Review Article

A Review on the Floating Drug Delivery System – Its Evaluations and Recent Works Done in 4-5 Years

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ABSTRACT

Since floating drug delivery systems may solve the disadvantages associated with traditional drug delivery systems, such as frequent dosing, limited bioavailability, etc., in comparison to quick stomach emptying time, they have attracted a lot of attention in recent decades. A system that stays in the stomach for an adequate amount of time and delivers the active medication continuously is known as an ideal floating drug delivery system. These continue to float over the stomach contents. prolonging the pharmacological effects and enhancing the drug's bioavailability. This overview of gastroretentive and floating tablets was written to gather recent research on the topic, as well as information on the floating tablets' principles, benefits, categorization, preparation, and assessment methods, and a list of medications that have been developed as floating tablets. formulation evaluation and future scope of floating tablets. The review concentrated on the types of floating medication delivery systems and the formulation aspect of effervescent floating drug delivery systems. The review's objective is to gather the research being done on this floating medicine delivery device. The review addresses several aspects that impact stomach retention (long duration) and offers useful information about the pharmaceutical formulation side of it.

Keywords: Gastro-Retentive, Floating Dosage Forms, Floating Tablets, Floating Microspheres, Gastric Floating, Buoyancy, etc.

INTRODUCTION

The most practical way to distribute various proteins, medications, and bioactive substances is orally. Improved oral bioavailability of pharmaceutical pharmaceuticals with a specific gastrointestinal (GI) tract absorption window may be achieved with the use of gastroretentive drug delivery systems (GRDDS) [1]. The goal of designing a novel oral controlled drug delivery system is supposed to be to maximize the medications' pharmacological effect at the intended location. Nevertheless, the process of development faces many physiological challenges, including the incapacity to confine and localize the DDS within appropriate GI tract areas and significant fluctuations in the process of stomach emptying [2,3].

Since most medications undergo absorption in the upper portion of the small intestine, this variability may thus result in unexpected bioavailability and timeframes to reach peak plasma levels [4]. The process of absorbing drugs from the gastrointestinal system is intricate and diverse. It is commonly known that the duration of contact with the small intestine mucosa affects how much medicine is absorbed via the gastrointestinal tract [5,6]. Small intestinal transit time is therefore a crucial factor to consider when evaluating medications that are not fully absorbed.

The majority of oral dosage forms have several physiological restrictions, including variable gastrointestinal transit, which results in non-uniform absorption profiles due to variable gastric emptying, partial drug release, and a shorter dosage form resident time in the stomach [7,8]. Because some of the medicine is not absorbed after it passes through the absorption site, causes inadequate absorption of medications with an absorption window, particularly in the upper section of the small intestine [9]. Numerous variables influence the stomach emptying of dose forms in humans, leading to significant variability both within and between subjects. Given that a large number of medications are effectively absorbed in the upper gastrointestinal tract, such substantial variability raises the risk of non-uniform absorption and unexpected bioavailability. Hence a beneficial delivery system would possess the ability to control and prolong the gastric emptying time and can deliver drugs in higher concentrations to the absorption site (i.e. upper part of the small intestine) [10].

Many FDDS have been created recently, each with unique advantages and limitations. These include hollow microspheres, raft-forming systems, gas generating systems, single including multiple unit hydro dynamically balanced systems (HBS), and hollow microspheres [11,12].

A medication called FDDS is formulated with hydrocolloids that create a gel and are intended to stay buoyant in the contents of the stomach. Under somewhat controlled circumstances, the pH of the gastrointestinal tract is where drug disintegration and release from the dosage form held

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in the stomach juices occur. When it comes to medications that operate locally, are insoluble in gastric fluids, or have site-specific absorption, the retentive qualities of the dose form are irrelevant [13].

Criteria for HBS

Needs must be sufficiently structured to create a cohesive gel barrier. The amount of drugs released from the dosage form, the rate at which the stomach empties, the length of time the dosage form travels through the gastrointestinal tract, and the location of drug absorption can all affect how well oral medication delivery works. must keep the total specific gravity below the stomach content. Must disintegrate sufficiently slowly to act as a reservoir for the delivery mechanism [14,15].

