WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 13, Issue 3, 131-141. Review Article ISSN 2277–7105

FLOATING DRUG DELIVERY SYSTEM: AN UPDATED REVIEW

Bhavna R. Machale*, Madhuri G. More, Aishwarya P. Shelar, Prof. Waghmare S. A., Anisha V. Shelar

Dept. of Pharmaceutics, Loknete Shri Dada Patil Pharate College of Pharmacy, Mandavgaon Pharata, Pune, Maharashtra, India.

Article Received on
11 December 2023,

Revised on 01 Jan. 2024,
Accepted on 22 Jan. 2024

DOI: 10.20959/wjpr20243-29834

***Corresponding Author**
Bhavna R. Machale
Dept. of Pharmaceutics, Loknete Shri Dada Patil Pharate College of Pharmacy, Mandavgaon Pharata, Pune, Maharashtra, India.

ABSTRACT

Purpose of writing this review on floating drug delivery system wasto focus on the principle mechanism of floatation to achieve gastric retention.[1] Recent technological and scientific research has been devoted to the development of rate Controlled drug delivery systems to overcome physiological adversities such as short gastric Residence times and unpredictable gastric emptying times. The present review addresses briefly about the floating drug delivery systems. This review also summarizes the in vitro techniques, in vivo studies to evaluate the performance and application of floating systems. These systems are useful to several problems encountered during the development of a pharmaceutical dosage form.

KEYWORDS: Floating drug delivery system, classification, evaluation.

INTRODUCTION

The focus of pharmaceutical research is steadily shifted from the development of new chemical entities to the development of novel drug deliverysystem of existing drug molecule to maximize their effectiveness in terms of therapeutic action, reducing frequency of dosing and wastage of drugs, patient compliance and reduced adverse effects.

The aim of drug delivery system is to afford a therapeutic amount of drug to the proper site in the body to attain promptly and than maintain desired drugconcentration.[1]

Oral route of administration has received more attention and success because gastrointestinal physiology offers more flexibility in dosage form design than other. In oral drug delivery

system not all drug (or) therapeutic agent are absorbed uniformly throughout the (GIT) since many drug are well absorbed in upper part of GIT, such high Variability may lead to non-uniform absorption And makes the bioavailability unpredicted. Hence, a beneficial delivery system would be one which posses ability to control and prolonged the gastric emptying time and can deliver drug in higher concentration to the absorption site.[1]

Drug Suitable for Gastro retentive Drug Delivery System[2]

- The Drugs which are locally active in the stomach like Antacids, Misoprostol, etc.
- Drugs showing narrow absorption window in Gastro intestinal tract e.g.
- Riboflavin, Furosemide, etc.
- Drugs showing instability in the colonic environment e.g. Ranitidine HCl, Captopril, etc.
- Drugs which are effective against normal colonic microbes e.g. antibiotics against Helicobacter pylori.
- Drugs which have low solubility at high pH values e.g. Chlordiazepoxide, Diazepam, etc.

Drugs Unsuitable for Gastroretentive Drug Delivery System[2]

- Drugs which have very limited solubility in the acid medium e.g. Phenytoin, etc.
- Drugs enduring instability in the gastric environmental conditions e.g. Erythromycin, etc.
- The Drugs which are mainly employed for their selective release in the colon e.g. 5-amino Salicylic acid and corticosteroids, etc.

CLASSIFICATION OF GRDDS[3-8]

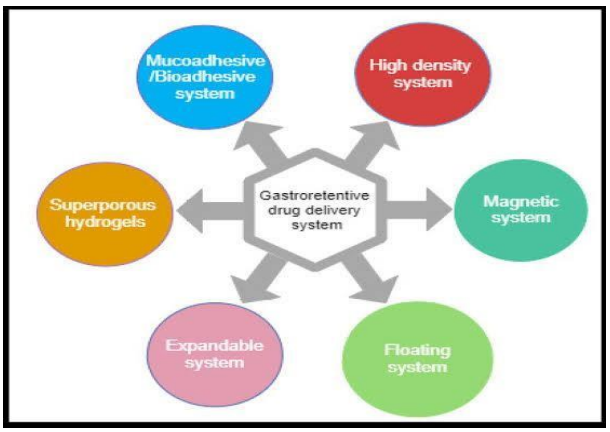

Figure 1: Types of Gastro retentive Dosage Form.[8]

