IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Human Journals
Review Article
May 2023 Vol.:27, Issue:2

A Review: Floating Drug Delivery System

IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Abhijeet K. Raut*[1], Vinayak K. Deshmukh[2], Anil R. Pawar[3], Pranjal D. Lohakane[1]

[1]*Deparment of Quality Assurance Techniques Mula Education Society's College of Pharmacy Sonai, India.*

[2]*Principal, Mula Education Society's College of Pharmacy, Sonai Tal. Newasa Dist.- Ahmednagar Maharashtra 414105. India.*

[3]*Department of Pharmaceutics, Mula Education Society's College of Pharmacy, Sonai Tal. Newasa Dist.- Ahmednagar Maharashtra 414105. India.*

Submitted: 27 April 2023
Accepted: 02 May 2023
Published: 30 May 2023

Keywords: Floating Tablets, Control Drug Release, Patient Compliance, Improved Bioavailabilty.

ABSTRACT

By overcoming physiological challenges such short gastric residence periods (GRT) and unpredictably long stomach emptying times, rate controlled oral medication delivery devices have recently made scientific and technological strides (GET). Several methods are now used to extend the GRT, including delayed gastric emptying devices such as swelling and expanding systems, polymeric bio adhesive systems, modified-shape systems, high-density systems, and floating drug delivery systems (FDDS), also known as hydrodynamically balanced systems (HBS). The two approaches are taken in the development of FDDS by creating both effervescent and non-effervescent floating tablets with a buoyancy mechanism as its foundation. Drugs with limited solubility and higher pH levels can be delivered by FDDS because they have a restricted window for absorption in the upper gastrointestinal system, are unstable in the lower intestine environment, and have local activity. The physiological and formulation factors that affect gastric retention time are included in the most recent advancements in floating drug delivery systems. Additionally, approaches to formulating single-unit and multiple-unit floating systems, as well as their classification and formulation aspects, are covered in detail. The application of floating drug delivery devices and the evaluation criteria are also summarised in this paper.

HUMAN JOURNALS
www.ijppr.humanjournals.com

INTRODUCTION

Drug delivery systems are used to deliver pure, unprocessed drugs in solid, liquid, or semi-solid form to specific body sites. These systems must be therapeutically effective, safe, and stable enough to deliver the required dosage of the drug, achieve the desired concentration, and then maintain the adjusted concentration. Oral medication delivery systems make up a large portion of the commercialised drug delivery systems.[1] Oral drug delivery is typically favoured due to reduced treatment costs, higher patient compliance, and ease of administration. Despite several advantages, a medication's frequency of administration should be increased because it is quickly eliminated from the stomach.[2] The distribution of medications must offer a longer duration of stomach residence in order to get beyond these obstacles. The time of medication release is improved, drug waste is reduced, and drug solubility is improved for drugs that are less soluble in high ambient pH levels thanks to gastro retention. Since their release is continuously delayed and regulated, many medications that are released in the stomach offer the strongest therapeutic effects. The need for repeated dosages would be unnecessary and this form of drug delivery technology would have significantly fewer negative effects. Drugs are formulated in multi-layered or bilayer tablets for pharmacological dosing.

A unique method of combining the loading dose and the maintenance dose in a tablet. This style allows for the creation of a prolonged release medication in combination with an instant-release dose. In order to maintain a sustained blood level, two layers are used, the first with a longer release ratio. By providing the initial dose, the immediate release segment will quickly degrade following absorption. dose of drug for quick effect, which goes through the matrix layer without damaging it. Most of the time, the gut progressively dissolves from its exposed parts along this course. enables the initial blood level to be maintained.[3]

Conventional controlled-release dosage forms often delay the beginning of effect following oral administration and prolong drug release. Because the drug is rapidly released from the fast release layer, causing a rapid rise in drug plasma concentration, and is then continuously released from the sustained release layer, the stacked tablets offer a pharmacokinetic advantage over conventional controlled release dosage forms.[4]