Among the significant classes of drug delivery devices with stomach retentive activity are floating systems. Medication such as metformin, furosemide, ciprofloxacin, allopurinol, and cyclosporine may profit from gastric retention. Medication that is less soluble in the small intestine's pH than the stomach (such as chlordiazepoxide and cinnarizine), susceptible to breakdown in the intestinal pH (such as captopril), and acting locally in the stomach (such as misoprostol) can be administered in dosage forms that retain stomach acid. HBS dosage form can be used to give antibiotics, catecholamines, sedatives, analgesics, anticonvulsants, muscle relaxants, antihypertensive, and vitamins [16,17].

For medications that are taken twice a day or more, controlled-release or extended-release dose formulations with longer half-lives in the stomach are ideal. limited to absorption in the upper GI tract, Unsoluble in water aimed at areas of the upper gastrointestinal system, Bioavailable via mechanisms of active transport, Sensitising the mucosa, jarring, uncomfortable, or dangerous in the lower gastrointestinal area, more efficient when plasma concentrations are more steady [18].

that have an absorption window in the upper small intestine or stomach, that are unstable in the intestinal or colonic surroundings, that are locally active in the stomach, and that have low solubility at high pH values.

Physiology of stomach

The GI tract, which includes the throat (pharynx), is essentially a nine-meter-long tube that passes through the center of the body from the mouth to the anus. esophagus, stomach, duodenum, jejunum, and ileum in the small intestine, and the cecum, appendix, colon, and rectum in the large intestine [19]. With minor regional differences, the GI tract wall's overall structure is the same for the majority of its length, extending from the esophagus to the anus. The stomach is an organ that can combine and store substances. The process of mixing and grinding the contents of the stomach occurs in the antrum area. When on a fast, the stomach is a compressed bag that has a residual volume of about 50 milliliters and is partially filled with air and gastric fluid (pH 1-3) [20]. Along with the rest of the GI system, the mucus spread and covered the stomach's mucosal surface. The two kinds of continuous movement in the GI tract are the digestive motility pattern and the inner digestive motility pattern. When fasting, the former predominates and its main job is to clear the upper GI tract of any leftover material. The stomach's apparent absorbing surface area is around 0.1 m^2, and its average length is approximately 0.2 meters [21].

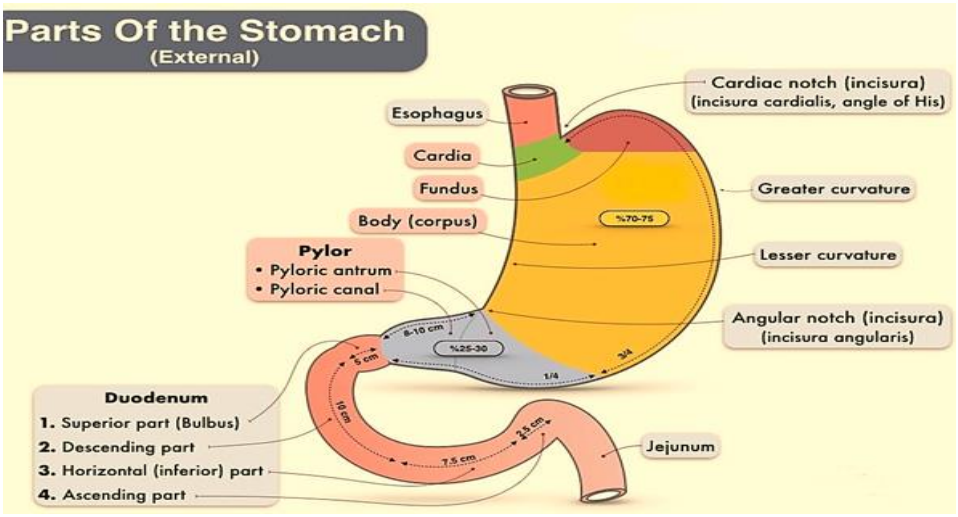

Figure 1: Anatomy of the stomach [21].

The stomach is anatomically separated into three sections: the Fundus, the Body, and the Antrim (pylorus). The closest part produced FDDS (Floating drug delivery system) is one innovative strategy in this field. By continually releasing the drug for a protracted length of time before it reaches its absorption site, FDDS can enhance the controlled administration of medications that have an absorption window [22].

