosage forms are the most used. FDDS have a bulk density less than gastric fluids and so remain buoyant in the stomach without affecting the gastric emptying rate for a prolonged period. While the system is floating on the gastric contents, the drug is released slowly at the desired rate from the system. After release of drug, the residual system is eliminated from the stomach. This results in an increased GRT and a better control of the fluctuations in plasma drug concentration. However, besides a minimal gastric content needed to allow the proper achievement of the

buoyancy retention effect, a minimal level of floating force (F) is also required to maintain the buoyancy of the dosage form on the surface of the meal. To measure the floating force kinetics, a novel apparatus for determination of resultant weight has been reported in the literature. The apparatus operates by measuring continuously the force equivalent to F (as a function of time) that is required to maintain a submerged object. The object floats better if F is on the higher positive side. This apparatus helps in optimizing FDDS with respect to stability and sustainability of floating forces produced to prevent any unforeseeable variations in intra-gastric buoyancy.

$$F = F_{buoyancy} - F_{gravity} = (Df - Ds)\, g\, v$$

Where, F = total vertical force,

Df = fluid density,

Ds = object density,

v = volume and

g = acceleration due to gravity.

Based on the buoyancy mechanism, FDDS can be classified into: (A) single unit floating dosage systems; (B) multiple unit floating dosage systems; (C) raft forming systems.

APPROACHES TO GASTRIC RETENTION:

Several approaches have been used to increase the GRT of a dosage form in stomach by employing a variety of concepts. These include –

