GASTRORETENTIVE FLOATING BEADS: A TARGETED APPROACH FOR GASTRIC ULCER TREATMENT

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ABSTRACT:

According to recent scientific and patent literature, there is a growing interest in innovative dosage forms that stay in the stomach for a lengthy and consistent amount of time. In order to address physiological differences, such as short stomach residence times and unexpected gastric emptying times employing gastro retentive drug delivery systems, numerous technological initiatives have been made in the study and development of rate-controlled oral drug delivery systems. Floating dosage forms can be made in a variety of ways, including tablets and capsules, by combining the right ingredients and a gas-generating agent.It is anticipated that floating beads may improve pharmacotherapy. Floating drug livery systems, swelling and expanding systems, polymeric bioadhesive systems, high-density systems, modified-shape systems, and other delayed gastric emptying devices are some of the methods now used to extend the GRT. Floating dose formulations are starting to show promise. When a medicine has a limited window for absorption in a specific area of the gastrointestinal tract, gastro-retentive delivery systems can be kept in the stomach to help improve absorption and bioavailability. This paper discusses current and recent advancements in stomach-specific floating medicine delivery systems for gastro retention as well as a variety of floating dosage form approaches.

KEYWORDS:

Gastroretentive drug delivery, Floating beads, Gastric ulcer therap, Polymeric multiparticulate systems, Controlled drug release.

INTRODUCTION:

Dosage forms that stay in the stomach longer than traditional dosage forms benefit greatly from the capacity to extend and regulate the

emptying time, as gastric emptying is a highly variable process. Designing controlled release systems for improved absorption and increased bioavailability presents a number of challenges. The difficulty to limit the dose form in the intended gastrointestinal tract region is one of these challenges. The process of absorbing drugs from the gastrointestinal tract is complicated and dependent on numerous factors. It is commonly known that the duration of contact with the small intestinal mucosa determines the degree of gastrointestinal tract medication absorption.[1]For medications that are not fully absorbed, small intestinal transit time is a crucial factor. A summary of basic human physiology is provided, including information on gastric emptying, motility patterns, and physiological and formulation factors influencing stomach emptying. Drugs' gastric residence time can be further extended by gastroretentive mechanisms, which can stay in the stomach area for several hours. Long-term stomach retention increases bioavailability, decreases drug waste, and increases the solubility of medications that are less soluble in high pH environments. Additionally, it can be used to deliver drugs locally to the stomach a nd proximal small intestines.Gastro retention contributes to improved accessibility to novel drugs with novel therapeutic potential and significant patient benefits. The mechanisms of mucoadhesion, [2,3]flotation, [4]sedimentation,[5,6] expansion, [7,8]changed shape systems,[9,10] or the concurrent administration of pharmacological drugs[11,12] that postpone gastric emptying can all be used to manage the gastric retention of solid dosage forms.These methods have led to a detailed description of the classification of floating drug delivery systems (FDDS).Scientists have talked about evaluating FDDS in vivo and in vitro to determine the effectiveness and use of such systems.The effectiveness of such systems for medications with bioavailability issues has been demonstrated in a number of recent examples.

BASIC PHYSIOLOGY OF GASTROINTESTINAL TRACT:

The stomach is separated into three anatomical regions: The antrum is the primary location for mixing motions and serves as a pump for stomach emptying by pushing actions, while the proximal part forms the fundus and body acts as a reservoir for undigested materials.[13]Both when fasting and when eating, the stomach empties. Nonetheless, the motility patent is unique in two states. Interdigestive electrical events occur during a fast, cycling through the colon and stomach every two to three hours. According to Wilson and Washington (1989), this is known as the interdigestive myoelectric cycle or migrating myloelectric cycle (MMC), which is further separated into the following four phases.[14]