MECHANISM OF FLOATING SYSTEMS

The medicine is slowly released from the system at the desired rate while floating on the gastric contents. The stomach's residual system is emptied after the medication has been released. For the buoyancy retention principle to be properly achieved, however, a minimum degree of floating force (F) is also necessary to maintain the dose form consistently buoyant on the surface of the meal. A novel method for calculating the resultant weight has been described in the literature as a way to measure the kinetics of the floating force. The device works by continually measuring the force F (expressed as a function of time) needed to keep the submerged object in place. If F is higher on the positive side, the object floats better.[5]

Gastrointestinal Retention

Drugs' stomach residence times can be greatly extended by gastro retentive systems since they can stay in the gastric region for several hours. For medications that are less soluble in a high pH environment, prolonged stomach retention increases bioavailability, lowers drug waste, and enhances solubility. has uses for delivering medications locally to the stomach and nearby small intestines. Gastro retention aids in improving patient access to novel medications with novel therapeutic prospects and significant advantages5. For maximum gastrointestinal absorption of medications and site-specific administration, one has to have a solid foundational understanding of the anatomic and physiological properties of the human GIT. This is achieved through the use of floating drug delivery systems (FDDS). These are listed and quickly explained.[6]

Basic Gastrointestinal Tract Physiology

The stomach is anatomically separated into three sections: the fundus, body, and antrum (pylorus). While the antrum is the primary location for mixing motions and serves as a pump for stomach emptying by thrusting activities, the proximal portion made of the fundus and body serves as a reservoir for undigested material.[7]

Stomach Physiology

The digestive tract between the oesophagus and small intestine is extended in the stomach. With the exception of having an additional, oblique layer of smooth muscle inside the circular layer, which helps with the execution of intricate grinding actions, the stomach's wall is physically comparable to the other segments of the digestive tube. When the stomach is

empty, it contracts, throwing up discrete folds known as rugae made of the mucosa and submucosa of the stomach.[8]

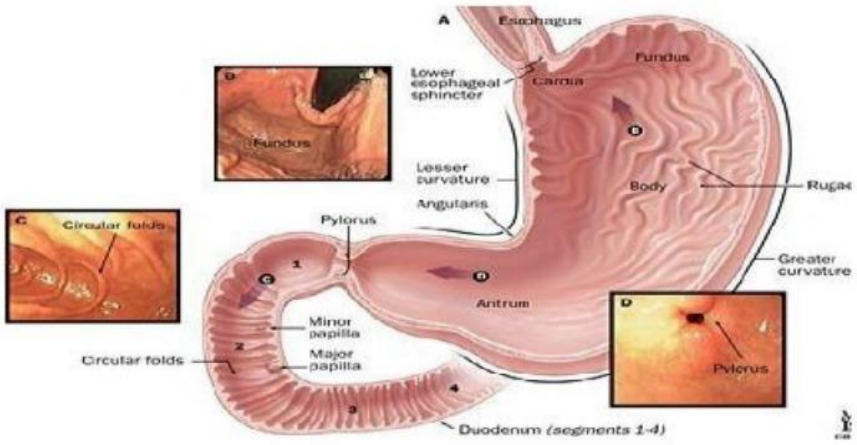

Figure 1: Physiology of stomach

Images of the four primary secretary epithelial cell types that line the surface of the stomach and descend into the gastric pits and glands are as follows:

Mucous cells release an alkaline mucus that shields the epithelium from acid and shear stress.