Approaches to Gastric Retention

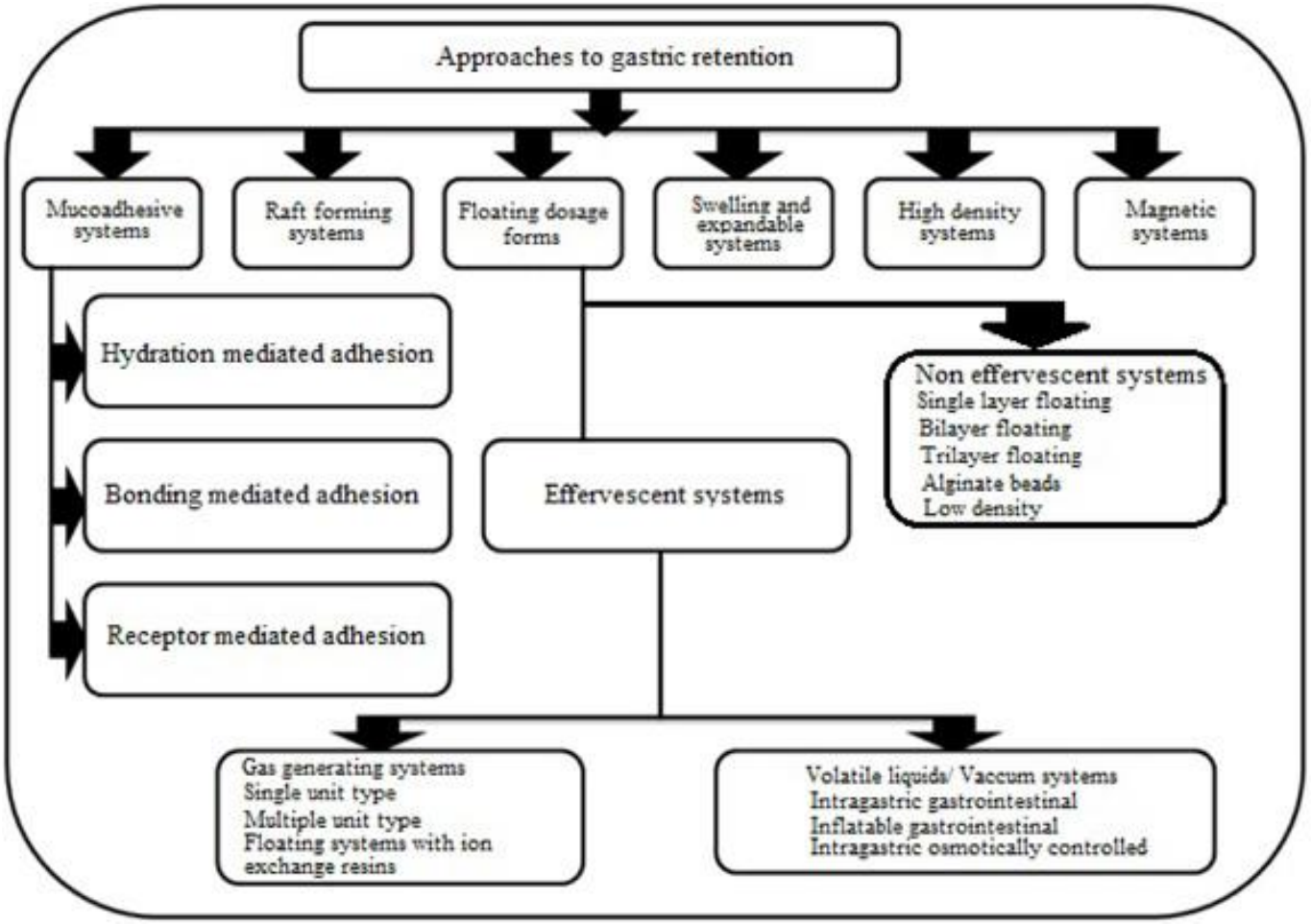

Fig 1.3: Schematic representation of various gastro retentive formulations

a) Floating Systems:

Floating Drug Delivery Systems (FDDS) have a bulk density lower than gastric fluids and thus remain buoyant in the stomach for a prolonged period, without affecting the gastric emptying rate. While the system is floating on the gastric contents, the drug is released slowly at a desired rate from the system. After the release of the drug, the residual system is emptied from the stomach. This results in an increase in the GRT and a better control of fluctuations in the plasma drug concentrations. Floating systems can be classified into two distinct categories, effervescent and effervescent systems.

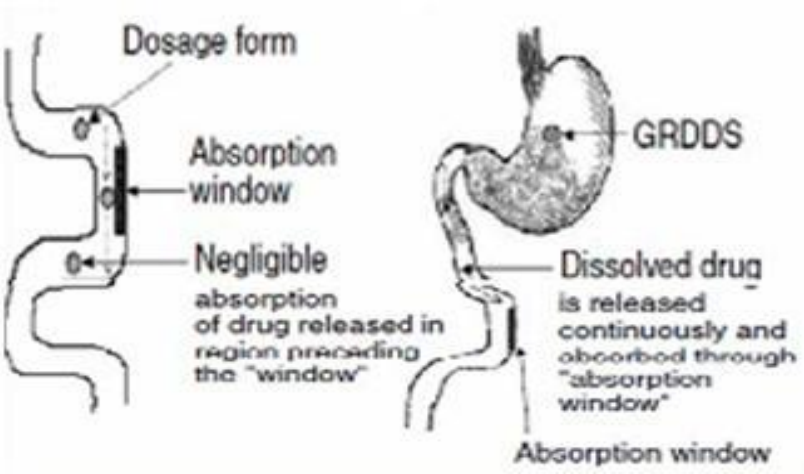

Fig 1.4: Drug absorption in the case of (a) Conventional dosage forms (b) GRDDS

i) Effervescent systems

Effervescent floating drug delivery systems generate gas (CO2), thus reduce the density of the system, and remain buoyant in the stomach for a prolonged period and release the drug slowly at a desired rate. The main ingredients of effervescent system include swellable polymers like chitosan, methyl cellulose and effervescent compounds such as citric acid, sodium bicarbonate, citric acid, and tartaric acid.