High Density System

These GRDF type have a density of -3g / cm3, and are retained in the stomach rugae. These Systems can be maintained in the lower part of the stomach above a maximum threshold density of 2.4-2.8g / cm3. The major limitation of it is that they are technically difficult to manufacture with a Large amount of drug product.

Swelling and Expandable System

The expandable GRDF is typically based on three configurations, a small configuration that allows For easy oral intake; an expanded form that is accomplished in the stomach and thus preventing its Passage through the pyloric sphincter and finally another small form that is achieved in the Stomach when retention is no longer necessary. Swelling usually occurs due to osmosis and theUnfolding is because of mechanical shape memory.

Mucoadhesive or Bioadhesive System

These systems allow the incorporation with the bioadhesive agents that allow the system to adhere To the walls of the stomach, thus avoiding gastric emptying. Bio/Mucoadhesive systems binds to The surface of the gastric epithelial cell, or mucin, and extend the GRT by increasing the intimacy And contact duration between the dosage type and the biological membrane.

Superporous Hydrogel

These are the swellable systems with an average pore size of > 100µm, within a minute they swell To equilibrium due to a rapid absorption of water through capillary wetting through multiple Interconnected open pores. They swell to a large size and expect to provide enough mechanical Strength to endure the pressure by the gastric contraction.

Magnetic System

The magnetic dosage types contain an extra-corporal magnet and a small internal magnet that Controls the gastrointestinal transit of the dosage form.

From the formulation and technological point of view Floating Drug Delivery System (FDDS) is Considerably easy and logical approach in the development of GRDF.[3,4,5,6,7]

BASIC GASTROINTESTINAL TRACT PHYSIOLOGY[3]

The stomach is anatomically divided into 3 regions: fundus, body, and antrum (pylorus).

Fundus: proximal part.

Body: acts as a reservoir for undigested material,

Pylorus: it is a site for mixing of contents and act as a pump for gastric emptyingby propelling actions.

Stomach Physiology

The stomach is an expanded digestive tube section present between the oesophagus and small Intestine. The stomach is contracted in the empty state, and the mucosa and sub mucosa are thrown Up into distinct folds called rugae.

Below are identified the four major types of secretary epithelial cells which coverthe surface of The stomach and extend into gastric pits and glands.

Mucous cells: secrete alkaline fluid.

Parietal cells: secretes a acid that is hydrochloric acid.

Chief cells: secrete pepsin, a proteolytic enzyme.

G cells: secrete the hormone gastrin.