Gastric Motility

A complex network of neuronal and hormonal signals regulates gastric motility. The enteric nervous system, as well as the sympathetic and parasympathetic (mostly vagus nerve) nervous systems, are the sources of nervous control. Numerous hormones have been demonstrated to have an impact on gastric motility; for instance, cholecystokinin and gastrin both work to relax the proximal stomach and increase contractions in the distal stomach. In conclusion, it is believed that the patterns of stomach motility are a result of the integration of a variety of inhibitory and stimulatory impulses by smooth muscle cells. While solids must be reduced to a diameter of less than 1-2 mm before passing the pyloric gatekeeper, liquid can pass through the pylorus with ease in spurts. For the dose form to dissolve in vivo, the stomach capacity is crucial. The stomach can hold 25–50 ml at rest.

The amount of stomach output in normal and achlorhydric people differs significantly. The effects of gastric pH on drug absorption via the delivery method are also notable. The pH of a fed stomach is 2.0-6.0, and it is 1.2-2.0 when it is fasting.[9]

Gastric Emptying Rate

Both when you are eaten and while you are fasting, your stomach is emptying. However, the two states' motility patterns are different from one another. A sequence of electrical events known as the inter-digestive cycle pass through the stomach and intestine every two to three hours while someone is fasting. This is known as the migrating myoelectric cycle (MMC), which is further broken down into the following 4 steps as stated by Wilson and Washington.

1. The 40-to-60-minute Phase I (Basal phase) lasts with irregular contractions.

2. Intermittent action potentials and contractions characterise Phase II (Preburst Phase), which lasts for 40 to 60 minutes. The intensity and frequency gradually rise as the phase develops as well.

3. The third phase (the burst phase) lasts 4 to 6 minutes.

After consuming a mixed meal, the pattern of contractions switches from a condition of being fasted to one of being fed. This also goes by the name "digestive mobility pattern" and consists of contractions that are ongoing like in Phase II of the fasted state. The size of the food particles is decreased by these contractions (to less than 1 mm), and they are then driven toward the pylorus in a suspension state. The fed state causes MMC to start later, which slows down the rate at which the stomach empties. Gastric emptying rates were determined using scintigraphy tests, which showed that controlled release dosage forms taken orally are primarily affected by two issues: a short gastric residency duration and an unpredictably high gastric emptying rate.[10]

Advantages of Floating Drug Delivery

1. Some drugs' bioavailability, like that of riboflavin, levodopa) CR-GRDF is substantially more effective more effective than administration of CR polymeric compositions that are not GRDF.

2. Medications with a short biological half-life may experience flipflop pharmacokinetics, which lowers the dose frequency. This is also possible with drugs when FDDS input is slow and continuous. These characteristic increases patient compliance, which enhances the therapy.

3. For local therapy in the stomach, the prolonged and sustained delivery of the medication from FDDS may be helpful.

4. Slow drug absorption into the body reduces counter activity, increasing drug effectiveness.

5. The pre systemic metabolism of the tested drug may be massively improved when the medication is supplied to the metabolic enzymes (cytochrome P-450, in particular CYP-3A4) in a sustained way.

Limitations/Disadvantages

1. These systems need a lot of fluid in the stomach to float and function properly when delivering drugs.

2. Unsuitable for medications with GIT solubility or stability issue.

3. It would not be advisable to take drugs like nifedipine, which is well absorbed throughout the GIT and undergoes first pass metabolism.

4. Drugs that irritate the stomach mucosa are also not preferred or appropriate.

5. These systems do not provide any much in the way of benefits compared to the standard dosage medication dosage formulations that are absorbed throughout the digestive.[10]

CLASSIFICATION OF FDDS

(**A) Effervescent FDDS**

1. Gas generating system

2. Volatile liquid containing system

(B)Non- Effervescent FDDS

1. Colloidal gel barrier system

2. Microporous compartment system

3. Floating microsphere

4. Alginate floating beads

(C) Raft forming system

1. Gas generating system

Low-density FDDS is based on the release of CO2 following oral delivery upon interaction with gastric juices. The materials are designed such that when entering the Co2 is liberated in the stomach as a result of an interaction with the acidic gastric contents, which become trapped in the gel-based hydrocolloid as shown in Figure No.1. It causes the dose form to rise while maintaining its buoyancy. In the end, it results in a decrease in the dose form's specific gravity, which causes it to float on the chime. The co_2 generating components are combined in a single layer or multiple layers within the tablet matrix to create a gas generation mechanism in the hydrocolloid layer, while the drug is released over a longer period of time in the other layer.

