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Review Article

A Review on Floating *In-Situ* Gel: A Promising Strategy for Prolonged Gastric Retention and Controlled Drug Release

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ABSTRACT

Drugs that have limited absorption windows or poor gastrointestinal tract stability may benefit from the use of floating drug delivery systems (FDDS), which have shown promise in increasing bioavailability and therapeutic efficacy. *In situ* gels, which gel when they come into touch with stomach secretions, provide a number of benefits, including regulated medication release and an extended period of stomach retention. The development, workings, and advantages of floating *in situ* gel systems are examined in this paper. It highlights the polymers utilized in these systems and talks about the different ways that gel formation can be achieved, such as pH modification, temperature modulation, and ionic crosslinking. The review also discusses the therapeutic implications and prospective benefits of FDDS in the future for enhancing treatment outcomes and patient compliance.

INTRODUCTION

Many technologies were developed in the modern period to create numerous ways of administration for drugs to be injected into the body so as to cure a variety of illnesses and ailments [1]. Because oral administration is convenient and comfortable for patients, it remains widespread even with on-going advancements in drug delivery techniques. Drug administration methods with controlled release are intended for oral use. The medication is released by these means of drug delivery in a regulated, predictable, and predefined manner [2]. These pharmaceutical administration methods distribute the drug in a regulated, predictable, and predefined manner. Because of problems with stability or absorption they are inappropriate while taking drugs that hadlimited bioavailability. Modern methods that are meant to prolong the residency of these medications in the gastrointestinal tract can help to improve these issues [3].

Solid dosage forms can be managed in their gastrointestinal retention using a variety of mechanisms, including mucoadhesion, flotation, sedimentation, expansion, and changed shape systems. Pharmacological drugs that put off gastric emptying can also be used in this manner. According to these methods, floating drug delivery devices is the most promising method for regulating medication release [4].

Over the past few years, there has been a lot of effort focused on advancing the research of *in-situ* gel systems. *In situ* gel forming systems have been the subject of an increasing number of studies in recent years, and their use in various biomedical applications including drug delivery has been documented by multiple patents. The benefits of *in situ* forming polymeric delivery methods, like easier administration and lower administration frequency, better patient compliance, and increased comfort, have piqued interest [5].

Floating Drug Delivery System (FDDS)

Davis published the 1st description of floating medicine delivery systems in 1968. These low-density systems were one of the most important strategies for achieving gastrointestinal retention and obtaining adequate drug bioavailability because they possess sufficient ability to float above the stomach's contents and remain there for a considerable amount of time [6]. This is the best method for drugs with a short

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window of absorption in the upper small intestine or stomach. FDDS floats in the stomach for a long time without having any effect the rate at which the stomach empties its contents due to the fact that their bulk density is smaller than that of stomach fluids [7].

These forms of dosage floating on top of the gastrointestinal contents for prolonged duration of period without slowing down the pace of gastric emptying because their density is less than 1 mg/cc, or a bulk density that is low compared to the stomach juice. Because the drug floats atop stomach content, it flows out from the stomach at the appropriate rate and gradually. The stomach's residue system is emptied following the drug's release. In certain situations, this leads to a longer stomach retention period and more effective management of plasma medication concentration fluctuations [8-13].

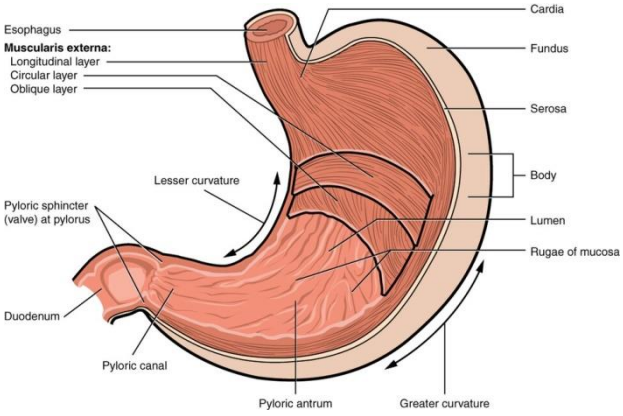

Figure 1: Stomach illustration. © OpenStax College; licensed under CC BY 3.0. Source: *Anatomy & Physiology* (Connexions Web site), http://cnx.org/content/col11496/1.6/.