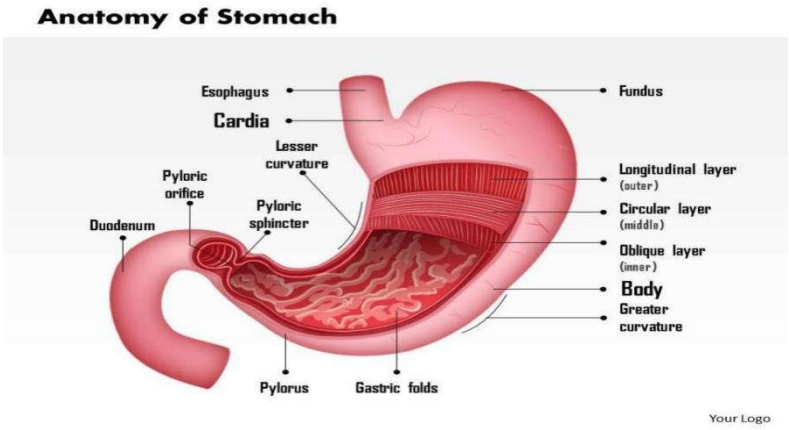

Figure No:1

APPROACHES TO DESIGN FLOATING DOSAGE FORMS:

Single unit dosage form:

Globular shells that appear to have a lower density than stomach fluid can be utilized as a medication carrier for controlled release in the low-density technique. A fluid-filled device that floats in the stomach can also be used to produce a buoyant dose form.[15]Popcorn, poprice, and polystyrol have all been used as drug transporters in coated shells. These shells have been undercoated with sugar polymeric materials such cellulose acetate phthalate and methacrylic polymer. A drug-polymer mixture is applied on top of these. Depending on the intended release type, ethylcellulose or hydroxypropyl cellulose may be the preferred polymer. Ultimately, the product releases the medication gradually over an extended period of time while floating on the gastric juice.[16]A gas-filled floatation chamber is incorporated into a microporous component that contains a drug reservoir in fluid-filled floating chamber dosage forms. The top and bottom walls have holes or apertures that allow gastrointestinal tract fluid to pass through and dissolve the medication. To keep the medicine from dissolving, the other two walls that come into contact with the liquid are sealed. Air, a partial vacuum, or any other suitable gas, liquid, or solid with the right specific gravity and inert behavior could be the fluid present. The gadget is small enough to be swallowed, stays afloat in the stomach for a considerable amount of time, and, upon full release, the shell breaks down, travels to the colon, and is expelled.The purpose of hydrodynamically balanced systems (HBS) is to increase absorption and extend the duration of the dosage form in the gastrointestinal tract. These systems work best for medications that are more soluble in acidic environments and that have a specific location of absorption in the upper portion of the small intestine. The dose form

needs to have a bulk density of less than 1 in order to stay in the stomach for an extended amount of time. It should remain in the stomach, retain its structural integrity, and continuously release the medication from the dose form. Chlordiazeopoxide hydrochloride is the best example of how HBS capsules have shown to be an effective approach.The medication is a classic example of a solubility issue, showing a 4000-fold change in solubility between pH 3 and pH 6 (the solubility of chlordiazepoxide hydrochloride is 150 mg/mL and is ~0.1 mg/mL at neutral pH).[17]The blood level time profile of three commercial 10-mg pills and HBS of chlordiazeopoxide hydrochloride were similar. HBS can be prepared as a capsule or a floating tablet. To produce floatable tablets, a variety of polymers and polymer combinations using wet granulation as a manufacturing process have been investigated. It has been demonstrated that a variety of tablet varieties, including bilayered and matrix tablets, exhibit floatable properties. Hydroxypropyl cellulose, hydroxypropyl methylcellulose, crosspovidone, sodium carboxymethyl cellulose, and ethyl cellulose are a few of the polymers utilized. A disproportionate three-layer matrix technology is used in the self-correcting floatable asymmetric configuration drug delivery system to regulate drug release.[18]By initially maintaining a constant area at the diffusing front with subsequent dissolution/erosion towards the completion of the release process, an asymmetric configuration drug delivery system has been developed to improve the 3-layer principle and achieve zero-order release kinetics. In order to extend the gastric residence time in vivo, the system was built to float. This resulted in a longer overall transit time within the gastrointestinal tract environment with maximal absorptive capacity and, as a result, improved bioavailability. This specific feature would apply to medications that are absorbed by active transport from either the proximal or distal region of the small intestine, have a narrow window of absorption, and have pH-dependent solubility.Single-unit formulations are linked to issues including adhering to one another or becoming blocked in the digestive system, which could potentially cause irritation.