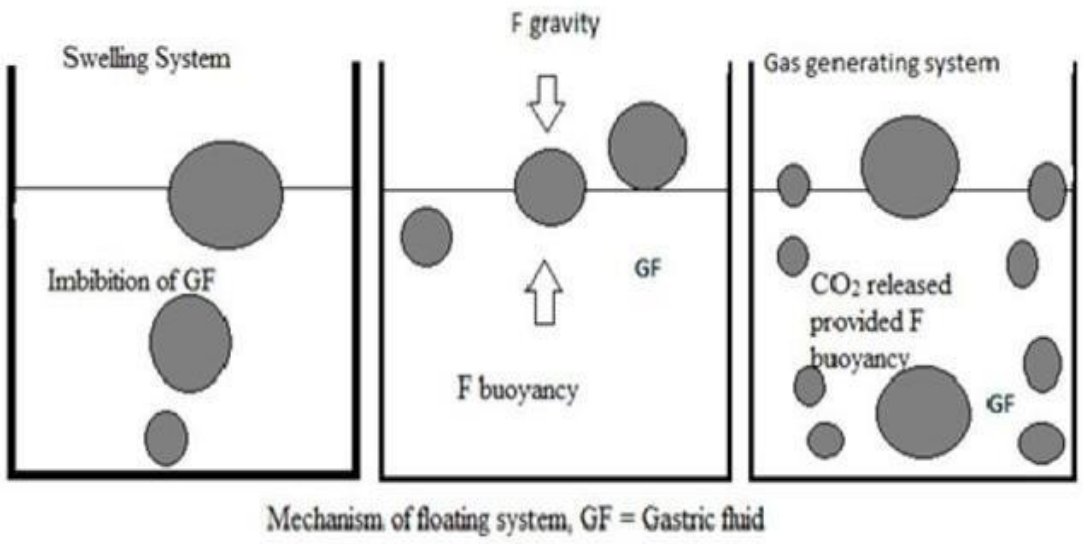

Figure No.2: Mechanism of floating [11]

2. Volatile liquid containing system

A gadget made of a hollow deformable unit in convertible compressed state makes up this osmotically controlled floating system. Internally divided into a first and second chamber and separated by an impermeable, pressure-sensitive movable unit, the housing would be attached to its deformable unit. A volatile liquid, such as cyclopentane or ether, gets vaporised in the second chamber at a physiological temperature to form a gas, allowing the drug reservoir to float. The first chamber typically contains an active drug. With the assistance of a bioerodible stopper that allowed the vapour to escape, the unit is ejected from the stomach.[12]

(B)Non- Effervescent FDDS

1. Colloidal gel barrier system

This technique increases the amount of medicine that is delivered in solution form to the absorption site while extending stomach retention duration. In order to stay buoyant on the stomach content, it fundamentally comprises medication with gel-forming hydrocolloids.

One or more hydrocolloids of the cellulose type that produce gels, such as hydroxypropyl methylcellulose (HPMC), polysaccharides, and matrix-forming polymers like polycarbophil, polystyrene, and polyacrylate are included in such a system. The hydrocolloid in the system hydrates to create a colloid gel barrier to its surroundings when in contact with gastro-intestinal (GI) fluid.

2. Microporous compartment systems

This method has pores on the top and bottom sides and encapsulates a drug reservoir inside a microporous compartment. To avoid any direct contact of the stomach surface with the undissolved medication, the peripheral wall of the drug reservoir compartment is entirely sealed. The delivery system floats over the gastric content in the stomach thanks to the air-filled flotation chamber. To the extent that it stops the drug's existence and carries the dissolved medication for continuous transit across the intestine for absorption, gastric fluid penetrates through the aperture through the stomach.[14]

3. Floating Microspheres/Micro balloons

Hollow microspheres, commonly referred to as micro balloons, are thought to be the most effective buoyant device. It is made up of the microsphere's central hollow area.