The term "inter-digestive myoelectric cycle" or "migrating myoelectric cycle" (MMC) refers to a sequence of electrical events that occur during the fasting condition and cycle

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through the stomach and intestine every two to three hours.

The MMC is further broken into four parts. When a mixed meal is consumed, the pattern of contractions shifts from the fasted state to the fed state, which is also known as the digestive motility pattern.

Phase 1- (Basic phase) lasts from 30-60 mins with rare contractions.

Phase 2- (Preburst phase) lasts for 20-40 mins with intermittent action potential and contractions.

Phase 3- (Burst phase) lasts for 10-20 minutes which includes intense and regular contractions for a short period.

Phase 4-last for 0-5 minutes and occurs between phase 2 and 1 of 2 consecutive cycles [23].

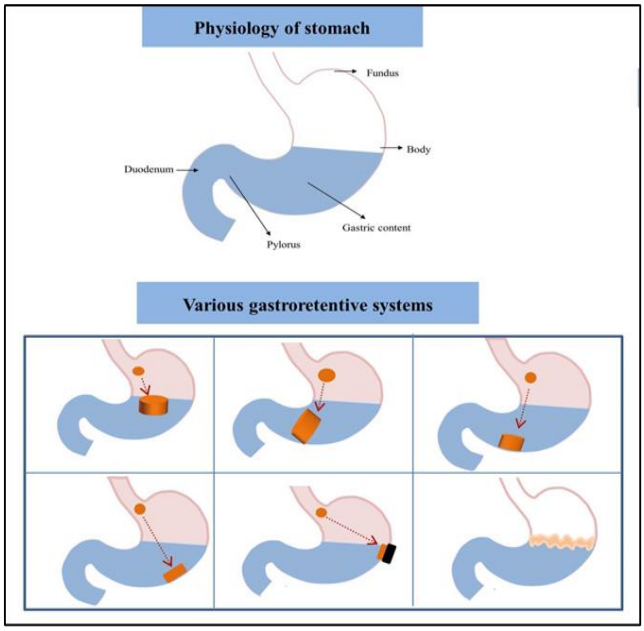

Figure 2: Different approaches of gastric retention. [24-26]

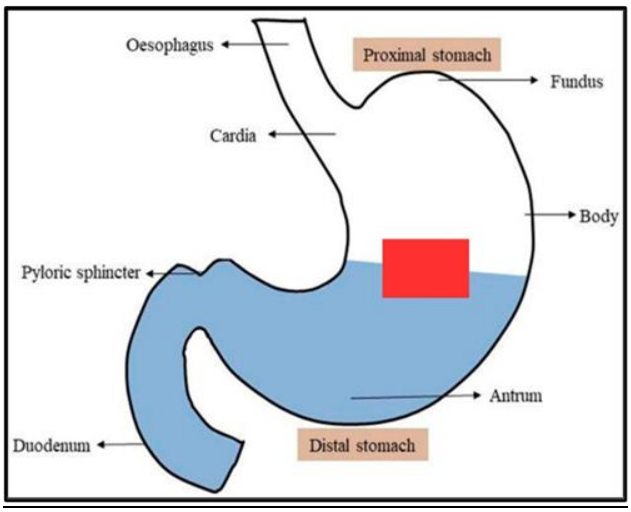

Figure 3: Floating of drug in GI tract [29,30].

Hydrodynamically balanced or floating systems float in the stomach for longer periods of time without slowing down the rate at which the stomach empties because their bulk density is lower than that of gastric fluid [27]. Whenever the system is floating on the fluids of the stomach, the drug is released at a predefined rate from the stomach. After the medicine is released, its residual system is eliminated from the stomach. This leads to an increase in the length of time that stomach retention lasts and improved management of plasma drug concentration fluctuation [28].

Factors affecting the gastro retentive system

Several tactics, such as leaving the medication in the stomach, have been tested in an attempt to extend the retention duration. Some of these strategies include the use of mucous adhesive mechanisms, higher-density systems, modified-shape systems, floating dosage forms (gas-generating along with swelling/expanding systems), co-administration of drugs that delay the emptying of the stomach, and mucoadhesive systems. The bioavailability and efficacy of these techniques in the gastroretentive mechanism are influenced by many circumstances [31].