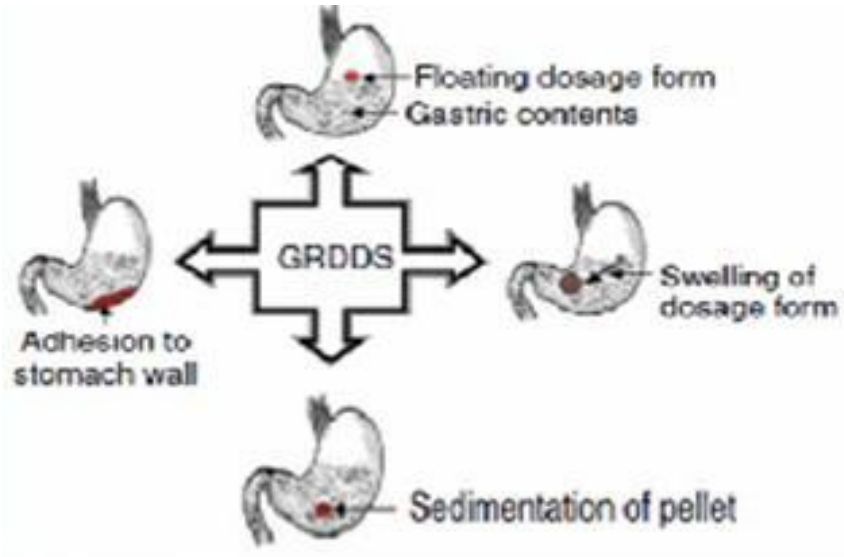

Fig 1.5: Classification of Gastro retentive Drug Delivery System

ii) Non-effervescent systems

This type of system, after swallowing, swells unrestrained via imbibition's of gastric fluid to an extent that it prevents their exit from the stomach. These systems may be referred to as the „plug-type systems" since they tend to remain lodged near the pyloric sphincter. One of the formulation methods of such dosage forms involves the mixing of drug with a gel, which swells in contact with gastric fluid after oral administration and maintains a relative integrity of shape and a bulk density of less than one within the outer gelatinous barrier. The air trapped by the swollen polymer confers buoyancy to these dosage forms. Examples of this type of FDDS include colloidal gel barrier, micro porous compartment system, alginate beads, and hollow Microspheres. Another type is a Fluid- filled floating chamber which includes incorporation of a gas-filled floatation chamber into a micro porous component that houses a drug reservoir. Apertures or openings are present along the top and bottom walls through which the gastrointestinal tract fluid enters to dissolve the drug. The other two walls in contact with the fluid are sealed so that the undissolved drug remains therein. The fluid present could be air, under partial vacuum or any other suitable gas, liquid, or solid having an appropriate specific gravity and an inert behavior. The device is of swallow able size, remains a float within the stomach for a prolonged time, and after the complete release the shell disintegrates, passes off to the intestine, and is eliminated.

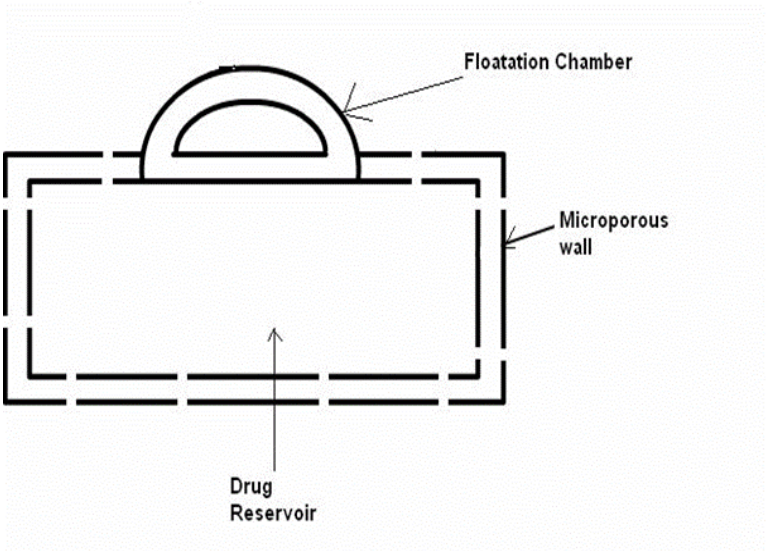

Fig 1.6: Gas filled floatation chamber a. Single Layer Floating Tablets

They are formulated by intimate mixing of drug with a gel-forming hydrocolloid, which swells in contact with gastric fluid and maintain bulk density of less than unity. The air trapped by the swollen polymer confers buoyancy to these dosage forms.

