Review Article

A Review on Floating Drug Delivery Systems

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ABSTRACT

The purpose of writing review on Floating Drug Delivery System (FDDS) was to compile the recent literature with specific focus on the principal mechanism of floatation to achieve gastric retention. The recent developments of FDDS including the physiological and formulation variables affecting gastric retention, approaches to design single-unit and multiple-unit floating systems, and their classification and formulation aspects are covered in detail. FDDS improves the drug bioavailability and patient compliance by increasing the gastric residence time and controlling the drug release. Gastro-retentive systems can remain in the gastric region for several hours for significantly prolong residence time of drugs by which improves bioavailability, reduces drug waste, and improves solubility for drugs that are less soluble in a high PH environment. These systems are useful to overcome several problems encountered during the development of a pharmaceutical dosage form.

Keywords: Floating drug delivery systems, multiple unit, bioavailability, gastric residence time.

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INTRODUCTION

Drug delivery system that floats Low-density systems having enough buoyancy to float over the contents of the stomach and remain buoyant there without slowing down the rate at which the stomach empties its contents are known as floating drug delivery systems (FDDS) or hydrodynamically controlled systems. The medicine is slowly withdrawn from the system at the desired rate while the body is floating on the contents of the stomach. The stomach's residual system is emptied after the medication has been released. As a result, the oscillations in plasma drug concentration are better managed and GRT is raised. However, in addition to the minimal gastric content necessary for the proper application of the buoyancy retention principle, the buoyancy retention principle also calls for a minimal level of floating force (F).[1]

For dose forms that stay in the stomach longer than standard dosage forms, the ability to extend and control the emptying time is a crucial asset. Gastric emptying of dosage forms is an incredibly varied process. Designing controlled release systems for greater absorption and increased bioavailability presents a number of challenges. The difficulty to limit the dose form in the desired region of the gastrointestinal tract is one of these challenges. The process of drug absorption from the digestive system is intricate and influenced by a variety of factors. It is commonly accepted that the length of time a medicine spends in contact with the small intestinal mucosa influences how much of the gastrointestinal tract it absorbs. Small intestinal transit time is therefore a crucial factor for drugs that incompletely absorbed.[2]

Drugs stomach residency times can be greatly extended by floating delivery 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. It can be used to administer medications locally to the stomach and nearby small intestines. Gastro retention aids in improving the accessibility of novel drugs with fresh therapeutic opportunities and significant patient advantages. Mucoadhesion, flotation, sedimentation, expansion adjusted shape systems, or the concurrent administration of pharmacological agents that delay stomach emptying can all be used to manage the gastric retention of solid dosage forms.[3]

Without having any control over the drug delivery system, solid oral dosage forms like capsules and tablets supply a certain drug concentration in the systemic blood circulation and also generate significant changes in plasma drug concentrations. The oral administration of any medicine is the most practical and preferable method of delivering it to the systemic circulation. The oral controlled release drug delivery method has recently attracted more attention in the pharmaceutical industry in order to gain greater therapeutic advantages. Such as case of dosage administration, patient adherence to the product, and adaptability in drug formulation. Drugs with short half-lives and easy absorption from the gastrointestinal tract [GIT]

are swiftly removed from the systemic circulation. To get around this restriction, sustained-controlled release oral formulations have been created in an effort to release the medication gradually into the gastrointestinal tract and sustain a therapeutic drug concentration in the bloodstream for a considerable amount of time. The techniques of mucoadhesion, sedimentation, flotation, changed shape systems, expansion, or the simultaneous administration of pharmacological agents followed by gastric emptying are used to achieve the maximal stomach retention of solid dosage forms.[4] On the basis of these methods, a thorough description of the classification of floating drug delivery systems (FDDS) has been provided. The reduced effectiveness of the supplied dose caused by the DDS's inability to release all of the drug because of humans' comparatively short stomach residence time through the main Many methods are currently used in the extension of stomachic residence times (GRT) to create successful stomach-specific or gastro-retentive drug delivery systems, including hydrodynamically balanced systems (HBS)/floating drug delivery systems, low density systems, raft systems using alginate gels, bio adhesive or mucoadhesive systems, high density systems, super porous hydro gels, and magnetic systems.[5]

Physiology of stomach

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 prior to it reaching its absorption site, FDDS can enhance the controlled administration of medications that have an absorption window.[6]

FDDS help these medications by enhancing them. Bioavailability effectiveness of treatment and potential dose decrease. Long-term maintenance of therapeutic levels at the same level, resulting in less variation in the therapeutic levels lessen drug waste increases medication solubility Fundus and body act as a reservoir for undigested materials because they are less soluble in high pH environments (for example, weakly basic drugs like domperidone, papaverine), whereas the atrium is the primary location for mixing motions and serves as a pump for gastric emptying by pushing activities. Both when one is fasting and when one is eaten, the stomach empties. 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 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 digestive motility pattern.[7]

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) last for 10-20 mints which includes intense and regular contractions for short period.