Classification of Floating Drug Delivery

i.Effervescent System

These consist of various effervescent chemicals such as citrus acid, acid tartaric, and sodium bicarbonate, as well as matrix type systems derived from swellable polymer like chitosan and methylcellulose. They are designed so that CO_2 is released upon contact with the stomach contents and accumulates in swollen hydrocolloids, giving the dosage forms buoyancy [14]. In recent years, a floating pill type that produces CO_2 gas in numerous units was recently invented [15].

ii.Non Effervescent System

The method entails closely blending the medication with gel-forming hydrocolloids, which expand upon coming into contact with stomach fluid following oral ingestion and preserve a comparatively intact form and the bulk density of a lower one. The air retained by the swelling polymers inside the outermost gelatinous barrier gives these dose forms their buoyancy [16].

Need of Floating Drug Delivery System

Background the quest for an efficient and patient friendly oral drug therapy has has prompted the creation and use of floating drug delivery systems (FDDS). FDDS provide sustained gastric retention, and improved bioavailability, controlled drug release which can surpass some of the limitations associated with other conventional methods [17]. These systems have shown many benefits in terms of patient compliance to the treatment, therapeutic outcomes generated and due to that their possibilities for targeted and localized drug delivery are endless.

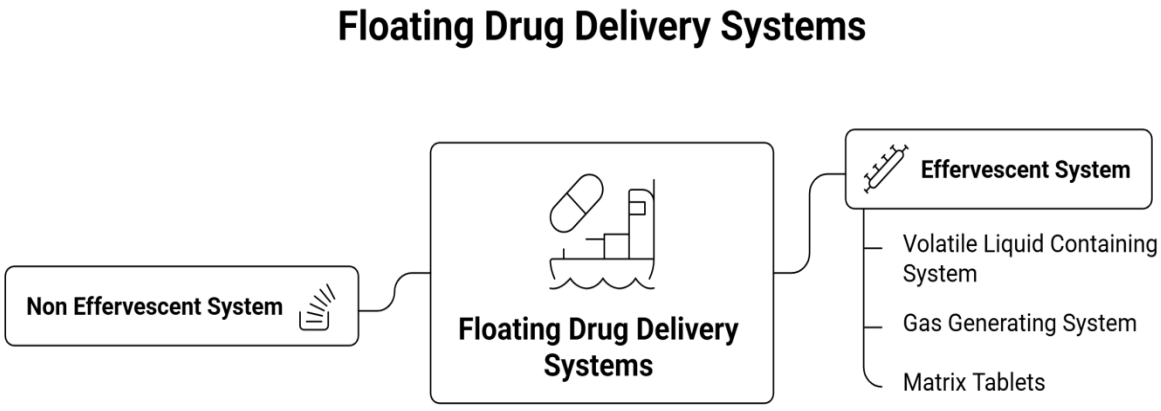

Figure 2: Classification of floating drug delivery systems

In future subsequent research and technology, FDDS are predicted to have more pivotal role in the development of pharmaceutics for different therapeutic applications with innovative solutions [18].

Advantages of FDDS

- Floating dosage forms, such as tablets or capsules, will remain in the fluid for a long time despite the gut pH being alkaline.
- FDDS is advantageous for drugs like antacids that are meant to have a localized action in the stomach.
- When a patient has diarrhea or a strong bowel movement, FDDS dose forms help the medicine stay in the stomach longer and produce a better reaction [19].
- Decreased variations in medication concentration: The variations in concentrations of drugs in the blood are reduced due to prolonged release and avoidable concentration-dependent side effects. The fact that drugs possess a poor therapeutic index is particularly significant [20].
- To enable medication targeting primarily through mucosal membranes in order to allow non-invasive drug administration.
- Its hydrophilicity extends the *in vivo* circulating time of the delivery device, which is a crucial stealth property.
- By enabling drug targeting, primarily through mucosal membranes, it exhibits bioadhesiveness to facilitate non-invasive medicine delivery.
- To lessen the nasolacrimal duct-drained medicines' systemic absorption [21].

