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REVIEW ON GASTRO RETENTIVE DRUG DELIVERY SYSTEMS

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ABSTRACT

Gastro retentive drug delivery systems (GRDDS) have garnered significant attention in recent years due to their potential to enhance therapeutic efficacy and patient compliance by prolonging gastric residence time and optimizing drug release kinetics. This review provides a comprehensive overview of the latest advancements in GRDDS, focusing on formulation strategies, design principles, and evaluation methodologies. Various approaches such as floating systems, mucoadhesive systems, expandable systems, and magnetic systems are discussed in detail, highlighting their mechanisms of action and applications in targeted drug delivery. Furthermore, recent innovations in materials science and formulation technologies have enabled the development of novel GRDDS with improved biocompatibility, stability, and controlled release profiles. The review also addresses challenges associated with GRDDS, including physiological variability, drug stability, and regulatory considerations, and proposes potential strategies to overcome these obstacles. Additionally, the clinical relevance of GRDDS in the treatment of various gastrointestinal disorders and their future prospects in personalized medicine and targeted therapy are explored. Overall, this review aims to provide valuable insights into the current state-of-the-art in GRDDS research and its implications for the advancement of drug delivery science.

KEYWORDS: Gastro retentive drug delivery system (GRDDS); Bio-adhesive; Mucoadhesive; Floating drug delivery system.

1. INTRODUCTION

Drug Delivery system is becoming increasingly sophisticated as pharmaceutical scientists acquire a better Understanding of the physicochemical and biological parameters pertinent to their performances. Controlled Drug Delivery System provides drug release at a predetermined, predictable and controlled rate to achieve high therapeutic Efficiency with minimal toxicity. Consequently much effort has been put into development of strategies that could improve patient compliance through Oral route.[1] Gastric emptying of dosage forms is an extremely variable process and ability to prolong and control the Emptying time is a valuable asset for dosage forms, which reside in the stomach for a longer period of time than Conventional dosage forms. Several difficulties are faced in designing controlled release systems for better absorption And enhanced bioavailability. One of such difficulties is the inability to confine the dosage form in the desired area of The gastrointestinal tract.[2] The release of active agents is, therefore, largely independent of external factors. For oral solid Delivery systems, drug absorption is unsatisfactory and highly variable between the individuals. An important Requisite for the successful performance of oral controlled release drug delivery system is that the drug should have Good absorption throughout the gastrointestinal tract (GIT). The major problem is the physiological variability such As gastrointestinal transit in addition to gastric retention time, as the later plays a dominating role in the over all Transit of the dosage form.[4]

1.2. Back ground Gastro retentive drug delivery system

GRDDS serves to increase the residence time of the dosage form in the stomach for more effective drug Release in upper GI tract. This plainly helps in delivering those drugs that are better absorbed at acidic pH, Show instability in the intestinal region, or have a narrow window of absorption in upper GI tract.[9] Expansion in swelling and expanding systems; geometry, in modified shaped systems; and floatation or Buoyancy, which is seen in floating systems. Other strategies include giving drug at the same time as fatty Acid salts or sham feeding hydrogels that change the stomach's motility pattern to a fed state and are either Indigestible like polycarbophil or enzyme digestible.[10]

2. HISTORICAL BACKGROUND

2.1. Initial Concepts (1960s-1970s)

It was in the late 1960s and early 1970s that the concept of extending the duration of stomach residence Time for oral drugs started to gain momentum. Scientists realized that in order to

improve a medication's Bioavailability and effectiveness, it was necessary to keep it in the stomach for a maximum Time.[11]

2.2.Floating Systems (1970s-1980s)

One of the first notable developments was floating medication delivery systems. Because of their lower Density than gastric fluids, these systems are able to float on the gastric fluid of the stomach and release the Medication gradually. Among the examples are tablets that produce gas and release carbon dioxide to Produce a buoyant system.[12]

2.3.Expanding Systems (1980s-1990s)