b) Bilayer Floating Tablets:

A bilayer tablet contains two-layer one immediate release layer which releases initial dose from system while another sustained release layer absorbs gastric fluid, forming an impermeable colloidal gel barrier on its surface, and maintain a bulk density of less than unity and thereby it remains buoyant in the stomach.

c) Alginate Beads:

Multi-unit floating dosage forms were developed from freeze-dried calcium alginate. Spherical beads of approximately 2.5 mm diameter can be prepared by dropping a sodium alginate solution into an aqueous solution of calcium chloride, causing precipitation of calcium alginate leading to formation of porous system, which can maintain a floating force for over 12 h. When compared with solid beads, which gave a short residence, time of 1 h, and these floating beads gave a prolonged residence time of more than 5.5 hours.

d) Hollow Microspheres:

Hollow microspheres (micro balloons), loaded with drug in their outer polymer shells were prepared by a novel emulsion-solvent diffusion method. The ethanol: dichloromethane solution of the drug and an enteric acrylic polymer was poured into an agitated aqueous solution of PVA that was thermally controlled at 40℃. The gas phase generated in dispersed polymer droplet by evaporation of dichloromethane formed an internal cavity in the microsphere of polymer with drug. The micro balloons floated continuously over the surface of acidic dissolution media containing surfactant for more than 12 h in vitro.

ii) Bio Mucoadhesive systems

Bio adhesive drug delivery systems (BDDS) are used as a delivery device within the lumen to enhance drug absorption in a site-specific manner. This approach involves the use of bio-adhesive polymers, which can adhere to the epithelial surface in the stomach. Gastric Mucoadhesion does not tend to be strong enough to impart to dosage forms the ability to resist the strong propulsion forces of the stomach wall. The continuous production of mucous by the gastric mucosa to replace the mucous that is lost through peristaltic contractions and

the dilution of the stomach content also seem to limit the potential of mucoadhesion as a gastroretentive force. Some of the most promising excipients that have been used commonly in these systems include Carbopol, lectins, chitosan, and etc.

a) Hydration-mediated adhesion:

Certain hydrophilic polymers tend to imbibe large amounts of water and become sticky, thereby acquiring bio-adhesive properties.

b) Bonding-mediated adhesion:

The adhesion of polymers to a mucus or epithelial cell surface involves various bonding mechanisms, including physical-mechanical bonding and chemical bonding. Physical-mechanical bonds can result from the insertion of the adhesive material into the crevices or folds of the mucosa. Chemical bonds may be either covalent (primary) or ionic (secondary) in nature. Secondary chemical bonds consist of dispersive interactions (i.e., Vander Waals interactions) and stronger specific interactions such as hydrogen bonds. The hydrophilic functional groups responsible for forming hydrogen bonds are the hydroxyl and carboxylic groups.

iii) Receptor-mediated adhesion:

Certain polymers can bind to specific receptor sites on the surface of cells, thereby enhancing the gastric retention of dosage forms. Certain plant lectins such as tomato lectins interact specifically with the sugar groups present in mucus or on the glycocalyx.

iv) Swelling/ Expanding Systems:

This is a class of gastroretentive systems capable of expanding in stomach. The expanded structure is trapped in stomach for prolonged period leading to sustained drug release and subsequent controlled absorption in stomach and intestine. These systems are administered per-orally in the form of capsule bearing the dosage form in a folded and compact configuration. When exposed to gastric environment capsule shell breaks and the dosage form attains its expanded structure, which is retained in stomach for longer time. Advantages of these systems include easy formulation, simple in operation and reproducible results; however, they suffer from serious drawback like clogging of pylorus end of stomach.