Density – Gastric retention time (GRT) is a function of dosage form buoyancy that is dependent on the density [32].

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% to 100% retention at 24 hours compared with other shapes [33].

Single or multiple unit formulation – Multiple unit formulations allow for combined administration of units that have various release profiles or as containing incompatible substances, demonstrate a more predictable release profile, and allow a greater degree of safety towards dosage form failure than single unit dosage forms. They also allow for relatively little performance impairment resulting from unit failure.

Fed or unfed state – Periods of intense motor activity, especially the migration of the myoelectric complex (MMC), which happens every 1.5 to 2 hours, are what define the GI motility during a fast. The MMC removes undigested matter from the stomach, and if the formulation is administered at the same time as the MMC, the unit's GRT should be extremely brief. GRT is significantly longer and MMC is delayed compared to the fed state [34].

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

Frequency of feed – The GRT can increase by over 400 minutes 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 hours) is less compared with their age and race-matched female counterparts (4.6±1.2 hours), regardless of the weight, height, and body surface.

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Age – Elderly people, especially those over 70, have a significantly longer GRT.

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

Concomitant drug administration – Anticholinergics like atropine and propantheline, opiates like codeine, and prokinetic agents like metoclopramide and cisapride can affect floating time.

Biological factors – Diabetes and Crohn's disease, etc [35].

Advantages

Site-specific drug delivery. Controlled delivery of drugs. It improved drug absorption with increased GRT and excess duration of contact of dosage regimen at its target site. Administration of a prolonged-release floating dosage form tablet or capsule will result in the dissolution of the drug in gastric fluid. After emptying of the stomach contents, the dissolved drug is available for absorption in the small intestine. It is therefore expected that a drug will be fully absorbed from the floating dosage form if it remains in solution form even at alkaline pH of the intestine [31-35].

Disadvantages

Drugs with cause irritation to the stomach cannot be used. A sufficient amount of gastric fluid should be available in GIT. Gastric retention is influenced by many factors such as gastric motility, pH, and the presence of food. These factors are never constant and hence the buoyancy cannot be predicted exactly or accurately. Unpredictable bioavailability [36].

Polymers are used in floating system

Polymers are used in floating systems to target drug delivery at specific regions in the GI tract i.e. stomach. Both synthetic and natural polymers are used in floating drug delivery [37]. Natural polymers used in floating systems are Guar gum, Chitosan, xanthan gum, Gellan gum, Sodium alginate, etc. Synthetic polymers used for floating drug delivery are HPMC, Eudragit, ethyl cellulose, etc [38,39].

Synthetic polymers

Synthetic polymers are becoming increasingly important in pharmaceuticals. The use of synthetic polymer ranges from binder, film coating agent, etc. Polymers are macromolecules that are very large and contain a variety of functional groups [40]. Synthetic polymers are either purely synthetic or they are modified forms of natural polymers known as semi-synthetic see Table 1.

Table 1: List of some polymers used in FDDS

Polymer	Sub Type	Examples
Synthetic Polymer	Biodegradable	Lactides, glycosides, and their copolymers. Poly alkyl cyanoacrylates, polyanhydrides
	Non-biodegradable	Polymethyl methacrylate, Glycidyl, methacrylate, and epoxy polymers. [41]
Natural	Proteins	Albumin, Gelatin, Collagen
	Carbohydrates	Agarose, carragenan, Chitosan, starch
	Chemically modified carbohydrates	Poly dextran, poly starch [41,42]

Need for a floating drug delivery system.