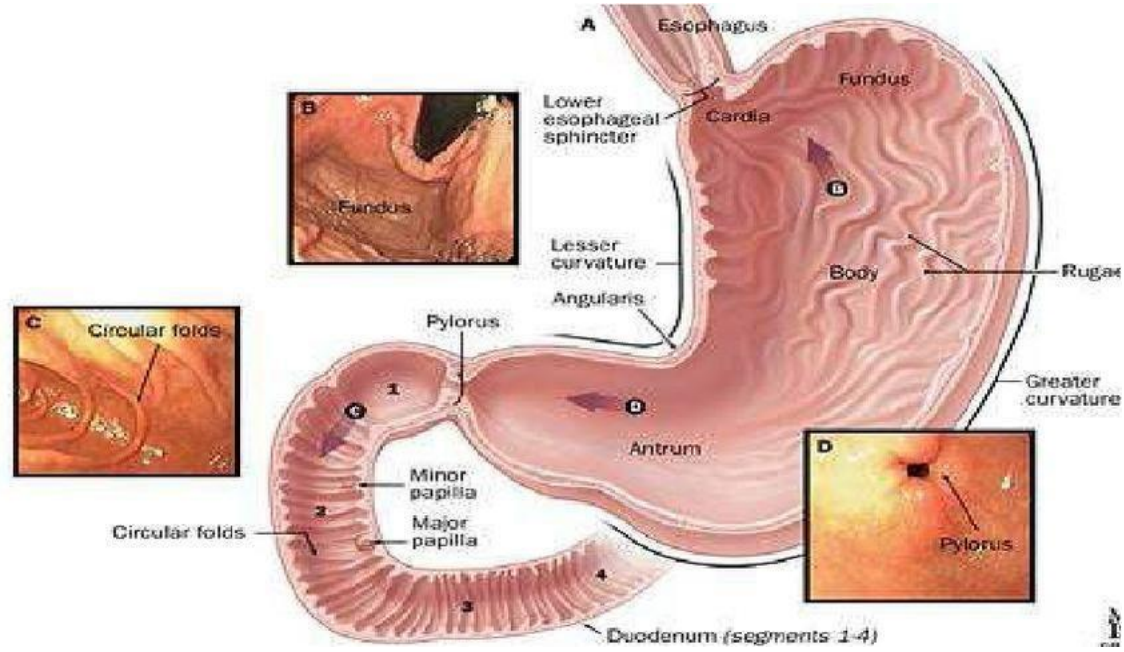

Figure 2: Physiology of stomach.

Gastric empty rate

Gastric emptying happens during both fasting and fed conditions. An inter- digestive sequence of Electrical events take place during the fasting process, which pass every 2 to 3 hours in both the Stomach and intestines.

It is called the inter-digestive mylo-electric cycle or myloelectric migratory cycle (MMC), which is Further divided into 4 stages.

1. Phase I (Basal phase): it lasts from 40 to 60 minutes with rare contractions.
2. Phase II (Preburst phase): lasts for 40 to 60 minutes with intermittent action potential and Contractions.
3. Phase III (burst phase): lasts for 4 to 6 minutes, which includes intense and regular Contractions for short period of time.
4. Phase IV: lasts for 0 to 5 minutes and occurs between phases III and I of 2 consecutive Cycles.[3]

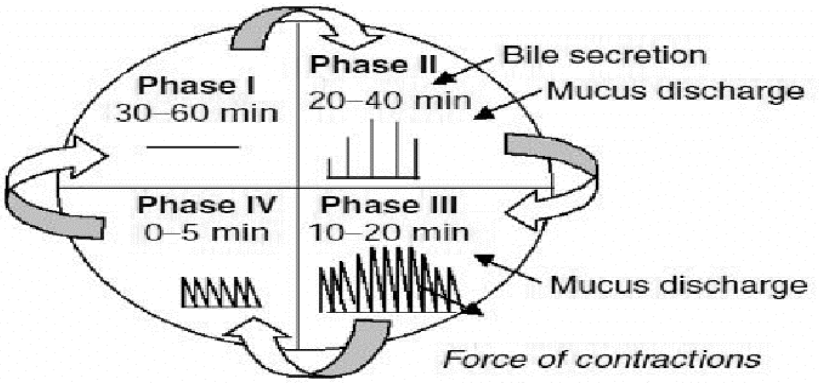

Figure 3: Motility Pattern in GIT.[3]

Factors Controlling Gastric Retention Time of a Dosage Form[9]

- Nature of the mealFed or Unfed State
- Age
- Frequency of feed
- Concomitant drug administrationDensity
- Size and ShapeCaloric ContentGender
- Posture

Advantages of FDDS

1. Floating dosage forms such as tablets or capsules Will remains in the solution for prolonged time Even at the alkaline pH of the intestine.
2. FDDS are advantageous for drugs meant for Local action in the stomach eg: Antacids
3. FDDS dosage forms are advantageous in case of Vigorous intestinal movement and in diarrhoea to Keep the drug in floating condition in stomach to Get a relatively better response.