Multiple-Unit Dosage Forms:

Creating a dependable formulation with all the benefits of a single-unit form and none of the aforementioned drawbacks of single-unit formulations is the goal of inventing multiple-unit dosage forms. Numerous multiple-unit floatable dose forms have been created in an effort to achieve this goal. Numerous polymers, including albumin, gelatin, starch, polymethacrylate, polyacrylamine, and polyalkylcyanoacrylate, have been utilized in microspheres due to their high loading capacity. "Microballoons," or spherical polymeric microsponges, have been created. Microspheres have outstanding in vitro

floatability and a distinctive interior hollow structure.[19]Recent patent literature has documented a number of devices with characteristics that extend, unfold, or are inflated by carbon dioxide generated in the devices following administration in carbon dioxide-generating multiple-unit oral formulations. If the extended diameter of these dose forms exceeds around 12 to 18 mm, they are not allowed to pass through the pyloric sphincter.[20,21]

FACTORS AFFECTING GASTRIC RETENTION:

- **Dosage form density:** According to reports, the density of stomach fluid is 1.004 grams per milliliter. For buoyancy, the dosage form's density should be lower than this in order to prolong its retention in the stomach. Dosage forms may initially have a high density but float in the stomach as a result of swelling induced density loss.[22]Meal composition: Fats, especially fatty acids, have a strong reductive influence on the rate of emptying and inhibit stomach secretion. It has been demonstrated that carbohydrates and proteins, albeit to a lesser degree,hinder stomach emptying. The rate of emptying decreases in proportion to an increase in the viscosity of the stomach juices.
- **Content of calories:** A high-protein and high-fat meal can extend the gastric residence period by four to 10 hours. The food's frequency: Due to low frequency MMC, the stomach residence time can rise by more than six hours when consecutive meals are administered as opposed to a single meal.
- **Dosage form size:** Indigestible solids larger than 1-2 mm are generally recognized to be held in the stomach throughout the postprandial phase before being expelled by a cyclical, recurrent burst of interdigestive gastric contractions. Numerous recent investigations have demonstrated that whereas 13.0mm tablets are held until the arrival of following sweeping "housekeeper waves," non-disintegrating tablets as large as 7.0mm can be discharged from the human stomach during the postprandial period. This highlights the necessity of enlarging dose forms in the stomach to increase the duration of gastric stay.
- **Sex:** Regardless of weight, height, or body surface area, women typically have a slower gastric emptying rate (4.6 1.2 hours) than men (3.40.6 hours). Body posture: -Standing and resting on the right side promote gastric emptying because the stomach's natural curve creates a downward path, while lying on the left or in a supine position slows it down. Subject's emotional state: -The impact of emotional variables on stomach motility based on whether the emotional experience is depressing or aggressive.

- **Effects of medications**: Tricyclic antidepressants (Imipramine, amitriptyline), poorly soluble antacids (Aluminum hydroxide), anticholinergics (Atropine, Propantheline), narcotic analgesics (Morphine), and metoclopramide, domperidom, and cisapride (Antiemetics) stimulate gastric emptying. Exercise: Excessive physical activity delays the emptying of the stomach. Disease states: Diabetes, hypothyroidism, pyloric stenosis, gastroenteritis, and gastric ulcers all slow down the emptying of the stomach. Hyperthyroidism and duodenal ulcers accelerate the rate of stomach emptying.
- **Gastrointestinal pH**: At low stomach pH, gastric emptying is slowed down; at higher or alkaline pH, it is accelerated. Chemicals that change the pH of the gastrointestinal tract also change how the stomach empties. The order in which different acids hinder stomach emptying is HCL>Acetic>lactic>tartaric>citric. This impact diminishes as molecular weight increases. In alkaline solutions, the stomach emptying rate is increased more by a low base concentration (1% NaHCO3) than by a greater concentration (5%).[23]

FLOATING BEADS:

Oral administration is convenient, safe, and economical, it continues to be the most popular method of medication delivery. However, some medications that need to be absorbed in the stomach or proximal small intestine may be less effective if the stomach empties quickly. To get around this problem, floating drug delivery methods have been created that stay buoyant in stomach fluids, lengthening the dose form's gastric retention period.This is especially helpful for medications that have local activity in the stomach, a limited absorption window, or low solubility at high pH. FDDS is a significant development in controlled release technology with the goal of maximizing therapeutic results.[24]

TYPES OF FLOATING DRUG DELIVERY SYSTEMS:

Two very different technologies have been used in the creation of FDDS based on the buoyancy mechanism: Effervescent and non-effervescent systems.