Only a particular place can absorb some medications. They demand a release at a specified location or one that ensures the maximum quantity of medicine reaches the designated location. These days, the pharmaceutical industry is concentrated on medications that need to be site-specific. By holding the dose form in the stomach and releasing the medication gradually to a designated spot in the stomach, duodenum, or intestine, gastro-retentive administration is one of the site-specific methods for drug delivery to the stomach or the intestine. [43,44]

Probable candidates for FDDS

Drugs that have a narrow absorptive window in the stomach or upper parts of the small intestine, e.g., furosemide, riboflavin-5-phosphate, metformin hydrochloride, ciprofloxacin, alfuzosin hydrochloride, ofloxacin, norfloxacin, domperidone, etc. Drugs unstable in the lower part of GIT, e.g., captopril. Drugs insoluble in intestinal fluids, e.g., quinidine, diazepam. Drugs that degrade in the colon, e.g., ranitidine hydrochloride, and metronidazole. [45]

Methods for preparing floating dosage form

The floating dosage forms can be prepared using the following methods.

using hydrocolloids that gel, such as cellulose derivatives, gelatine, hydrophilic gums, and alginates. using low-density enteric materials, such as cellulose acetate phthalate, and methacrylic polymer. by packing it inside a capsule and lowering the particle size [46]. by creating gaseous carbon dioxide and then trapping it within the gel network. through the creation of drug-filled, hollow micro-balloons made of acrylic polymer and filled capsules. By including an inflatable chamber that is submerged in a liquid (such as a solvent) that vaporizes at body temperature, causing the chambers to expand inside the stomach [47,48].

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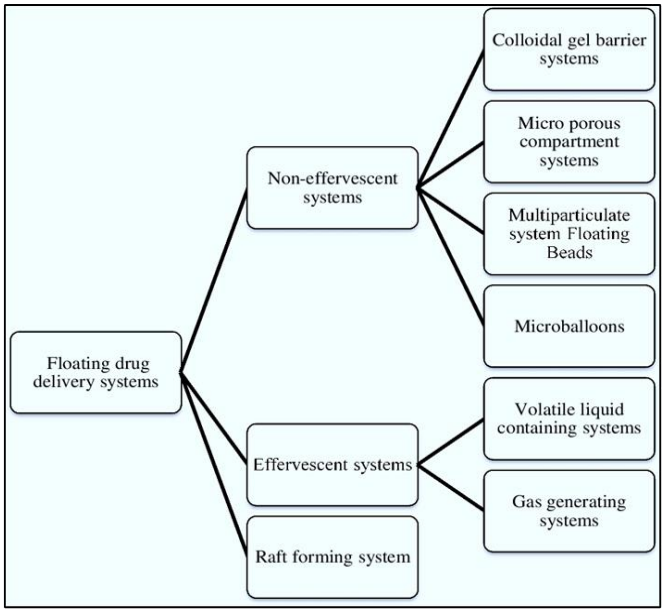

Figure 4: Types of Floating Drug Delivery System. [40-50]

Effervescent system

In effervescent systems, the major constituents are carbonates (like Na bicarbonate) and alternating organic acids (like acid and salt acid) that produce CO2 gas, decreasing the system's density and causing it to float above the gastric fluid. Adding a matrix with a liquid component that releases gas that evaporates at the temperature of the body serves as a stand-in. [51]

Gas generating system

These are created by thoroughly combining the drug and CO2 generators in the matrix tablet. These float around in the stomach longer than gastric fluids because they have a lower bulk density, which slows down the gastric emptying rate [52].

Volatile liquid-containing system

This system is created to float within the abdomen owing to a floatation chamber which can be a vacuum or full of air or a harmless gas, whereas a drug reservoir is encapsulated within a microporous compartment.

Non- effervescent FDDS

This kind of system swells uncontrolled when swallowing because of inhibitions of viscous fluids, which prevent them from leaving the belly. They can also be identified as plug-type systems because they need to bend to stay trapped near the pyloric valve. One way to make these forms in limitless quantities is to combine the drug with a gel that, when swallowed, expands when it comes into contact with a viscous liquid, but only one bulk density and form integrity remain inside the outer jelly-like barrier. The buoyant stream has an indiscriminate quantity of buoyancy due to the compound's capacity to retain air. The most widely used excipient is by far non-effervescent floating drug delivery [52,53].

Colloidal gel barrier system

This method prolongs the time of stomach retention while delivering a greater quantity of drug in solution form to the absorption site. In essence, it contains medicine that turns hydrocolloids into gel so that it floats over stomach contents. such as polyacrylate, polystyrene, and polycarbophil. When the hydrocolloid in the system comes into contact with gastrointestinal fluid, it hydrates to form a colloid gel barrier to its surroundings [54].