4. Acidic substance like aspirin causes irritation on The stomach wall when come in contact with it Hence; HBS/FDDS formulations may be useful for The administration of aspirin and other similar Drugs.
5. The FDDS are advantageous for drugs absorbed Through the stomach eg: Ferrous salts, Antacids.
6. Treatment of gastrointestinal disorders such as Gastroesophagealreflux
7. Ease of administration and better
8. Patient compliance
9. Site-specific drug delivery

Disadvantages of FDDS[5,10,11]

1. Floating systems are not feasible for those drugs that have solubility or stability problems in gastric Fluids.
2. They require a sufficiently high level of fluids in the stomach, so that the drug dosages form float there in and work efficiently.
3. Drugs that cause irritation and lesion
4. To gastric mucosa are not suitable to be formulated as floating drug Delivery systems.

CLASSIFICATION OF FLOATING DRUG DELIVERY SYSTEM[12]

A. Single Unit Floating Dosage Systems

- Non-effervescent Systems (Hydro dynamically balanced Systems)
- Effervescent Systems (Gas-Generating Systems)

B. Multiple Unit Floating Dosage Systems

- Non-effervescent Systems (Hydro dynamically balanced Systems)
- Effervescent Systems (Gas-Generating Systems)
- Hollow Microspheres

C. Raft Forming Systems

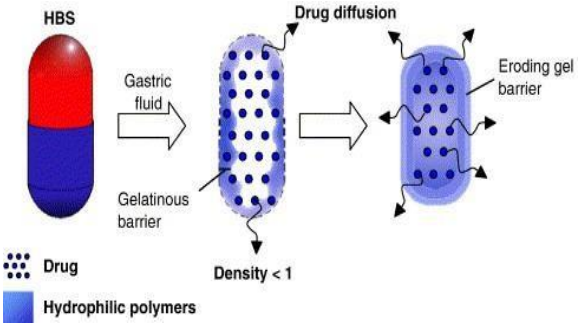

Figure 3: Hydromically balanced Systems.

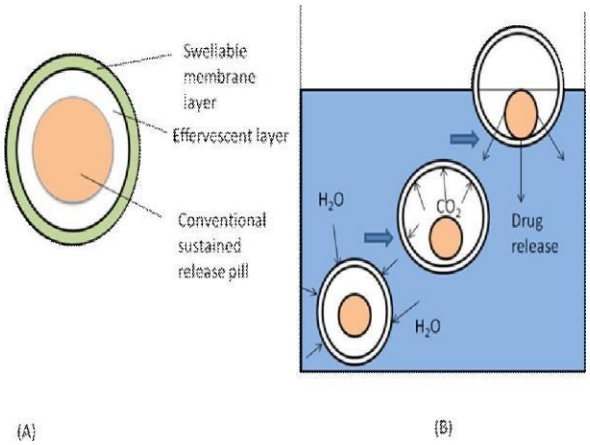

Figure 4: Gasgenerating System.

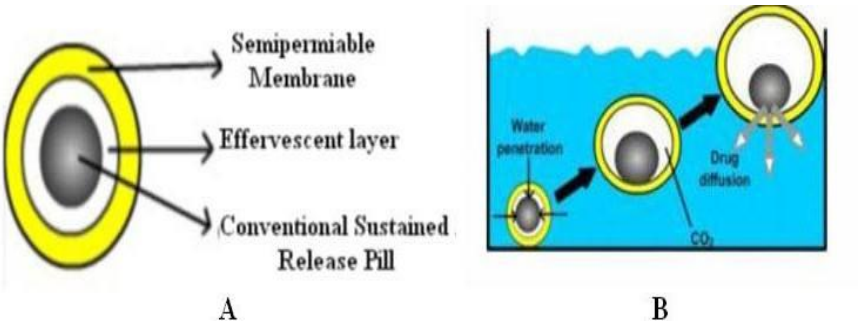

Figure 5: Multiple-unit oral drug delivery system.[13]