1.Effervescent System:

Gas-generating agents, carbonates (like sodium bicarbonate), and other organic acids (like tartaric acid and citric acid) in the formulation are used in effervescent systems to create carbon dioxide (CO2) gas, which lowers the system's density and causes it to float on the stomach fluid. An alternative is to add a matrix that contains a percentage of liquid, which causes the gas to evaporate at body temperature. These effervescent systems are further divided into two categories. One system

for producing gas.Vacuum and volatile liquid systems . Systems for producing gas[25]

Hydrodynamically Balanced System (HBS) or Intra Gastric Single Layer Floating Tablets: These are created by thoroughly combining the medication in the matrix tablet with the CO2-generating chemicals. Because they have a lower bulk density than gastric fluids, they stay floating in the stomach for a longer amount of time, which detracts from the gastric emptying rate. The medicine is gradually released from the floating system at the appropriate rate, and the leftover system is then eliminated from the stomach. As a result, the GRT rises and plasma drug concentration fluctuation is better controlled.

IntraGastric BilayedFloating Tablets: these are also compressed tablets with two layers: (1) an immediate release layer and (2) a sustained release layer.

Multiple Unit Type Floating Pills: These systems are made up of double-layered sustained-release capsules that act as "seeds." Effervescent agents make up the inner layer, and a swellable membrane layer makes up the outer layer. The system immediately sinks when submerged in a dissolving solvent at body temperature, forming bloated pills that resemble balloons and float because of their reduced density. The production and entrapment of CO2 within the systems is the cause of this decreased density.[26]

Systems that contain volatile liquids or vacuums Intragastric Floating Gastrointestinal Medication Administration Method :The drug reservoir is contained within a microporous compartment, and the floating chamber—which can be a vacuum or filled with air or a harmless gas—allows these systems to float in the stomach.

Systems for Inflatable Gastrointestinal Delivery: These devices include an inflatable chamber that expands in the stomach due to the gasification of liquid ether at body temperature. In order to create these systems, a drug reservoir—which may be a drug-impregnated polymeric matrix—is loaded into the inflated chamber and then enclosed in a gelatin capsule. The medication reservoir and inflated chamber are released when the capsule dissolves after oral administration. The medication reservoir is automatically inflated and held in the stomach fluid by the inflatable chamber.

Intragastric Osmotically Controlled Drug Delivery System: It consists of a biodegradable capsule with an inflated floating support and an osmotic pressure-controlled drug delivery system. The intragastric osmotically regulated drug delivery mechanism is released when the capsule rapidly breaks down in the stomach. The deformable hollow polymeric bag formed by the inflatable support within is filled with a liquid that gasifies at body temperature to cause the bag to expand. The drug reservoir

compartment and the osmotically active compartment make up the osmotic pressure controlled drug delivery mechanism. A pressure-responsive collapsible bag with a medication delivery hole that is impermeable to liquid and vapor encloses the drug reservoir compartment. A semi-permeable housing encloses the osmotically active compartment, which holds an osmotically active salt. In order to dissolve the osmotically active compartment in the stomach, the water in the GI fluid is continuously absorbed via the semi-permeable membrane. The collapsible bag is subsequently subjected to an osmotic pressure, which causes the bag reservoir compartment to contract and initiate the drug release of a drug solution formulation through the delivery aperture. In order to deflate the floating support, it is also designed to have a bio-erodible plug that erodes after a set amount of time. The stomach is subsequently cleared of the deflated medication delivery mechanism.[27]

2.Non Effervescent Systems:

The mechanism of polymer swelling or bioadhesion to the GI tract's mucosal layer underlies the non-effervescent FDDS. Gel-forming or highly swellable cellulose type hydrocolloids, polysaccharides, matrix-forming materials like polycarbonate, polyacrylate, polymethacrylate, and polystyrene, as well as bio-adhesive polymers like chitosan and carbopol, are the most frequently used excipients in non-effervescent FDDS. The several kinds of these systems are as follows:

Single layer floating tablets:They are made by carefully combining the medication with a gel-forming hydrocolloid, which maintains a bulk density of less than unity and swells when it comes into contact with stomach fluid. These dose forms are buoyant due to the air retained by the inflated polymer.[28]

Bilayer floating tablets:A bilayer tablet has two layers: an immediate release layer that releases the first dose from the system, and a sustained release layer that absorbs gastric fluid and forms an impermeable colloidal gel barrier on its surface. The sustained release layer maintains a bulk density of less than unity, which keeps the tablet buoyant in the stomach.