Phase 4-last for 0-5 mints and occurs between phase 2 and 1 of 2 consecutive cycles[8].

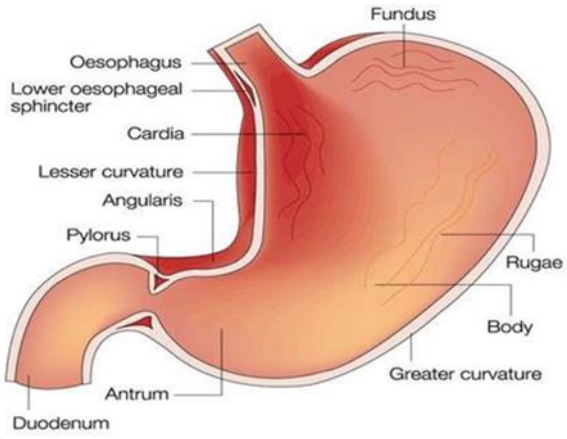

Figure 1: Structure of stomach

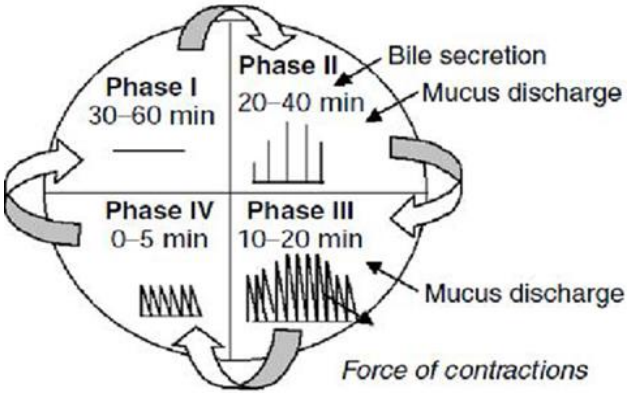

Figure 2: motility pattern of GIT

FACTORS AFFECTING FLOATING DRUG DELIVERY SYSTEM[9]

A. Density:

Density of the dose form should be smaller than the gastric contents (1.004gm/ml).

B. Size and Shape:

Dosage form units with a diameter of more than 7.5 mm are reported to have an increased GRT competed to with those with a diameter of 9.9 mm. The dosage form with a shape tetrahedron and ring shape devises with a flexural modulus of 48 and 22.5 kilopond per square inch (KSI) are claimed to have improved GIT for 90 to 100% retention at 24 hours compared with other shapes. [10]

C. Fed or Unfed State:

When someone is fasting, their gastrointestinal tract (GI) motility is characterized by bursts of vigorous motor activity or migrating myoelectric complexes (MMC), which happen roughly every 1.5 to 2 hours. The MMC removes undigested matter from the stomach, therefore if the formulation is administered at the same time as the MMC,

the unit's GRT should be very brief. However, MMC is sluggish and GRT takes a lot longer in the fed state. [11]

D. Nature of the meal:

Feeding of indigestible polymers of fatty acid salts might modify the motility pattern of the stomach to a fed state, therefore lowering the gastric emptying rate and prolonging the medication release.

E. Caloric Content:

A meal with a high protein and fat content can extend GRT by 4 to 10 hours.

F. Feeding frequency:

Due to the low frequency of MMC, the GRT can increase by over 400 minutes when multiple meals are given in succession rather than a single meal.

G. Gender:

Regardless of weight, height, or body surface, males' mean ambulatory GRT during meals (3.40.4 hours) is shorter than that of their age- and race-matched female counterparts (4.61.2 hours).

H. Age:

People over 70 years old, in particular, have much longer GRTs.

I. Posture:

GRT can vary between a patient's supine and upright ambulatory states. Anticholinergic drugs like atropine and propentheline, opiates like codeine, and prokinetic drugs like metoclopramide and cisapride are all administered together.