Hydrogels and other polymer-based materials were extensively utilized to create expandable systems that Inflate or unfold in the stomach, increasing their size to impede transit through the pylorus. Overall, the Evolution of gastro retentive drug delivery system reflects a continuous effort to optimize oral drug delivery, Increase the therapeutic outcomes, and improve patient experiences.[12]

3. FACTORS INFLUENCING DRUG DELIVERY SYSTEM

The effectiveness of Gastro retentive Drug Delivery Systems (GRDDS) is influenced by a variety of factors That can affect the retention time in the stomach and the overall drug release profile. These factors include Physiological, formulation, and physicochemical properties. Here are the key factors:

1. **Motility**: Gastric emptying time varies between the fasted and fed states. In the fed state, the Gastric retention time is generally longer due to delayed gastric emptying. The presence of food can Significantly affect the performance of GRDDS.[13]
2. **Gastric Transit Time**: Individual differences in gastric transit time can impact the effectiveness of GRDDS. Conditions like gastroparesis or use of prokinetic agents can alter transit time.
3. **Size of the dosage form:** The GRT of dosage form units larger than 7.5 mm is said to Be higher than those of units 9.9 mm in diameter. Larger dose forms often have a longer gastric retention Period than smaller ones because they are emptied during the digesting phase (weaker MMC) and because The pyloric sphincter hinders their transit into the small intestine.[14]
4. **Density**: The dosage form's density (1.004 g/ml) should be lower than the contents of the stomach. It Needs to fall between 1 and 2.5 grams per cubic centimetre.[18] Dosage form buoyancy determines GRT, Which is a density dependent function.[18]

5. **Gender**: Gastric retention time for male 3 to 4 hours and for female 4 to 6 hours. Male have lees retention Time than female.
6. **State of disease**: The gastric retention time is altered by disorders involving the stomach, such as Diabetes, Crohn's disease, etc.[19]

4. NEED FOR GASTRO -RETENTIVE DRUGS DELEVERY SYSTEM

- Some drugs are absorbed at specific site only. They Require release at specific site or a release such that Maximum amount of drug reaches to the specific site.
- Pharmaceutical field is now focusing towards such Drugs which require site specificity
- Gastro-retentive delivery is one of the site specific Delivery for the delivery of drugs either at stomach or at Intestine.
- It is obtained by retaining dosage form into Stomach and drug is being released at controlled manner To specific site either in stomach, duodenum and Intestine.
- Drug delivery systems are defined as formulations or devices that facilitate the introduction of therapeutic substances into the body, enhancing efficacy and safety by controlling the rate, time, and location of drug release.[20]

5. POTENTIAL CANDIDATES FOR GASTRO-RETENTIVE DRUGS DELEVERY SYSTEM

1) Drugs that are primarily absorbed in thestomach e.g. Amoxicillin.
2) Drugs that are poorly soluble in alkaline pH e.g. Furosemide, Diazepam.
3) Drugs that have narrow absorption window e.g. Levodopa, Methotrexate.
4) Drugs that degrade in the colon e.g. Ranitidine, Metformin HCL.
5) Drugs that disturb normal colonic microbes e.g. Antibiotics against Helicobacter pylori.
6) Rapidly absorbed from the GI tract e.g. Tetracycline.
7) Drugs acting locally in the stomach.[23] The rationale for the selection of active Pharmaceutical ingredients for fabrication as a GRDDS is described in Table 1.