Alginate beads:Freeze-dried calcium alginate is used to create multi-unit floating dosage forms. A sodium alginate solution can be dropped into an aqueous calcium chloride solution to create spherical beads with a diameter of around 2.5 mm. This causes the calcium alginate to precipitate, creating a porous system that can sustain a floating force for more than 12 hours. These floating beads provided a longer residence period of over 5.5 hours when compared to solid beads, which had a short residence time of one hour.

Hollow microspheres:A unique emulsion solvent diffusion approach was used to create hollow microspheres (microballons) that were loaded with medication in their outer polymer shells. An agitated aqueous solution of PVA that was thermally regulated at 400 C was filled with the medication and enteric acrylic polymer ethanol: dichloromethane solution. An internal cavity was created in the polymer microsphere containing the drug by the gas phase produced in the dispersed polymer droplet by the evaporation of dichloromethane. For nearly 12 hours in vitro, the microballons floated continuously over the surface of acidic dissolution fluid containing surfactant.[29]

Mechanism of floating drug delivery system:

Floating drug delivery systems are low density devices with sufficient buoyancy to float above stomach contents and remain in the stomach for an extended period of time. When the device floats over the stomach's contents, the medication is delivered gradually and at the appropriate pace, lengthening the gastro-retention period and decreasing volatility.[30]However, the dosage form must have a minimal amount of floating force (F) to stay buoyant on the surface in addition to the minimal stomach content required for the buoyancy retention principle to be applied successfully. The force in units of F is continuously measured by the gadget as a function of the time required to maintain the submerged objects. As seen in the illustration, the object floats better if F is on the upper positive sideshown as in figure 2. In order to prevent the detrimental impacts of unanticipated intragastric buoyancy capability fluctuations, this device helps optimize FDDS with respect to the stability and longevity of the floating forces created. F = F buoyancy minus F gravity F is equal to (DF – Ds). where F is the total vertical force, DF is the fluid density, Ds is the object density, and g is the acceleration brought on by gravity. v stands for volume.[31]

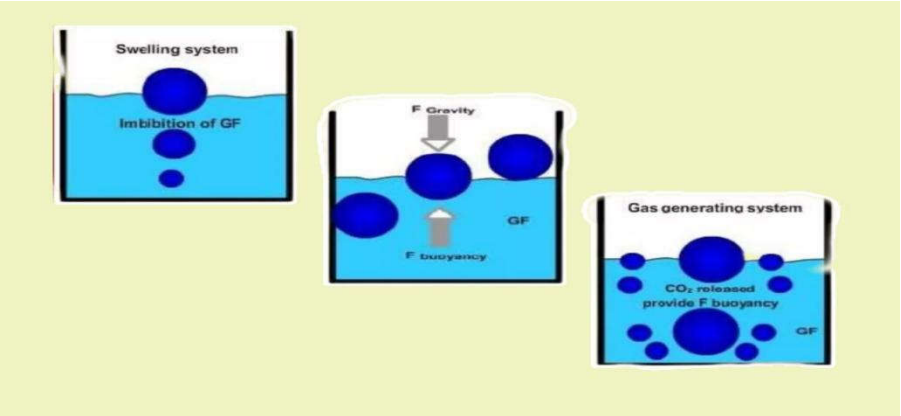

Figure No:2

Commonly Employed Polymers in Gastro retentive Floating Beads:

Sodium Alginate: A naturally occurring polysaccharide, sodium alginate is an anionic linear polymer comprising residues of α-1, 4-linked L-glucuronic acid and β-1, 4-linked D-mannuronic acid that are placed at random with the chains. It is a stable gel that has divalent cations, such as Ca2+, which are used to release medications over time. Excellent mucoadhesive properties, biodegradability, biocompatibility, and mild gelation conditions characterize alginate. Because alginate beads are stable in acidic conditions and so stop the drug from degrading in the stomach's acidic environment, it is also employed for floating drug delivery.[32,33]

Pectin: pure carbohydrate product made from apple pomace or a diluted acid extract of the inner part of citrus fruit rinds.[34,35]