Micro porous compartment system

This method has pores at the top and bottom walls and encapsulates a drug reservoir inside a microporous compartment. The delivery system floats above the gastric content in the stomach thanks to the flotation chamber made of air that has been trapped there.

Floating microsphere/ micro balloons

Micro balloons, also known as hollow microspheres, are believed to be the most efficient buoyant material. It consists of the central hollow portion of the microsphere. A state-of-the-art solvent diffusion emulsion method is used to form hollow microspheres with a polymer shelf that is loaded with medication [55].

Alginate floating beads

Calcium alginate that has been freeze-dried was used to create floating dosage forms in multiple units. By injecting sodium alginate mixture into an aqueous calcium chloride solution, calcium alginate precipitates, creating a porous system that can sustain a buoyant force for more than 12 hours, resulting in spherical beads with a diameter of about 2.5 mm. In contrast to solid beads, which provided a residence time of only one hour, these floating beads provided a residence length of over five hours [56].

Raft forming system

Raft-forming devices are attracting a lot of interest for helping with the administration of antacid medications and drugs for infections of the gastrointestinal tract and disorders. The drug can be released gradually into the stomach by expanding and creating a viscous gastric fluid whenever a gel-forming solution comes into contact with the gastric fluid [57].

Evaluation of gastro-retentive dosage form [58-60].

Weight variations

Take 20 tablets, each to be weighed separately. Compute the mean weight and contrast each tablet's weight with the mean. If no tablet varies by more than twice the percentage restriction and if no more than two tablets are outside the limit, the tablet passes the U.S.P. test [61].

Hardness

To test the tablet's hardness, various testers are used, including the Monsanto tester, Strong-cobb tester, Pfizer tester, Erweka tester, and Schleuniger tester. These tests are necessary to ensure that the tablet can withstand the

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shock and strain during manufacturing, packing, and transportation, as well as when handled by the patient [62].

Thickness

Tablet for measuring Any of the devices indicated above can be used to perform the very straightforward procedure of determining thickness. The vernier caliper is the tool most frequently used to test tablet thickness. The vernier caliper is available with a digital display or manual reading, and it provides a reading in mm.

Friability

The Roche friabilator is used to evaluate a tablet's friability, which determines whether or not the tablet is durable against abrasion. This is composed of a machine that rotates a plastic drum at 25 revolutions per minute for 100 revolutions. The twenty tablets that were weighed before the test are then removed from the drum, wiped with a towel, and weighed again; for a normal tablet, the weight change cannot be within a range of 0.5 to 1.0% [63,64].

Floating systems

Buoyancy lag time

It is determined to assess the time taken by the dosage form to float on the top of the dissolution medium after it is placed in the medium. These parameters can be measured as a part of the dissolution test [65,66].

Floating time

Test for buoyancy is usually performed in SGF Simulated Gastric Fluid maintained at 37^{0C}. The time for which the dosage form continuously floats on the dissolution media is termed floating time [67].

Specific gravity / Density

Density can be determined by the displacement method using Benzene as a displacement medium.

Resultant weight

The two primary variables used to describe buoyancy are bulk density and floating time. However, because density varies with an alteration in the resulting weight over time, a single density determination is insufficient to represent buoyancy. For instance, a matrix tablet containing bicarbonate while matrix polymer floats at first due to gas creation and entrapment, but after a while, some medication is released and concurrently, some of the matrix polymer's outer layer may erode, changing the dosage form's final weight.

Swelling systems

Swelling index: After immersion of swelling dosage form into SGF at 37^{0C}, the dosage form is removed at regular intervals, and dimensional changes are measured in terms of increase in tablet thickness/diameter with time [68].

Swelling index/ Water uptake

It is an indirect measurement of the swelling property of a swellable matrix. Here dosage form is removed at regular intervals and weight changes are determined over time [68,69].

$$\text{Swelling index} = \frac{\text{wt} - \text{wo}}{\text{wo}} \times 100$$

Where, Wt = weight of dosage form at time t.

Wo = initial weight of dosage form.