A new solvent is used to create hollow microsphere that are loaded with a medication in their outer polymer shelf. Emulsion.[15]

4. Alginate beads/Floating beads

Calcium alginate spherical beads with a diameter of about 2.5 mm have been developed into multi-unit floating dosage forms. These beads can be made by mixing sodium alginate solution into an aqueous solution of calcium chloride, which causes calcium alginate to precipitate. The beads are then separated, snap-frozen in liquid nitrogen, and freeze-dried at 400 °C for 24 hours to create a porous system. These floating beads offer a longer residence

period of more than 5.5 h and this constructed system would maintain a floating force for over 12.[16]

5. Raft-forming systems

For the administration of antacids and medications for gastrointestinal and diseases, raft-forming systems are receiving a lot of attention.

A gel-forming solution expands when it comes into touch with gastric fluid, creating a viscous, cohesive gel that is entrapped with CO2 bubbles and creates a raft layer on top of the gastric fluid to help release drugs more gradually into the stomach.[16]

Factors Affecting Floating Drug Delivery System

1. Density of dosage form

The function of dosage form buoyancy, which is dependent on density, is floating. The dosage form's density should be less than the gastric contents' (1.004g/ml) density. To demonstrate floating property, a density of less than 1.0 gm/cm3 is needed. [17] Consequently, dosage forms with stomach contents can float to the surface at densities below that high density systems float to the surface, while stomach.

2. Shape and size of dosage form

Other aspects that affect gastric retention are the dose form's size and shape. When compared to dosage form units with a diameter of 9.9 mm or less, those with a diameter of greater than 7.5 mm are said to boost GRT. In comparison to other forms, the dosage form with tetrahedron and ring shape devises that have flexural moduli of 48 and 22.5 kilo pounds per square inch (KSI) is said to display superior GIT for 90 to 100% retention at 24 hours.[18]

3. Food intake and its Nature

The amount of food consumed, its viscosity and volume, its caloric content, and the frequency of eating all have a significant impact on the retention of dosage forms in the stomach. The gastric retention time (GRT) of the dose form is influenced by the presence or absence of food in the gastrointestinal tract (GIT). Feeding indigestible polymers or fatty acid salts can cause the stomach's motility pattern to change to a fed state, which prolongs medication release and slows down gastric emptying.

4. Caloric content

A meal high in proteins and fats can extend the gastric retention time (GRT) by 4 to 10 hours [16]. Due to the low frequency of migrating myoelectric complexes, floating can extend by over 400 minutes when consecutive meals are provided instead of one (MMC).

5. Effect of gender, posture and age

Compared to men, women have slower stomach emptying rates. The average stomach retention time is not significantly affected by position (GRT). The GRT of elderly people, especially those over 70, is much longer, which slows down stomach emptying. Drug delivery is also affected by conditions like diabetes and crohn's disease, among others.

6. Fed or Unfed State

The migrating myoelectric complexes (MMC), which take place every 1.5 to 2 hours, are times of intense motor activity that define the gastric motility under fasting settings. The MMC removes undigested matter from the stomach, so if the formulation is administered at the same time as the MMC, the GRT of the unit should be quite brief. However, in the fed condition, GRT is significantly longer and MMC is delayed.[19]

7. Concomitant drug administration

opiates, anticholinergics such as atropine and propantheline such as metoclopramide, prokinetic drugs like codeine, cisapride may have an impact on floating time.[6]

Evaluation of Floating Drug Delivery System

1. Shape of Tablets Compressed tablet

Compressed tablets intended for FDDS are checked under a microscope to check their consistency in terms of shape.