Chitosan: A helpful excipient for creating prolonged release formulations and boosting the bioavailability of drugs that are poorly soluble in water is chitosan. Alkaline deacetylation of chitin, a naturally occurring polymer that is non-toxic, biocompatible, and biodegradable, yields chitosan. In the pharmaceutical and medical domains, hydrogel polymeric beads based on chitosan have been investigated as nanoparticulate carriers.The ability of a gel bead to bind chitosan is significantly impacted by the presence of calcium ions in the chitosan solution throughout the incubation period. The rate and scope of the chitosan binding process will increase as the calcium chloride concentration rises.[36]

GuarGum: The plant Cyamopsis Tetragonolobus is the source of guar gum, a galactomannan. It is a polysaccharide made up of mannose and galactose repeating units.Galactose residues are 1, 6-linked to the backbone's linear chain of 1, 4-linked mannose residues at every other mannose, creating short side branches.Guar gum is stable in the acidic pH and temperature range of 5-7. Strong acids (pH 3 or lower) and temperatures higher than 500C cause guar gum to hydrolyze and lose its viscosity. Guar gum is a superior emulsifier and more soluble than locust bean gum because it contains more galactose branch points.[37,38]

METHODS:

1.Solvent Evaporation Method:

Floating multiparticulate dosage forms with a hollow core are prepared using solvent diffusion and evaporation techniques. The drug is dissolved or dispersed in a polymer solution prepared in an organic solvent and emulsified into an aqueous phase containing polyvinyl alcohol to form an oil-in-water emulsion. Evaporation of the organic solvent leads to polymer precipitation at the o/w interface, creating a porous cavity that imparts buoyancy. Various polymers such as cellulose acetate, chitosan,

Eudragit, methocel, and polyacrylates have been explored for this system. The resulting low-density microparticles exhibit high drug encapsulation efficiency, excellent floating behavior, and tunable drug release profiles. These microparticles can also be compressed into fast-dissolving tablets, offering a convenient oral dosage form.

2.Emulsion Gelation Method:

In this process, the polymer was dissolved in distilled water and homogenized using a magnetic stirrer. After complete homogenization, the required quantity of oil was added, followed by the drug. The resulting uniform mixture of drug, oil, and polymer was then extruded dropwise through a 21-gauge needle into a 5% calcium chloride solution and allowed to stand at room temperature for ionotropic gelation. After a predetermined curing period, the formed beads were collected by filtration, washed twice with distilled water, and dried at room temperature for 12 hours.(41)

3.Inotropic Gelation Method:

This method involves the formation of a gel matrix through crosslinking of a polyelectrolyte with counterions and is widely employed for drug encapsulation. Polyelectrolytes such as sodium alginate contain anionic functional groups capable of coating the drug core and modulating drug release. When these anionic groups interact with polyvalent cations, a three-dimensional meshwork is formed, resulting in gelation. Microspheres are prepared by extruding a drug–polymer solution from a syringe into an aqueous solution containing polyvalent cations, leading to instantaneous crosslinking and microsphere formation.(42)

APPLICATION:

The upper gastrointestinal tract's limited absorption window, gastroretentive floating beads have several uses for medications with low bioavailability. By maintaining the dosage form at the absorption site, the method improves bioavailability.[43]Site-Specific Medication Administration These systems are particularly helpful for medications like furosemide and riboflavin that are specifically absorbed from the stomach or the proximal portion of the small intestine. The stomach is the primary site of furosemide absorption, with the duodenum coming in second. According to earlier research, a monolithic floating dosage form with a longer stomach residence duration was created, increasing bioavailability. Compared to traditional furosemide pills, the floating tablets' AUC was greater.[44]

Absorption Enhancement:
In order to achieve absorption, drugs having low bioavailability due to site-specific absorption from the upper gastrointestinal tract are desirable candidates for formulation as floating drug delivery devices. For example. Comparing floating dosage forms to commercially available LASIX tablets (33.4%) and enteric-coated LASIX-long products (29.5%), a notable increase in bioavailability (42.9%) could be attained. Reduced negative consequences in the colon: The amount of medication that enters the colon is limited by the floating drug delivery system's retention of the medication in the stomach. Consequently, it is possible to prevent unwanted drug activity in the colon. The addition of oil gives beads buoyancy, which helps medications that are sensitive to the colon region stay in the stomach.[45]

Reduced fluctuations of drug concentration:
Continuous drug input following CRGRDF dosing produces blood drug levels within a smaller range than instant release dose formulations. As a result, concentration-dependent side effects linked to peak concentrations can be prevented and drug impact variations are minimized.This characteristic is particularly crucial for medications that may have a therapeutic index.A wonderful medication delivery method, floating gastric beads have several uses in the medical and pharmaceutical industries. They are useful for a variety of therapeutic applications due to their special qualities, which include extended stomach residence, controlled drug release, and targeted delivery. Here, we explore the various uses for floating gastric beads.