CLASSIFICATION OF FLOATING DRUG DELIVERY SYSTEM [12]

(A) Effervescent FDDS

1. Gas generating system.
2. Volatile liquid containing system

(B) Non – Effervescent FDDS

1. Colloidal gel barrier system.
2. Micro porous compartment system
3. Floating microspheres / micro balloons
4. Alginate floating beads

(C) Raft forming system

(A) Effervescent system

Effervescent systems use carbonates (such as Na bicarbonate) and alternate organic acids (such as acid and salt acid) as primary ingredients to provide CO2 gas, thereby lowering the density of the system and causing it to float over the gastric fluid. A substitute is the incorporation of a matrix that contains a liquid part that produces gas that evaporates at body temperature.[13]

1. 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.[14]

2. Volatile liquid containing system:

This system is created to float within the abdomen owing to floatation chamber which can be a vacuum or full of air or a harmless gas, whereas drug reservoir is encapsulated within a micro porous compartment. [15]

(B) Non- Effervescent FDDS

When swallowing, this type of system swells uncontrollably due to viscous fluid inhibitions to the point where it blocks their exit from the abdomen. Since they require a bend to remain lodged close to the pyloric valve, these systems could also be distinguished as plug-type systems. One of the methods for creating such infinite quantity forms involves mixing the medication with a gel that, when taken orally, swells when in contact with viscous fluid while preserving form integrity and bulk density of just one inside the outer jelly-like barrier. The compound's ability to hold back air gives the buoyant current indeterminate amount forms buoyancy. Non-effervescent floating drug delivery is by far the most frequently utilized excipient. [16]

1. Colloidal gel barrier system:

This technique increases the amount of medication that is delivered in solution form to the absorption site while extending stomach retention duration. It essentially contains medication that produces gel from hydrocolloids to float on stomach content. Like polystyrene, polycarbophil, and polyacrylate. The hydrocolloid in the system hydrates to produce a colloid gel barrier to its surroundings when it comes into touch with gastro intestinal fluid.[17]

2. 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.[18]

3. Floating microsphere/ micro balloons:

Hollow microspheres, commonly referred to as micro balloons, and are thought to be the most effective buoyant device. It is made up of the microsphere's central hollow area. By using a cutting-edge solvent diffusion process for emulsion, hollow microspheres are created that are loaded with a medicine in their outer polymer shelf.[19]

4. Alginate floating Beads:

Multi-unit floating dosage forms were developed from freeze dried calcium alginate. Spherical beads of

approximately 2.5 mm diameter can be prepared by dropping sodium alginate solution into aqueous solution of calcium chloride, causing precipitation of calcium alginate leading to formation of porous system, which can maintain a floating force for over 12 hours. When compared with solid beads, which gave a short residence time of 1 hour, and these floating beads gave a prolonged residence time of more than 5.5 hours.[20]

(C) Raft forming system:

For the administration of antacids and medications for gastro-intestinal infections and illnesses, raft-forming systems are receiving a lot of interest. When a gel-forming solution comes into contact with gastric fluid, it expands and creates a viscous gastric fluid, allowing for a gradual release of the medicine into the stomach.[21]

Benefits of FDDS

1. Floating dosage forms, such as tablets or capsules, will stay in the fluid for an extended period of time when the intestines have an alkaline pH.

2. FDDS are benefits for medications designed to operate locally in the stomach, such as antacids.

3. FDDS dosage forms have the advantage of keeping the medicine in a floating state in the stomach during diarrhea and agitated bowel movements, which results in a relatively better reaction.

4. Since aspirin and other similar medications might irritate the stomach wall when they come into touch with them, FDDS formulation may be helpful for their administration.

5. The FDDS offers benefits for medications that are absorbed through the stomach, such as ferrous salts.

6. Slow drug absorption into the body reduces antagonistic effects, increasing drug effectiveness.

7. FDDS improve clinical results by reducing drug concentration variation over a critical concentration, which enhances the pharmacological effects.

8. A floating dose form is a generally acknowledged method, especially for medications with a narrow upper small intestine absorption site.

Considerations of FDDS

1. For the drug delivery system to float and function well, the stomach needed to contain a high amount of fluid. Not suited for medications with GIT solubility or stability issues.

2. It might not be advisable to use medications like Nifedipine (a calcium channel blocker), which is well absorbed throughout the GIT and goes through first pass metabolism.

3. Drugs that irritate the stomach mucosa are also undesirable or inappropriate.

4. It is not advisable to use drugs that are unstable in the stomach's acidic environment.

5. Drink a full glass of water together with the dosage form.

6. A full glass of water (200-250 ml) should be consumed along with the dosage form.

7. Many substances, such as chlordiazepoxide, cinnarizine, and calcium supplements, are mostly absorbed from the stomach and upper GI tract.[22]

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