In-vitro evaluation test

The USP dissolving device type II paddle type was used to release the formulation's medication in vitro at 37 0.5 °C and revolving speeds of 50 rpm in a washbasin environment. The 900ml 0.1NHCl dissolving media was employed. For a duration of six hours, the samples were taken out at prearranged intervals. They were then diluted, filtered through a 0.45-µm membrane filter, and measured at an API-specific nm utilizing a Shimadzu UV-1800 double-beam spectrophotometer. A calibration curve was used to generate an equation that was used to determine the drug's cumulative percentage release or CPR [70,71].

FTIR Study

The medication and excipients were studied using the Fourier transform infrared (FT-IR) technology to examine their physical and chemical interactions. Using the KBr mixing approach, the FT-IR spectra of both the pure drug and the floating tablet were recorded on the institute's central instrument laboratory's FTIR-1700 Shimadzu FT-IR analyzer [72,73].

Differential Scanning Calorimetry (DSC)

The physical and chemical interactions between the medication and the excipients were investigated using DSC. On the DSC-60 instrument, which is housed at the institute's core instrument laboratory, the DSC spectra of pure drugs and drug composite mixtures were recorded (DSC-60, Shimadzu) [74].

Stability study

According to ICH Q1A (R2), new drug substances and products must have stability testing. Rules stability testing aims to establish a re-test period for the substance being tested or a shelf life for the drug product as well as recommended storage conditions. It also provides evidence on how the quality of a medicinal product or drug substance varies with time under the influence of various environmental factors like temperature, humidity, and light. Short-term stability analysis of the ideal batch was conducted at 40°C in a humidity container with 75% relative humidity (RH) to ascertain the variation in the in vitro dissolution profile and on storage. Samples were removed after a month to assess if the in vitro release of drugs pattern had changed [75-77]. From various standard resources like ScienceDirect, PubMed, MDPI, Springer Nature, Taylor Francis, and Dovepress, collected information given below in Table 2.

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Table 2: Floating formulations for GRDDS Research done by some listed researchers in the last 5-7 years.

Drug name	Disease	Preparation methods	References
Capsaicin	Peptic ulcers	Nanofiber films	(Karavasili C., et al, 2024) [78]
Dihydromyricetin	Parasite infections, liver diseases, and hangovers	Compression coating technique,	(Hao liu., et al 2023) [79]
Brivaracetam	Epilepsy	Direct compression, Floating tab	(Jinsong Ding et al 2023) [80]
Propranolol Hydrochloride	Hypertension and cardiovascular disorders	3d-printed	(Mohammed AA et al 2023) [81]
Ciprofloxacin Hydrochloride	Broad-spectrum fluoroquinolone antibiotics	*Sf*grdds direct compression method	(Sheu M-T et al 2023) [82]
Niclosamide	Antiparasitic drug being repositioned for helicobacter pylori	3 D Printed Nanocrystals by the Melting Solidification Printing Process.	(Real JP, Real DA et al 2023) [83]
Flavonolignan Silymarin	Treat acute and chronic hepatic diseases.	Direct compression, Floating tab	(Khan JA et al 2023) [84]
Metformin Hydrochloride	Diabetes type ii	Three-dimensional printing (3DP)	(Millán-Jiménez M et al 2023) [85]
Gabapentin,	Treat overactive bladder	3d-printed	(Ghori MU et al 2023) [86]
Famotidine	Treat gastric and duodenal ulcers, zollinger-ellison syndrome, and reflux esophagitis	Semisolid extrusion 3d printing	(Kim DW et al 2023) [87]
Clarithromycin And Pantoprazole	Treating ulcers and lower and upper git bacterial infections.	Bilayer with direct compression	(Nawaz A et al 2023) [88]
Drotaverine Hydrochloride	An antispasmodic drug used for smooth muscle spasms and pain associated with gastrointestinal colics, renal colics, biliary colics, irritable bowel syndrome, postsurgical spasm, and uterine neck spasm	Direct compression, Floating mini-tablets	(Louis MM, et al 2023) [89]
Domperidone	Used to stop feeling or being sick (nausea or vomiting	3D-printed	(Patrojanasophon P. et al 2023) [90]
Ofloxacin	Treat bacterial infections of the skin, lungs, prostate, or urinary tract	HBS floating capsules	(Nayak AK et al 2023) [91]
Esomeprazole And Clarithromycin	Management of gastroesophageal reflux disease (GERD), broad-spectrum antibiotic	Effervescent floating bilayer tablets direct compression	(Muzammal M, Alamri AS, et al 2022) [92]
Metronidazole	Abdominal discomfort, weight loss, diarrhea, constipation	Direct compression	(Elkomy MH, et al 2022) [93]
Ciprofloxacin	Antiulcer therapeutic potential due to composed dietary fibers psyllium-moringa gum-alginate.	Beads using alginate-gelatin for cefadroxil drug encapsulation	(Singh B et al 2022) [94]
Sildenafil Citrate	Treatment of pah	Direct compression	(Diniz A. et al 2022) [95]
Neratinib	Breast cancer treatment	Effervescent floating matrix NTB	(Alshahrani S et al 2021) [96]
Metformin Hcl	Diabetes type ii	Direct compression floating tab	(Huh HW et al 2021) [97]
Dipyridamole	Widely used to prevent angina and inhibit thromboembolic complications	Acrylamide-based hydrogels are neutral hydrogels	(Salama AH et al 2021) [98]
Amoxicillin Trihydrate	Treatment of *Helicobacter pylori*	Floating-alginate based beads	(Raafat AI et al 2021) [99]
Losartan Potassium	Used to treat hypertension	Effervescent floating matrix tablets	(Rahamathulla M et al 2021) [100]
Theophylline	To treat COPD Asthma	Bilayer floating theophylline tablets	(Avbunudiagba JA et al 2020) [101]
Losartan And Hydrochlorothiazide	Treatment of hypertension	Bilayer floating tablet by direct compression	(Maddiboyina B et al 2020) [102]