2. Tablet Dimensions

According to official compendia, a calibrated Vernier calliper is used to measure the thickness and diameter of tablets in FDDS form, much like with traditional tablets.

Three tablets of each formulation are chosen at random, and each tablet's thickness is measured.

3. Hardness of the Tablet

Using a hardness tester of the Monsanto type, randomly select 20 tablets from each batch of formulations should be used to determine the hardness.

4. Weight Variation

Twenty randomly chosen tablets are carefully weighed, and the average tablet weight is computed. The individual weight divergence from the average weight is then determined.

5. Thickness of the Tablet

The individual crown to crown thickness of ten tablets is determined using slide callipers for each batch.

6. Measurement of Floating Capacity

Three separate tablets are placed in a flask with 400 ml of 0.1(N) HCL solutions. The duration of floating and the time it takes for each tablet to consistently float on the water's surface are then measured in minutes for each tablet as they go up and down the flask. The next step is to calculate the sample mean and standard deviation.

7. Density of the formulation

The volumes and masses of the tablets are calculated in triplicate to determine their apparent densities. Using the mathematical equation for a cylinder, the volume V of the cylindrical tablets is estimated from their height h and radius r (both measured using a micrometre gauge).

$$(V = A \times r2 \times h)$$

8. Drug Content in Tablets

Randomly chosen from each batch, ten pills are added to a 100 ml volumetric flask that has been filled with 0.1(N) HCL. Take 1 ml from the volumetric flask and pour it into the test tube after stirring and setting it aside for two hours. After that, samples are filtered, appropriately diluted, and subjected to spectrophotometric analysis at a suitable wavelength. [5]

9. *In vitro* dissolution study

The dissolving vessel held the tablet inside. 5 ml of the sample are taken at 1-hour, 2-hour, 3-

hour, 4-hour, 5-hour, 6-hour, 8-hour, 10-hour, and 12-hour intervals, or at any additional intervals as required. After each sampling, 5 ml of the dissolving media were replaced with new, bringing the total amount of dissolution fluid to 900 ml. The mean values are depicted versus time in the release studies, which used "n" tablets. Each sample is examined using a UV visible spectrophotometer at its maximum wavelength in comparison to a reagent blank, and the corresponding concentration is calculated using the appropriate calibration curve.[20]

10. Buoyancy/Floating test

The duration of the dosage form's buoyancy on the simulated stomach fluid after introduction and the duration of that buoyancy are both timed. Total floating time (TFT) is the total amount of time that a dosage form remains buoyant. Floating lag time (FLT) or buoyancy lag time (BLT) is the amount of time that it takes for a dosage form to appear on the surface of a medium.[21]

11. Swelling study

By observing a dose form's weight rise or water intake, swelling behaviour can be determined. The growth in tablet diameter and/or thickness over time could be used to quantify the dimensional changes. The equation's result, a percent weight gain, can be used to assess water uptake.

$$WU = (Wt - Wo)\ x100$$

Where,

WU= Water uptake

Wt = Weight of dosage form at time t.

Wo = Initial weight of dosage form

Application of Floating Drug Delivery Systems

1. Sustained Release Drug Delivery System

The stomach can hold onto HBS systems for long periods of time, allowing the medicine to be released throughout a long period of time. the issue Consequences of brief gastric residence duration CR formulation that is oral, therefore it with the aid of these systems. These programmes have a bulk density of 1, which leads to They can float on the contents of the stomach. These Systems are travelling across a comparatively broad area. From the

pyloric aperture is forbidden, for instance floating capsules with a sustained release of the development of nicardipine hydrochloride and were assessed in real time. Utilizing rabbits, the formulation was contrasted with commercially available MICARD capsules. Compared to traditional MICARD capsules, sustained release floating capsules showed a longer duration of administration (16 hours) on plasma concentration time curves (8 hours).[22]

2. Site-specific Drug Delivery

These systems are especially useful for medications like riboflavin and furosemide that are specifically absorbed from the stomach or the first part of the small intestine. The stomach absorbs furosemide the most, followed by the duodenum. According to reports, a monolithic floating dosage form with a longer stomach residence duration was created, increasing the bioavailability. The floating tablets' AUC was almost 1.8 times higher than that of regular furosemide tablets.