Raft Forming System

For the delivery of antacid and other medications for gastro-infection and gastro intestinal Disorders, a Raft forming systems are mostly considered. Upon contact with gastric fluid the gel Forming solution swells and creates a viscous compact gel.[1]

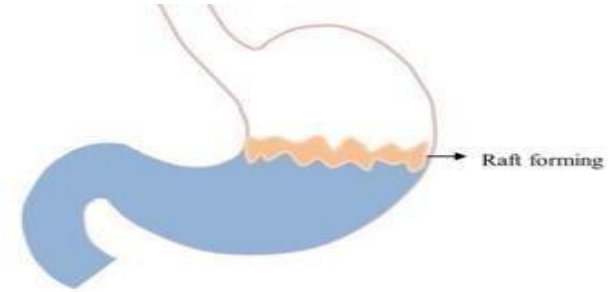

Figure 6: GRDDS based on Raft Forming System.[14]

EVALUATION TECHNIQUE[5,15,16]

Tablet Dimensions

Thickness and diameter were measured using a calibrated vernier caliper. Three tablets of each formulation were picked randomly and thickness was measured individually.

Hardness

Hardness indicates the ability of a tablet to withstand mechanical shockswhile handling. The hardness of the tablets was determined using Monsanto hardness tester.

Weight Variation Test

Ten tablets were selected randomly From each batch and weighed individually to Check for weight variation.

Tablet Density

Tablet density was an important parameter for floating tablets. The tablet would floats only when its density was less than that of gastric fluid

Friability test

The friability of tablets was Determined by using Roche Friabilator. It Was expressed in percentage (%). Ten Tablets were initially weighed (W) and transferred into friabilator. The friabilator was operated at 25 rpm for 4 minutes or run Up to 100 revolutions. The tablets were weighed again (Wo). The % friability was Then calculated by –

$$\%F = 100\ (1\text{-}W0/W)$$

% Friability of tablets less than 1% was Considered acceptable.

Angle of Repose

The frictional forces in a loose powder or granules The granules were allowed toflow through the funnel fixed to a stand at definite height (h). The angle of reposewas then calculated by measuring the height and radius of the heap of granules formed.[1]

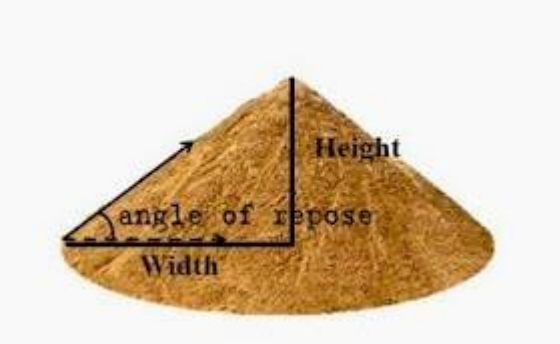

Figure 7: Angle of repose

$\theta = \tan^{-1}(h/r)$

θ = angle of repose

h = height of the heapr = radius of the heap

APPLICATION OF FLOATING DRUG DELIVERY SYSTEM[17]

Enhanced Bioavailability

The bioavailability of riboflavin CR-GRDF is substantially increased compared with the Administration of non GRDF CR polymeric formulations.

Sustained delivery of drugs

Oral CR formulations experienced problems in the GIT like gastric residence time. HBS systems That can stay in the stomach for prolonged period of timeand having a bulk density of less than 1 And can float on the gastric contentscan usually overcome these problems.

Site specific drug delivery systems

The controlled, gradual drug delivery to the stomach provides appropriate local therapeutic rates And reduces the systemic exposure of the drug. The dosing frequency can be decreased by Extended gastric availability from a site driven drug delivery system. E.g. Furosemide and Riboflavin.

Improvement of Absorption

Drugs with low bioavailability due to site specific absorption from the upper part of the GIT are Possible candidates to be developed as floating drug deliverysystems, by optimizing their Absorption.