v) Super porous hydrogel systems

These swellable systems differ sufficiently from the conventional types to warrant separate classification. In this approach, to improve gastric retention time (GRT) super porous hydrogels of average pore size >100 micro miter, swell to equilibrium size within a minute due to rapid water uptake by capillary wetting through numerous interconnected open pores. They swell to a large size (swelling ratio: 100 or more) and are intended to have sufficient mechanical strength to withstand pressure by gastric contraction. This is advised by co-formulation of hydrophilic particulate material.

vi) Magnetic Systems

This approach to enhance the gastric retention time (GRT) is based on the simple principle that the dosage form contains a small internal magnet and a magnet placed on the abdomen over the position of the stomach. Although magnetic system seems to work, the external magnet must be positioned with a degree of precision that might compromise patient compliance.

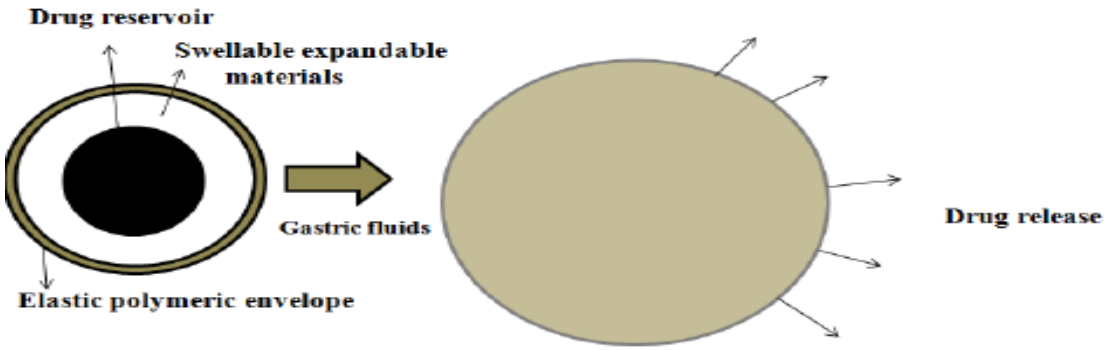

Fig 1.7: Drug release from swellable systems

vii) High-density systems:

Basically, gastric contents have a density close to water (¨1.004 g cm-3). When the patient is upright small high-density pellets sink to the bottom of the stomach, where they become entrapped in the folds of the antrum and withstand the peristaltic waves of the stomach wall. A density close to 2.5 g cm-3 seems necessary for significant prolongation of gastric residence time and barium sulphate, zinc oxide, iron powder, and titanium dioxide are used as excipients. Although encouraging results were reported in ruminants, effectiveness in human beings was not observed and no system has been marketed.

viii) Raft systems:

Raft-forming systems have received much attention for the delivery of antacids and drug delivery for gastrointestinal infections and other disorders. The mechanism involved in the raft formation includes the formation of a viscous cohesive gel in contact with gastric fluids, wherein each portion of the liquid swells forming a continuous layer called a raft. This raft floats on gastric fluid because of the low bulk density created by the formation of CO2. Usually, the system contains a gel-forming agent and alkaline bicarbonates or carbonates responsible for the formation of CO2 to make the system less dense and able to float on the gastric fluids.

CRITERIA FOR SELECTION OF DRUGS20

Certain types of drugs only benefit for gastro retentive devices. These include:

- Drugs acting locally in the stomach.
- Exhibit site-specific absorption.
- It must have sufficient structure to form a cohesive gel barrier.
- It must maintain an overall specific gravity less than that of gastric content.
- It should dissolve slowly enough to serve as a “Reservoir” for the delivery system.

FACTORS AFFECTING GASTRIC RETENTION

Various attempts have been made to retain the dosage forms in the stomach as a way of increasing the retention time. The various factors which influence the efficacy of GRDF`s as a gastro-retentive system are:

Density: GRT is a function of dosage form buoyancy that is dependent on the density.