1.Extended Release of Drugs:
Extended medication release is one of the main uses for floating gastric beads. These beads are designed to release medication gradually while staying buoyant in the stomach for a long time. This is particularly helpful for medications that need to maintain therapeutic blood concentrations. Patients benefit from lower dosages and steady medication levels, which improves the effectiveness of treatment.[46]

2.Improved Bioavailability:
For medications with poor absorption or limited solubility, floating gastric beads provide a solution. They can increase the drug's bioavailability by releasing it straight into the stomach. For substances that are poorly soluble, this can be very helpful since it guarantees that a larger percentage of the medication is absorbed, improving therapeutic results.

3. Targeted medication distribution:
Targeted medication distribution is made possible by the floating gastric beads' prolonged buoyancy in the stomach. This is very helpful for upper gastrointestinal tract disorders. By releasing medications exactly where they are required, these beads can lower systemic side effects and boost the drug's concentration at the intended location. [47]

4.Treatment of Gastric Emptying Disorders:
Conventional medication delivery techniques may not work in cases of delayed gastric emptying, in which the stomach takes an abnormally lengthy period to empty its contents into the intestines. By offering prolonged medication release inside the stomach, floating gastric beads provide an answer. For patients with illnesses like gastroparesis or other motility issues, this can be very important.

5.Gastrointestinal Infections and Ulcers:
Localized infections or ulcers in the gastrointestinal system may benefit greatly from the focused administration provided by floating gastric beads. To deliver direct and sustained treatment at the site of infection or ulceration, these beads can be loaded with antibiotics, antifungals, or antiulcer drugs.[48]

6.Combination Therapy:
Combining many medications into a single set of floating beads is an intriguing application. This method improves patient compliance by streamlining complicated treatment plans. For example, using anti-inflammatory and pain-relieving drugs in the same beads can help treat ailments like arthritis.

7.Pediatric and Geriatric Medicine:
In these fields, gastric floating beads are advantageous. Children and elderly people may need precise dosage or frequently have difficulty taking medicines. Medication adherence and comfort can be enhanced by creating floating beads that offer age-appropriate dose schedules.

8.Hormone Replacement Therapy:
Accurate dosage is essential in this treatment. For ailments like hormone shortages, floating beads can be made to deliver hormones steadily and gradually.

9.Nutritional Supplementation:
Vitamins, minerals, and other nutritional supplements can be delivered under supervision using gastric floating beads. When individuals have

particular dietary needs or have trouble taking large supplements, this application may be helpful.[49]
Eliminating Helicobacter pylori By producing high drug levels at the gastric mucosa, removing Helicobacter pylori from the stomach's submucosal tissue, and enabling the treatment of stomach and duodenum ulcers, gastritis, and esophagitis, floating beads may greatly improve stomach pharmacotherapy.[50]
Decreased variations in the drug's concentration continuous administration of the medication after Compared to immediate release dose forms, controlled release administration results in blood drug concentrations within a smaller range. As a result,pharmacological impact variations are reduced and concentration-dependent side effects linked to peak concentrations can be avoided. For medications with a limited therapeutic index, this characteristic is especially crucial. 5. Enhanced receptor activation selectivity Certain selectivity in the pharmacological impact of medicines that activate distinct types of receptors at different concentrations can also be achieved by minimizing variations in drug concentration.[51]

EVALUATION:

1.In vitro Buoyancy Study:

Buoyancy studies were carried out using a USP dissolution apparatus type II containing 900 mL of 0.1 N hydrochloric acid with 0.02% Tween 80. The required quantity of beads was introduced into the dissolution medium, and the system was agitated using a paddle rotating at 100 rpm for 12 hours. At predetermined intervals, the floating and settled beads were collected separately. After drying, the beads were weighed, and the percentage buoyancy was calculated as the ratio of the total weight of floating beads to the total weight of both floating and settled beads.

$$\% \text{ buoyancy} = Qf/Qf + Qs$$

Where,

Qf = Weight of the floating Beads
Qs = Weight of settled Beads[52]

2.Drug Entrapement Efficiency:

Drug encapsulation efficiency was employed to determine the extent of drug entrapment within the microspheres. The method involves disintegrating the microspheres using 0.1 N hydrochloric acid to release the encapsulated drug. The extracted drug content was then quantified using a UV–visible spectrophotometer, and the encapsulation efficiency was calculated using the following formula.(53)

$$Entrapment\ efficiency = \frac{Actual\ drug\ content}{Therotical\ drug\ content} x100$$

3.Scanning Electron Microscopy (SEM):
A scanning electron microscope (SEM) can be used to morphologically a ssess the prepared dry beads' surface and internal structure.