Table 1: Rational of gastro- Retentive drug.[24]

Rational of gastro-retention drug	Name of drug
Narrow absorption window at upper part of GIT	Levodopa, Atenolol, Theophylline, Diltiazem.
PH dependent absorption from stomach(acidic drug)	Furosemide
Degradation at higher PH (higher stability at lower PH)	captopril
Degradation in intestine or colon	Ranitidine Hydrochloride
Drug for local action antacid, antiulcer, antibacterial for H. pylori infection	Amoxicillin, Misoprostol, Metronidazole

6. ANATOMY OF STOMACH

The gastro intestinal tract can be divided into three main Regions:

a) Stomach

b) Small intestine- duodenum, jejunum, and ileum

c) Large intestine

The GIT is a muscular tube of about 9m which extends From mouth to anus. Its function is to take nutrients and Eliminate out waste product by physiological processes Such as digestion, absorption, secretion, motility and Excretion. The stomach has three muscle layer called Oblique muscles and it is situated in the proximal part of The stomach, branching over the fundus and higher Regions of the gastric body. The stomach is divided into Fundus, body and pylorus.[25]

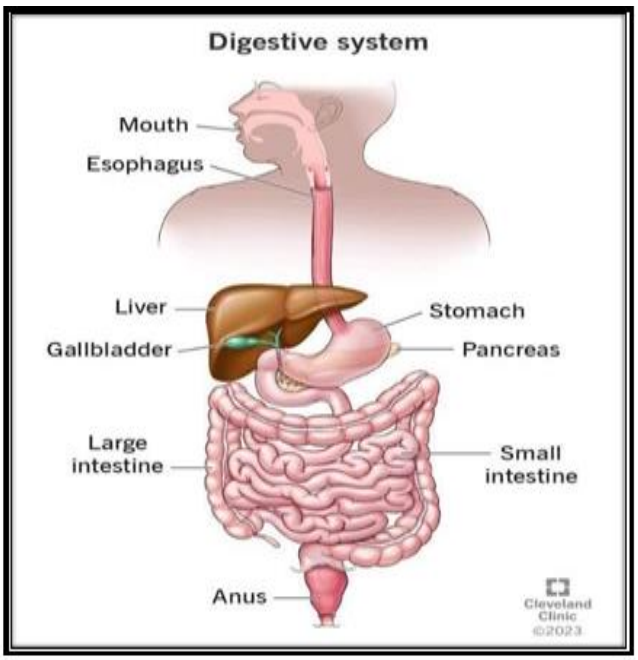

Fig.No.1: General Gastrointestinal tract.[27]

6.1 Physiology of stomach

The stomach is divided into three parts anatomically:

1) Body,

2) Antrum pylorus,

3) Fundus.

The antrum is the main site for mixing motions and functions as a pump for stomach emptying via thrusting activities, While the proximal portion, composed of the fundus and

body, serves as a reservoir for undigested material. Both while Eating and when fasting, gastric emptying takes place. Nonetheless, the motility patterns in the two states differ. An Electrical sequence of inter-digestional events occurs while fasting; these events occur in the stomach and intestine Every two to three hours. In addition to hydrochloric acid, The stomach produces endogenous factor in its parietal cells.[28]

The stomach is an expanded section "of the digestive Tube between the esophagus and small intestine. In the Empty state the stomach is contracted and its mucosa And sub mucosa are thrown up into folds calledrugae. There are 4 major types of secretory a epithelial cell that Covers the stomach and extends into gastric pits and Glands.

1. Mucous cells- secrete alkaline mucus
2. Parietal cells – secrete HCL
3. Chief cells- secrete pepsin

Both while feeding and when fasting, gastric emptying takes place. An Interdigitate sequence of electrical events cycles through the small intestine and stomach every two to Three hours when a person is fasting. The terms migrating myoelectric complex and, inter-digestive Myoelectric cycle describe this electrical activity.[30]