Size: Dosage form units with a diameter of more than 7.5 mm are reported to have an increased GRT compared with those with a diameter of 9.9 mm.

Shape of dosage form: Tetrahedron and ring-shaped devices with a flexural modulus of 48 and 22.5-kilo pounds per square inch (KSI) are reported to have better GRT = 90% to100% retention at 24 h compared with other shapes.

Single and multiple unit formulations: Multiple unit formulations show a more predictable

release profile and insignificant impairing of performance due to failure of units, allow co-administration of units with different release profiles or containing incompatible substances and permit a larger margin of safety against dosage form failure compared with single unit dosage forms.

Fed or unfed state: Under fasting conditions, the GI motility is characterized by periods of strong motor activity MMC that occurs every 1.5 to 2 h. The MMC sweeps undigested material from the stomach and, if the timing of administration of the formulation coincides with that of the MMC, the GRT of the unit can be expected to be very short. However, in the fed state, MMC is delayed and GRT is considerably longer.

Nature of meal: Feeding of indigestible polymers or fatty acid salts can change the motility pattern of the stomach to a fed state, thus decreasing the gastric emptying rate and prolonging drug release.

Caloric content of meal: GRT can be increased by 4 to 10 h with a meal that is high in proteins and fats.

Frequency of feed: The GRT can be increased by over 400 min when successive meals are given compared with a single meal due to the low frequency of MMC.

Gender: Mean ambulatory GRT in males (3.4 ± 0.6 h) is less compared with their age and race matched female counter parts (4.6 ± 1.2 h) regardless of the weight, height, and body surface.

Age: Elderly people, especially those above 70 years, have a significantly longer GRT.

Posture: GRT can vary between supine and upright ambulatory states of the patient.

Concomitant drug administration: Drugs that are gastric emptying include poorly soluble antacids (aluminium hydroxide), anticholinergics (atropine, propantheline), narcotic analgesics (morphine) and tricyclic anti-depressants (imipramine, amitriptyline.

Biological factors: Diseases like gastroenteritis, gastric ulcer, pyloric stenosis, diabetes, and hypothyroidism retard gastric emptying. Partial or total gastrectomy, duodenal ulcer and hypothyroidism promote gastric emptying rate.

APPLICATION OF FLOATING DRUG DELIEVERY SYSTEM:

a. Enhanced bioavailability:

The bioavailability of riboflavin CRGRDF is significantly enhanced in comparison to the administration of non CRGRDF polymeric formulations. There are several different processes, related to absorption and transit of the drug in the gastrointestinal tract, that act concomitantly to influence the magnitude of drug absorption.

b. Sustained drug delivery:

Oral CR formulations are encountered with problems such as gastric residence time in the GIT. These problems can be overcome with the HBS systems which can remain in the stomach for long periods and have a bulk density <1 because of which they can float on the gastric contents. These systems are relatively larger in size and passing from the pyloric opening is prohibited.

c. Site–specific drug delivery systems:

These systems are particularly advantageous for drugs that are specifically absorbed from the stomach or the proximal part of the small intestine. The controlled, slow delivery of drug to the stomach provides sufficient local therapeutic levels and limits the systemic exposure to the drug. This reduces side effects that are caused by the drug in the blood circulation. In addition, the prolonged gastric availability from a site-directed delivery system may also reduce the dosing frequency.eg: Furosemide and Riboflavin.

d. Absorption enhancement:

Drugs which are having poor bioavailability because of site-specific absorption from the upper part of the GIT are potential candidates to be formulated as floating drug delivery systems, there by maximizing their absorption.

e. Minimized adverse activity at the colon:

Retention of the drug in the HBS systems at the stomach minimizes the amount of drug that reaches the colon. Thus, undesirable activities of the drug in colon may be prevented. This pharmacodynamic aspect provides the rationale for GRDF formulation for beta lactam antibiotics that are absorbed only from the small intestine, and whose presence in the colon leads to the development of microorganism resistance.

f. Reduced fluctuations of drug concentration:

Continuous input of the drug following CRGRDF administration produces blood drug concentrations within a narrower range compared to the immediate release dosage forms. Thus, fluctuations in drug effects are minimized and concentration-dependent adverse effects that are associated with peak concentrations can be prevented. This feature is of special importance for drugs with a narrow therapeutic index.