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Bupropion	Treating depression	Direct compression floating tab	(Teaima MH et al 2020) [103]
Cefuroxime Axetil	Second-generation oral antibiotic to be widely used in therapy it exerts broad-spectrum antibacterial activity against methicillin-sensitive staphylococci, streptococcus pneumonia, Haemophilus influenzae	Hot melt extrusion technology	(Lalge R, et al 2019) [104]
Diclofenac	NSAID	Direct compression floating tab	(Shehzad MQ, et al 2019) [105]
Azelnidipine	Used for treating ischemic heart disease and cardiac remodeling after myocardial infarction	Effervescent floating matrix tablets	(Gaikwad SS et al 2019) [106]
Acyclovir	To treat the symptoms of chickenpox, shingles, herpes virus infections of the genitals	3D-printed	(Shin S et al 2019) [107]
Cefpodoxime Proxetil	Used as an extended-spectrum, semi-synthetic antibiotic of the cephalosporin class.	Direct compression floating tab	(Kukati L S et al 2018) [108]
Pregabalin	To treat epilepsy and anxiety.	Direct compression floating tab	(Kim S et al 2018) [109].
Amlodipine Besylate	Treatment of Hypertension and chronic stable angina. In both vascular disorders	Direct compression technique.	(Gurung S et al) [110]

CONCLUSION

Floating tablets are now a highly effective way to increase a drug's bioavailability, provide it a continuous release, and prevent many of its negative side effects. It has been demonstrated that floating pills are a viable treatment for stomach retention. These systems offer a unique benefit for drugs that are predominantly absorbed from the upper gastrointestinal tract. Thus, there is a lot of room for future advancement in the design of the ideal floating drug delivery system due to our growing understanding of the physiochemical and pharmacological aspects of drugs as well as the formulation development aspect.

The absorption of drugs in the gastrointestinal system is a very varied process with varying physiochemical features, according to an assessment of the literature. The dosage form's prolonged stomach retention caused by FDDS lengthens the time it takes for the medicine to absorb. Enhancing the bioavailability and regulated drug delivery of several medications is the goal of gastroretentive floating drug delivery systems. The floating medication delivery device enhances gastric retentive drug administration to maximize molecular delivery and offers a viable method for gastric retention. An overview of pharmacological parameters, dose forms, factors influencing stomach emptying, etc., is provided in this article.

ABBREVIATIONS

Floating Drug Delivery System – (FDDS)

Gastro-retentive Drug Delivery System – (GRDDS)

hydro dynamically balanced systems -(HBS)

Migrating myoelectric complex (MMC)

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