3. Absorption Enhancement

Potential candidates for floating drug delivery systems include medications with low bioavailability because of site-specific absorption from the upper gastrointestinal tract. For example, floating dosage forms have a significantly higher bioavailability (42.9%) compared to commercially available LASIX tablets (33.4%) and enteric coated LASIX-long product (29.5%).[23]

CONCLUSION

The floating medication delivery method was developed in an attempt to prolong the dosage form's stomach retention duration and regulate drug release. Controlling the gastric residence time with gastro-retentive dosage forms will give us new and significant treatment possibilities, and is one of the most practical methods for obtaining a prolonged and predictable drug delivery pattern in the gastrointestinal tract. The purpose of floating matrix tablets is to increase the bioavailability of a medication by extending the time it spends in the stomach after oral delivery, at a specific place, and under controlled release. This is particularly helpful for reaching controlled plasma levels.

REFERENCES

1. Gupta P and Gnanarajan PK. Floating Drug Delivery System: A Review. Int. J Pharm Res Rev. 2015; 4(8): 37-44
2. Shyama SK and Sivakumar R. Floating Drug Delivery System: An Updated Review. Int J Curr Pharm Clinical Res. 2014; 4(3):150-53
3. Nirmal J, Saisivam S, Peddanna C, Muralidharan S, Godwinkumar S and Nagarajan M. Bilayer tablets of Atorvastatin Calcium and Nicotinic acid; Formulation and evaluation. Chem Pharm Bulletin. 2008; 56(10): 1455-58)
4. Hamza Yassin El-Said and Mona HA. Design and In Vitro Evaluation of Novel SustainedRelease Double-Layer Tablets of Lornoxicam: Utility of Cyclodextrin and Xanthan Gum Combination. American Assoc Pharm Scientists. 2009; 10(4):1357-67
5. Fix JA, Cargill R and Engle K., "Controlled gastric emptying III: Gastric residence time of a no disintegrating geometric shape in human volunteers." Pharm Res. 1993; 10:1087-9.
6. Vyas SP, Roop KK. Floating Drug Delivery Concepts and Advances, First Edition, New Delhi. 2002; 196-217
7. Agyilirah GA, Green M and Ducret R. Evaluation of the gastric retention properties of a cross linked polymer coated tablet versus those of a non-disintegrating tablet. Int J Pharm. 1991; 75:241-247.
8. Hoffman F, Pressman JH and Code CF. Controlled entry of orally administered drugs, physiological considerations. Drug Dev Ind Pharm. 1983; 9:1077-1085.)
9. Streubel A, Siepmann J and Bodmeier R. Gastroretentive drug delivery system. Expert Opin Drug Delivery. 2006;3(2):217- 33
10. Mathur P, Verma N: Floating drug delivery system: An innovative acceptable approach in gastroretentive drug delivery. Scholars Research Library 2010; 2(2): 257-70
11. Vedha H, Chaudhary J: The recent developments on gastric floating drug delivery system: An overview. Journal of Pharmaceutical Technology and Research 2010; 2(1); 524-34
12. Sharma V, Dr. (2012). A review on floating type gastro retentive drug delivery system. International Research Journal of Pharmacy. 3. 37
13. Joseph N, Laxmi S, Jayakrishnan A. A floating type oral dosage form for piroxicam based on hollow microspheres: *in vitro* and *in vivo* evaluation in rabbits. J Controlled Release 2002; 79:71-9
14. Yang L, Fassihi R. Zero-order release kinetics from self- correcting floatable configuration drug delivery system. J Pharm Sci 1996; 85:170-3
15. Burns Attwood D, Barnwell SG. Assessment of a dissolution vessel designed for use with floating and erodible dosage forms. IntJ Pharm 1998;160:213-8
16. Chowdary K.P.R. Recent Research on Floating Drug Delivery Systems-A Review. JGTPS. 2014; 5(1): 1361-1373
17. Sharma N., A Comprehensive Review on Floating Drug Delivery System. IJRPBS 2011; 2 (2): 2011 428-441
18. Gopalakrishnan S.,. Floating Drug Delivery Systems: A Review.J. Pharm. Sci. Tec. 2011; 3 (2): 548-554.)
19. Geetha A., Kumar J. R, Mohan K., Sateesh V., *et al*. A Review on Floating Drug Delivery Systems. Int. J. Pharm. Res. Biomed. Anal. 2012; 1(1): 1-13
20. Vyas SP, Roop KK. Controlled drug delivery concepts and advances. First Edition, New Delhi; 2002. p. 196-217.
21. Harshal S, Chetan G, Surbhi U, Sujit P. Development and *in vitro* evaluation of an oral floating tablet of metronidazole. J Drug Delivery Ther 2018;8:83-6
22. Goyal M, Prajapati R, Purohit KK, Mehta SC. Floating drug delivery system. J Curr Pharm Res 2011;5:7-18
23. Klausner E, Sara E, Lavy E, Friedman M, Hoffman A. Novel levodopa gastro-retentive dosage form: *in vivo* evaluation in dogs. J Controlled Release 2003;88:117-26
24. Mantry S, Thilothama LR and Shashanka D: Formulation and in vitro evaluation of Metoprolol Succinate Floating Tablets by using two viscosity grades of HPMC. International Journal of Pharmaceutical Sciences and Research 2012; 3(9): 3507-13