Disadvantages of FDDS

- One disadvantage of floating systems is that the drug dose forms cannot float and work correctly unless there is sufficient stomach fluid present.
- For drugs that have problems staying soluble or stable in the stomach juices, floating systems is impractical.
- Additionally, these systems need for the availability of food to postpone their gastric emptying [22].
- Dose dumping
- First-pass metabolism drugs might not be the best option for stomach floating in-situ gel.
- *In vivo* and *in vitro* correlations show unpredictability [23].
- Its limited mechanical strength may results in an early disintegration [24].

***In-Situ* Gelling System**

The Latin term "*in-situ*" meaning "in its original place or in position" Numerous studies concentrated on creating novel medication delivery methods that would increase both bioavailability and efficacy at the same time, lowering the frequency of dosages to reduce adverse effects. Forty as a step forward, they create distribution of polymeric materials *in-situ* systems, motivated by the benefits of simple administration, precise dosing, extended drug residence duration in contact to mucosa relative to traditional fluid form of dosage and enhanced patient comfort and compliance [25].

Pharmaceutical supply systems that are injected or dispersed into the bloodstream prior to administration, but which are subsequently gelled *in situ* to form a gel, are known as polymer generating formulation for *in situ* use. It may be possible to significantly enhance the liquid *in situ* gelling process to provide a liquid oral formulation with a long-lasting release. Many research have been done on *in situ* gel formulations as continuous drug delivery vectors. The advantages of *in-situ* polymer injection systems, encompassing user-friendliness low administration speed, improved patient compliance, and convenience, attracted this focus. For the production of gel *in situ*, one or more changes of pH transitions, temperature control, and solvent exchange occur. There are several strategies to create gelling *in situ*, such as oral, nasal, ophthalmic etc. Formulations for on-site pharmaceutical administration systems employ a variety of natural and synthetic polymers, including pectin, polymers (PL), lactid poly-(DL lactid co-glycolide), polycaprolactone (XYL), and poly-(DL). for systems that offer healthcare on-site. Prescription bioavailability is more likely to be increased via gastroretentive gelling than by the conventional liquid dosage method. Because of the polymer's bioadhesive properties, the gel created by a light *in situ* gelling method floats clings to the gastric mucosa or covers the stomach, causing gastric dose retention and an extended duration of gastrointestinal tract residence for medications [26-29].

Floating gastroretentive the term "*in-situ* gel" describes a low-viscosity polymer solution that, when in contact with stomach fluids, changes its

polymeric structure and produces a robust, viscous gel having a thickness less than that of stomach juices. Ionic crosslinking, pH changes, and temperature variations can all cause gelation. Intraperitoneal, injectable, oral, ophthalmic, rectal, and vaginal methods can all be used to give *in situ* gels [30]. Solvent exchange, temperature modulation, pH change, and other stimuli can all assist for the advancement of *in-situ* gels. Drug delivery using smart polymeric systems is a potential approach; upon administration, these polymers experience a sol-gel transition. Aqueous gels of large molecules of hydrophilic in nature cross-linking polymers or polymers that create a 3D matrix in fluid are known as hydrogels. It has been demonstrated that these gels combine a much longer residence duration with higher drug bioavailability. Hydro gels are polymers that expand and cause a liquid-to-gel transition. They can also absorb and hold huge volumes of water or biological fluids [31].

Approaches of *In Situ* Gel Drug Delivery

In-situ gel can be produced using a range of techniques, including physical changes to biomaterials (such as swelling and liquid absorption), biological stimulation, and chemical reactions (such as enzymes, chemical polymerization, and photo-induced reactions) (e.g. pH, temperature).

***In-Situ* Gel Systems Induced By Physical Means**

- ***Swelling:*** In situ formation is the process where a substance takes in water via its immediate environment and expands to fill the necessary space. Glycerol monooleate is an example of a chemical. This polar in nature lipid swells in the presence of water to generate liquids phases that are crystalline. It may be broken down *in vivo* by enzymatic activity and possesses certain bioadhesive qualities.

- ***Diffusion:*** This process cause the polymer matrix to precipitate or solidify by allowing solvent obtained from the polymeric solutions to diffuse into the immediate tissue. It has been demonstrated that N-methyl pyrrolidone (NMP) is a helpful solvent for such systems [32].