Minimized adverse reaction at the colon

Retention of the drug in the stomach in HBS minimizes the amount of drugentering the colon. Unwanted drug activity in the colon region can thus be avoided.

Reduced drug concentration fluctuation:

Continuous input of the drug following CR-GRDF administration creates concentrations of the Blood drug within a narrower range compared with types of immediate release dosage forms.

CONCLUSION

Development of an efficient gastro retentive dosage form for stomach specific drug transport is an Actual project. Accordingly, to produce the preferred gastro retention several strategies were used. These systems offer the gain of better absorption of medication that are absorbed from the top part of stomach, which enhance the bioavailability and controlled delivery of many drugs with new and Vital therapeutic options. Floating drug delivery system guarantees

to be a technique for gastric retention. Although there are Wide variety of complicationsto be labored out to gain extended GI retention, many companies are Focusing inthe direction of commercializing this approach. Wide variety of industrial productand Patent issued in this field are evident of it.

REFERENCES

1. Singh BN and Kim HK, "Floating drug Delivery systems: an approach to oral Controlled drug delivery via gastric Retention". J. Control. Rel., 2000; 63: 235-59.
2. Sarojini S and Manavalan R. An overview on various approaches to Gastroretentive dosage Forms. Int J Drug Dev Res., 2012; 4(1): 01-13.
3. Chawla G, Gupta P, Vishal K and Bansal AK. Gastroretention a Means to Address Regional Variability in Intestinal Drug Absorption. Pharm Technol, 2002; 27(7): 50-68.
4. Mandal UK, Chatterjee B and Faria GS. Gastro-retentive drug delivery systems and their In vivo success: A recent update. Asian JPharm Sci., 2016; 11(5): 575-84.
5. Dixit N. Floating Drug Delivery System. J Curr Pharm Res., 2011; 7(1): 6-20.
6. Jassal M, Nautiyal U, Kundlas J and Singh D. A review: Gastroretentive drug delivery System (grdds). Indian J Pharm Biol Res., 2015; 3(1): 82-92.
7. Pawar VK, Kansal S, Garg G, Awasthi R, Singodia D and KulkarniGT. Gastroretentive Dosage forms: A review with special emphasis on floating drug delivery systems. Drug Deliv, 2010; 18(2): 97-110.
8. http://cms.turkjps.org/Uploads/Article_47811/TJPS-19-476-g6.png
9. Gopalakrishnan S and Chenthilnathan A. Floating Drug Delivery Systems: A Review. J Pharm Sci Technol, 2011; 3(2): 548-54.
10. Arunachalam A., Karthikeyan M., Floating drug delivery Systems: A review. Int. J. Res. Pharm. Sci., 2011; 2: 76-83.
11. Kumar N., Niranjan S.K, Irchhaiya R, Vishkarma K., Akhtar Ali. A Novel floating drug delivery International Research Journalof Pharmacy, 2012; 3.
12. Bhalla N., Goswami M. Drug Delivery System. International Journal of Research and Allied Science, 2012; 4: 20-28.
13. Rathod HJ, Mehta DP and Yadav JS. A review on Gastroretentive Drug Delivery Systems. Pharma Tutor, 2016; 4(7): 29-40.
14. Tripathi J, Thapa P, Maharjan R and Jeong SH. Current State and Future Perspectives on Gastroretentive Drug Delivery Systems.Pharmaceutics, 2019; 11(4): 1-22.
15. Narang N. An updated review On: Floating drug delivery system(FDDS). International

Journal Applied Pharmaceutics, 2011; 1(3).

16. Sharma N., Agarwal D., Gupta M.K. and Khinchi M.P. 2011. A Comprehensive Review on Floating Drug Delivery System. International Journal of Research in Pharmaceutical and BiomedicalSciences.
17. Arunachalam A, Karthikeyan M, Kishore K, Prasad PH, SethuramanS, Ashutosh kumar S And Manidipa S. Floating drug deliverysystems: A review. Int J Res Pharm Sci., 2011; 2(1): 76-83.