25. Raju DB, Sreenivas R and Varma MM: Formulation and evaluation of floating drug delivery system of Metformin Hydrochloride. Journal of Chemical and Pharmaceutical Research 2010; 2(2): 274-78
26. Sarojini S, Arivazagan D, Manavalan R and Jayanthi V: Buoyant Sustained Release Tablets Based On Polyethylene Oxide. International Journal of Pharmacy and Pharmaceutical Sciences 2010; (1): 144-49.
27. Pare A, Yadav SK and Patil UK: Formulation and Evaluation of Effervescent Floating Tablet of Amlodipine besylate. Research Journal of Pharmaceutics and Technology 2008; 1(4):526-30

	***Author Name – Abhijeet K. Raut*** *Author Affiliation- B. Pharma* *Student of M. Pharma at Mula Education Society's College of Pharmacy, Sonai* *Author Address/Institute Address- A/P- Sonai Tal- Newasa, Dist- Ahmednagar, Maharashtra- 414105.*
	***Author Name- Dr. Vinayak K. Deshmukh*** *Author Affiliation-* Principal*, Mula Education Society's College of Pharmacy, Sonai Tal. Newasa Dist.-Ahmednagar Maharashtra 414105. India* *Author Address/Institute Address-* A/P- Sonai Tal- Newasa, Dist- Ahmednagar, Maharashtra- 414105.
	***Author Name- Dr. Anil R. Pawar*** *Author Affiliation- Associate Professor and Head* Department *of Pharmaceutics, Mula Education Society's College of Pharmacy, Sonai Tal. Newasa Dist.-Ahmednagar Maharashtra 414105. India* *Author Address/Institute Address-* A/P- Sonai Tal- Newasa, Dist- Ahmednagar, Maharashtra- 414105.
	***Author Name- Pranjal D. Lohakane*** *Author Affiliation- B. Pharma* *Student of M. Pharma at Mula Education Society's College of Pharmacy, Sonai* *Author Address/Institute Address-* A/P- Sonai Tal- Newasa, Dist- Ahmednagar, Maharashtra- 414105.