***In-Situ* Gel Systems Triggered Chemically**

- ***Ionic Crosslinking:*** When there is different ions including k+, Ca2+, Mg2+, and Na+, several ion-sensitive polysaccharides, including sodium alginate, go through phase transitions. Aqueous liquid solutions are supplied *in-situ*, and under specific circumstances, they gel. A gelling agent is then used to create a system comprising additional excipients and the distributed medicament. The method works by using ionic complexation-activated polymer solutions, including sodium alginate. The solutions involve divalent ions that are complexed with Na-citrate, which undergo pH shift and liberate free divalent ions (Ca2+) when they broken down in the stomach's acidic environment [33].

- ***Crosslinking by Enzyme:*** *In situ* gel production aided via naturally occurring enzymes. To instance, Catalytic pH-sensitive polymers with mounted insulin as well as glucose oxidase may grow according to blood glucose levels, the insulin is released that has been entrapped. Thus, the pace of gel formation may be controlled by varying the quantity of enzyme, allowing combinations prior administration before the gel production.

- ***Photo-polymerization:*** In order to create gel that is either easily broken down using enzyme or chemical methods or that has the potential to last for an prolonged period of time *in vivo*, One method of treating a tissue location is by injecting a solution of initiator and monomers, like acrylate or other polymerizable groups with functional properties and then exposed to electromagnetic radiation. brief wavelength UV haven't employed since it have few tissue infiltration and is physiologically hazardous. Usually UV and visible wavelengths with extended wavelengths are employed [34].

Formation of *In-Situ* Gels in Response to Biological Stimulus

In-situ Gelling Depending on Temperature: Here the gel fluid at ambient temperature and they gel upon coming into contact with biological fluids because of the temperature increase. This technique makes advantage of temperature-induced phase shift. A rise in ambient temperature (lower critical solution temperature, LCST) can cause sudden changes in the soluble state of some polymers. This can lead to the formation of negatively temperature sensitive hydrogels, which make it less favorable

for the polymer to form hydrogen bonds with water than it is for polymer–polymer and water–water relations. Additionally, there is a sudden shift when the solvated macromolecule rapidly dehydrates and adopts a form that is more hydrophobic [35].

In-situ Gelling Depending on pH:

Polymers which are those with functional groups that are either acidic or alkaline and react to pH variations. Materials that respond to changes in pH can be applied to handle the pH, a crucial signal. An change in pH causes the fluid to gel. A great deal of ionizable groups characterize polymers that are poly electrolytes. When weakly basic (cationic) groups are present in the polymer, hydrogel swelling reduces when the pH outside increases, while it increases when weakly acidic (anionic) groups are present. An anionic polymer example would be carbomer and its derivatives [36].

Mechanism of *In-Situ* Gelation

Prior to administration, these are liquid solutions with water content, but under physiological conditions, they gel. In-situ gel formation can result from a number of processes, including temperature modification, pH shift, and ionic cross-linkage. In-situ gelation of an oral solution is caused by polymer solutions like pectin, as well as gellan and sodium alginate, which include divalent ions, that are complexed with sodium citrate. These ions are broken down in the stomach's acidic environment to liberate free divalent ions (Ca+2). It entails the complexation using cations and hydrogen bonding with water to construct dimensional networks through the aggregation of doubles helical segments to produce double helical junction zones. The medication is gradually discharged from the system at the desired rate while it is floating on the stomach [37].

Drug Suitable for *In Situ* Gel Delivery System [38]

- Drug which predominantly affects the stomach.
- Drug is mostly taken up by the stomach.
- Drug which is insoluble at high pH, like verapamil HCl and diazepam.
- Drugs such as cyclosporine and levodopa that have a limited window of absorption.
- Drug that the GIT absorbs quickly, such as tetracycline.
- Drug that breaks down in the colon, such as metformin and ranitidine;
- medication that alters the typical microorganisms in the colon, such as ampicillin.