4. Stability Studies:
The prepared beads were sealed in vials and stored at 400C/75% RH for 9 0 days. The beads were examined for in vitro release and drug content aft er 90 days of exposure. [54]

5.Floating Lag Time and Floating Time:
The floating time measurement test is typically carried out in 0.1 N HCl or stimulated gastric fluid kept at 37 °C. A USP dissolving apparatus with 900 milliliters of 0.1 N HCl as the dissolution media at 37°C is used to determine it. The floating lag time is the amount of time it takes for the dosage form to float, and the floating or flotation time is the amount of time it floats. A Sartorius electronic balance46 is suspended on a stainless steel basket that is attached to a metal rope as part of the system to monitor continuous floating behavior. The reading on the balances might be immediately picked up by a lotus spread sheet.900 ml of simulated gastric fluid (pH 1.2) kept at 37°C served as th e test medium for floating kinetics experiments.[55]

6.X-ray Method:
X-ray imaging is a widely used evaluation technique for floating dosage forms. Localization of the dosage form within the gastrointestinal tract helps in predicting and correlating gastric emptying time and gastrointestinal transit behavior. In this method, a radio-opaque substance is incorporated into the solid dosage form, enabling its visualization under X-ray imaging.[56]

7.Ultrasonography :
Certain abdominal organs can be seen thanks to ultrasonic waves that reflect significantly varying acoustic impedances across interfaces. The majority of DFs do not exhibit notable acoustic mismatches throughout their physiological milieu interface. As a result, ultrasonography is not frequently utilized to assess FDDS. The evaluation of the hydrogels' intragastric location, solvent penetration into the gel,

and interactions between the gastric wall and FDDS during peristalsis were all part of the characterisation.[57]

8.Angle of Repose:

By evaluating interparticulate friction, angle of repose aids in the assessment of powder flowability. Generally speaking, powder flowability decreases with increasing angle of repose. The glass funnel method was used to determine each powder blend's angle of repose.

$\tan \Theta = h/r$

Where, Θ - angle of repose, h - height of pile above the flat surface, r - radius of the circle formed by the powder blend. [58]

9.Swelling Index:

To determine the actual floating capacities of buoyant dosage forms as a function of time, an in vitro measuring device has been developed. It measures the force that is equal to the force F needed to maintain the object completely submerged in the fluid. This force establishes the object's final weight when submerged and can be used to measure whether it can float or not. According to the equation, the vectorial sum of the buoyancy (F bouy) and gravity (F grav) forces exerted on the object determines the force's magnitude, direction, and resulting weight.

$$F = F_{buoy} - F_{grav}$$
$$F = d_f g V - d_s g V = (d_f - d_s) g V$$

$F = (df - M / V)$ gVin which F is the total vertical force (resultant weight of the object), g is acceleration due to gravity, d f is the fluid density, d s is the object density, M is the object mass, and V is the volume of the object . By convention, a positive resultantweight signifies that the force F is exerted upwardand that the object is able to float, whereas a negative resultant weight means that the force F acts downward and that the object sinks.[59]

CONCLUSION:

New therapeutic compounds were required due to the discovery of new diseases and the resistance to current medications. Many chemical entities have been introduced in response; some have absorption windows in the upper portion of the small intestine, while others have absorption throughout the GIT. FDDS provides the unique delivery method needed for the medications needed for local action in the GIT.

Numerous FDDS have been created, including raft forming systems, hollow microspheres, single and multiple unit HBS, and single and multiple unit gas generating systems. Longer stomach retention and

improved dosage form efficacy are two benefits of developing sustained release formulations (40–44). Accurate bioavailability could be achieved by combining the floating characteristic of low density drug delivery systems with precise control over drug release patterns. Therefore, more research in this area is required to include efficient medication delivery methods.

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