Evaluation parameters:

Angle of Repose

Angle of repose was determined by using funnel method. The blend was poured through a funnel that can be raised vertically until a maximum cone height (h) was obtained. Radius of the heap (r) was measured and the angle of repose was calculated using the formula.

$$\emptyset = \tan^{-1}\frac{h}{r}$$

Where, θ is the angle of repose, h is height of pile; r is radius of the base of pile.

Angle of Repose (ɵ) properties

Angle of Repose (ɵ)	Flow
<25	Excellent
25-30	Good
30-40	Passable

Bulk Density

Apparent bulk density (ρb) was determined by pouring the blend into a graduated cylinder. The bulk volume (*Vb*) and weight of powder (*M*) were determined. The bulk density was calculated using the formula.

$$\rho b = \frac{m}{Vd}$$

Tapped Density

The measuring cylinder containing a known mass of blend was tapped for a fixed time. The minimum volume (*Vt*) occupied in the cylinder and weight (M) of the blend was measured.

The tapped density (*ρb*) was calculated using the following formula.

$$pt = \frac{m}{Vt}$$

Carr's compressibility index

The simplest way of measuring of free flow of powder is compressibility, an indication of the ease with which a material can be induced to flow is given by compressibility. The compressibility index of the granules was determined by Carr's compressibility index, which is calculated by using the following formula

$$I = \frac{Vo - Vt}{Vo} \times 100$$

% Compressibility properties

% Compressibility	**Flow ability**
5 – 12	Excellent
12 – 16	Good
18 – 21	Fair Passable
23 – 35	Poor
33 – 38	Very Poor
< 40	Very Very Poor

Hausner ratio

Hausner ratio is an indirect index of ease of powder flow. It is calculated by the following formula

$$\text{Haunser ratio} = \frac{pt}{pd}$$

Where ρt is tapped density and ρd is bulk density. A lower Hausner ratio (< 1.25) indicates better flow properties than higher ones (>1.25).

Post-compression evaluation parameters for formulated tablets

a. Weight variation

Twenty tablets from each formulation were selected at random and average weight was

determined. Then the individual tablets were weighed and compared with average weight.

b. Hardness

The hardness of the tablet from each formulation was determined using Pfizer hardness tester.

c. Friability

The stability of the tablets was determined using Roche Friabilator. This device subjects the tablets to the combined effect of abrasion and shock in a plastic chamber revolving at 25 rpm and dropping the tablets at a height of 6 inches in each revolution. Pre weighed sample of tablets was placed in the friabilator and were subjected to 100 revolutions. Tablets were dedusted using a soft muslin cloth and reweighed. The friability (f) is given by the formula.

$$\textbf{Friability (f)} = \left(1 - \frac{W_0}{W}\right) \times 100$$

Where, W_0 is weight of the tablets before the test and W is the weight of the tablet after the test.

d. Thickness and diameter

The thickness and diameter of tablet was carried out using Digital caliper. Five tablets were used for the above test from each batch and results were expressed in millimeter.

Conclusion:

Drug absorption in the GIT is a highly variable procedure and prolonging gastric retention of the dosage form extends the time for drug absorption. Floating dosage forms promises to be a potential approach for gastric retention. These systems consisting of swelling and expanding systems, floating, and inflating systems and bio adhesive systems are also useful for drugs, which are poorly soluble or unstable in intestinal fluids. The floating properties of these systems help in retaining these systems in the stomach for a long time. This review summarizes the various attempts, which have been made to develop a floating system, in vitro and in vivo evaluation studies and application of floating dosage forms.

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