Drug In Suitable for *In Situ* Gel Delivery System [39]

- Drug with extremely low acid solubility,.
- Medication which have inconsistency in the stomach, or solubility issues in the gastrointestinal tract, like phenytoin.
- Drugs meant for the colon's selective release, such as corticosteroids & 5-amino salicylic acid.
- Drugs like nifedipine and propranolol which get absorbed throughout the whole GIT, enters first-pass metabolism.

Polymers for *In Situ* Gel Preparation

Utilizing Natural Polymers to Prepare *In Situ* Gel

1. ***Xanthan Gum:*** Made via the pure aerobic fermentation of carbohydrates with the Xanthomonas campestris bacteria, xanthan gum comprises an exceptionally high molecular weight intercellular polymer [40]. A polymer with many side chains that are trisaccharides, xanthan is a lengthy chain polymer. This polymer is anionic due to the presence of both pyruvic acid and glucuronic acid groups in the side chain [41].

2. ***Gellan Gum:*** The extracellular linear polysaccharide gellan gum is an elevated molecular weight, anionic polymer of glucose, rhamnose, with deacetylated extracellular polysaccharide. Pseudomonas selodea grown in pure culture produces it as a fermentation product. Phytagel, Gelrite, and Gellan gum are other brand names used in commerce [42].

3. ***Karaya Gum:*** The vegetable gum known as "kaya gum" is secreted by Sterculia trees. The sugars galactose, as well as rhamnose, and galacturonic acid combine to form gum karaya, an acid polysaccharide. Among the commercial plant exudates, gum has the least solubility; yet, even at low concentrations (1%), it absorb water quickly and swells to create viscous colloidal solutions. The acetyl groups that make up karaya gum's composition are what cause it to swell [43].

4. ***Psyllium Husk:*** Psyllium husk is a polymeric material that is readily available, swellable, biocompatible, affordable, inert, and environmentally acceptable. It is derived from the dry coats of seeds of Plantago ovate. 5–10% of the seed's lipid composition consists of unsaturated fatty acids, sterols, proteins (15–18%), trace levels of aucubin and cyclopentanopyridine-class alkaloids, and 10–12% of the seed's mucilage is heteroxylan-type [44].

5. ***Pectin:*** They are anionic polysaccharides of plant origin, mainly composed of galacturonic acid, that were extracted from the cell walls of most plants. When divalent ions, such as calcium, are present, pectin gels. This process results in ionic cross linking, which is the cross linking of galacturonic acid units, as well as pH-dependent gelling [45].

6. ***Chitosan:*** Chitin undergoes alkaline deacetylation to yield chitosan, a naturally occurring and adaptable polymer. Because of its non-toxicity, biocompatibility, and biodegradability, it offers advantageous biological qualities. With its antibacterial properties and bioadhesive nature [46].

7. ***Xyloglucan:*** The polysaccharide known as xyloglucan is extracted from tamarind seeds. It consists of a (1-4)-β-D-glucan backbone chain with (1-6)-α-D xylose branches that are partly replaced by (1-2)-β-D-galactoxylose [47].

Utilizing Synthetic Polymers to Prepare *In Situ* Gel

1. ***Alginic Acid:*** Made up of β-D mannuronic acid (M) and α-L guluronic acid (G) residues joined by a 1,4-glycosidic link, alginic acid is a polysaccharide. It is a linear block copolymer. Diluted water-based solutions of alginates harden to gel through a cooperative mechanism whenever di- and trivalent metal ions become present. Comprising successive guluronic residue in the G blocks within the alginate chains. The characteristic is extensively utilized in the creation of vehicles for the continuous administration of bioactive compounds, typically in the form of matrix devices [48].

2. ***Hydroxypropyl Methyl Cellulose*** **:** *In situ* gels are commonly made with synthetic polymer HPMC, particularly in the pharmaceutical sector. For regulated medication delivery systems, its special characteristics include high viscosity, non-toxicity, and biocompatibility make it ideal. Because it extends the duration of the medication's residence time, this polymer is highly beneficial for oral, nasal, and ocular drug delivery. This promotes patient compliance and the medicine's therapeutic efficacy [49].

3. ***Carbopol:*** It is an example of a renowned pH-dependent material that stays in solutions at acidic pH values and gels having little viscosity at alkali pH levels. When mixed with HPMC, increase the viscosity of the carbopol solution simultaneously decreasing its acidity [50].

4. ***Poloxamer:*** These ABA-type triblock copolymers are composed of PEO units (A) and PPO units (B) combined. The poloxamer family comprises liquids, pastes, and solids with ethylene oxide-propylene oxide weight ratios ranging from 1:9 to 8:2 and molecular weights ranging from 1100 to 14,000. Aqueous poloxamer solutions that are concentrated are used to create thermo-reversible gels [51].

Effectiveness of the *In-Situ* Drug Delivery Method

- ***Ocular Delivery:***

Ocular *in situ* gels are major frequently used with natural polymers such xyloglucan, gellanic gum, and alginic acid. Various medications, including antimicrobials, anti-inflammatory pharmaceuticals, and stand-alone intraocular glaucoma treatment medications, were available for distribution locally. traditional delivery systems frequently lead to inadequate bioavailability and clinical reactions, and problems removing the drug from the eyes might be caused by excessive tear fluid levels and turning. Ophthalmic *in situ* gels are being developed in order to address bioavailability issues [52].

- ***Oral Delivery:***

Numerous oral formulations for the sustained administration of medications has developed. *In situ* oral drug administration methods employ natural polymers such as pectin, xyloglucan, gellan, and sodium alginate. Sodium alginate and calcium chloride are components of complexing agents. Compared to standard liquid doses, the *in situ* gastro-retentive gelling technique seeks to increase the bioavailability of pharmaceuticals. When using gellan therapeutically, a major source of worry was the medication application. Unlike regular eye drops, medications from *in situ* gels are delivered with longer viscosity gels [53].

- ***Nasal Drug Delivery Systems*:**

Mometase furoate was distributed as polymers creating *in situ* gel in the nose as part of a method developed and tested for treating allergic rheinitis. Research on the influence of on-site gel on reactive rats and an allergy model of rhinitis were conducted on animals to investigate the impacts of antigen-mediated nasal symptoms. The advancement of the nasonex formulation's effects was stopped by *in situ* gel [54]. It has been demonstrated that goblet cell appearance and intact ciliated epithelium are protected against nasal administration versus historopathology of the rat nasal cavity. The formula had a gel-like structure at ambient temperature and was in solution at 37°C. In pet testing, blood glucose concentration in the beginning readings was 40–5% lower after 4-5 hours, without any signs of cytotoxicity. Additionally, these systems are perfect for supplying the nasal system with protein and peptide drugs [55].

- ***Rectal and Vaginal -Delivery:***

Gels that are *in-situ* can also be used for vaginal and rectal medications. Despite being the easiest and most practical way to provide medication, which is orally is not feasible from a pharmacological or therapeutic standpoint. Rectal administration is a viable option in certain situations and could be utilized to provide medication regarding both systemic and local effects. In contrast to other regions of the GIT, the rectum's environment is thought to be quite steady and stable, and its enzyme activity is lower. However, because of the poor adherence to the rectal membrane and the possibility of dosage form evacuation, irregular medication absorption might pose a problem for the rectal cavity [56]. Apart from treating vaginal infections, causing labor induction, treating local symptoms of menopause and using contraception, it is a generally underutilized place. It might be a method for a treatment portfolio that includes chemotherapy and vaccine administration. Smooth systemic medication distribution can be facilitated by the vaginal epithelium's blood supply and wide surface area. Thermo reversible, sticky gels and pessaries have been investigated as formulations platforms for the administration of hormones that induce labor, antiviral and antibacterial chemicals, and even intravaginal vaccination delivery [57].

- ***Injectable-Drug Delivery Systems:***

Hydrogels are a great option for giving the back of the eye a steady and continuous biologics concentration. However, because complex ocular barriers and several elimination paths exist, standard preform hydrogel solutions do not effectively transport the medicine to the back of the eye when given topically. Furthermore, their strong first surge of the drug, weak mechanical characteristics, and quick drug release restrict their use for IVT injection medication administration to the posterior part of the eye. The flowing freely polymeric solution known as IISGDs changes into a gel-like or semisolid deposit form when injected at the target location and exposed to environmental stimuli such as light, temperature, and ionic concentration. Furthermore, they could be the perfect platform for maintaining [58].

Evaluations and Characterizations of *In-Situ* Gel System

i. ***Physical Appearance and pH*:** Particulate matter should not be present and *in situ* solutions ought to be transparent. The amount of time needed for a solution converted to gel in a pH 1.2 buffer is calculated, and the gel's visual consistency is verified. Using a black and white background, visual inspection was utilized to evaluate the clarity of the solutions. A digital pH meter that had been calibrated at 25°C was used to measure the pH [59].

ii. ***In-vitro Gelation Study*:** A colored formulation solution is made, and 15 milliliters of the gelation medium (0.1N HCl, pH 1.2) are placed in a test tube to assess the gel forming solution's *in vitro* gelling capacity. One milliliter of colored formulation is then added. A stiff gel is form as the solution and gelation medium

come into contact. Stiffness and the amount of time the gel stays constant are used to calculate a gelling capacity. The visualization method is another way to assess gelling potential. Using this procedure, five milliliters of 0.1 N HCL were placed in a glass tube and kept at 37°C±1°C. Numerous factors were noted, including the amount of time required for *in situ* gel formation, the gel's apparent stiffness, and how long the gel remained intact [60].

iii. ***Determination of Drug Content*:** 10 milliliters of in-situ gel from various batches, or 20 milligrams of metoclopramide hydrochloric acid, were precisely measured and then added to a 100 ml volumetric flask. After adding 50–70 ml of 0.1 N HCl, this was Sonicated about 30 minutes. A 100 ml volume adjustment was made. Visual inspection and the use of Whatman Filter Paper guaranteed that the contents were completely dispersed. A 10 ml sample was extracted from this solution, then 100 ml was made by diluting it with 0.1N HCl. Using a reference wavelength double beam UV-visible spectrophotometer, the contents of metoclopramide HCl were measured spectrophotometrically [61].

iv. ***Viscosity*:** Spindle number 2 is used at 50 rpm and a Brookfield digital viscometer set to one degree Celsius, the viscosity of each formulation was measured. Every 25 readings, the sample temperature was regulated. Using a cone and plate viscometer or Brookfield viscometer at an appropriate temperature of 25±1 C and one or two milliliter sample aliquots, the It is determined how viscous the solution is both prior to and following gelling. When the formulation is dissolved into a liquid, ionic contact causes a quick sol-gel transition that ought to be easy to swallow [62].

v. ***In-vitro Floating Study*:** The ability of gel to float is assessed using a 500 mL type II simulated dissolution device. After that, the created formulation gets added to the dissolution vessel in a volume of 10mL. It is recorded how long it takes the formulation to float (the floating lag time) and how long it stays on the surface continuously (the floating time) [63].

vi. ***Swelling Index:*** A straightforward procedure determines the swelling index of the gel. A 40 mL solution of 0.1N HCl (pH 1.2) was utilized to create an in-situ gel for this investigation. Divide each formulation's 0.1N HCl gel portion, then use paper towels to wipe away any extra HCl solution. After the gel has been weighed for 12 hours, weigh it again, add 50 milliliter of distilled water, pour the water out, weigh the gel again, compute the weight difference, and report it [64].

vii. ***In-vitro Drug Release Study:*** Using a USP dissolving equipment (type II) at 50 rpm in 900 mL of 0.1N HCl at pH 1.2 at 37°C, *in vitro* drug release is measured. A 10 milliliter mixture is taken and stored in a dissolving vessel in a Petri dish. Next, without causing any disturbance, the dissolving medium is added to the dissolution vessel. Every predetermined period, an appropriate sample is taken and replaced with new medium. The dissolution research needs to be done for a minimum of eight hours [65, 66].

CONCLUSION

With many advantages like regulated medication release and extended stomach retention, floating in-situ gels show great promise as a gastro-retentive drug delivery technology. With ongoing research and technological advancements, these systems are capable of significantly improved therapeutic outcomes and patient cooperation in the management of different gastric and systemic conditions. Compared to traditional oral dose forms, the floating oral *In-Situ* gel has a number of advantages due to its formulation and evaluation. Understanding the behavior of polymers that float and gel can help us to increase the stomach retention and, consequently, the bioavailability of different medications,

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