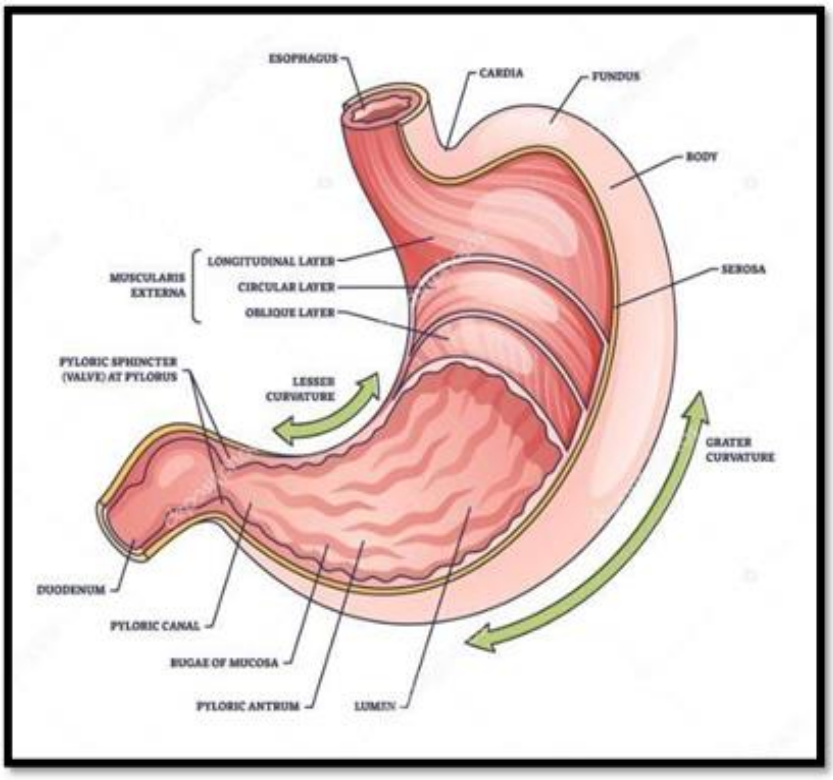

Fig. No. 2: Physiology of stomach.

6.2 Gastrointestinal transit time and motility

Based on fasted and fed states of stomach, there are two distinct patterns of gastrointestinal motility. The fasted state Is associated with some cyclic contractile events commonly known as Migrating Myoelectric Complex (MMC). Liquid components easily pass through the partially constricted sphincter. On the contrary, an "antral-sieving" Process retains the large undigested materials. Usually a series of interdigestive events takes place in stomach. The Migrating Myoelectric Complex (MMC), which governs the gastrointestinal motility pattern has been described as an Alternating cycles of activity and quiescence. Apparently there are four consecutive phases of activity in mmc.[31-32]

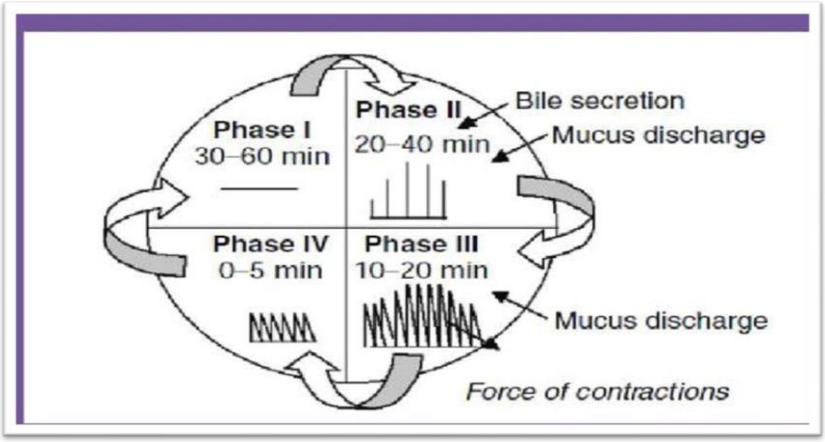

Fig. No. 3: Phase of Gastric motility.

- **Phase I:** It is a quiescent period lasting from 30 to 60 minutes with no contractions.
- **Phase II:** It consists of intermittent contractions that gradually increase in intensity as the phase progresses and It lasts about 20 to 40 minutes.
- **Phase III:** This is a short period of intense distal and proximal gastric contractions (4 to 5 contractions per Minute) lasting about 10 to 20 minutes; these contractions, also known as "housekeeper wave" sweep gastric Contents down to small intestine.
- **Phase IV:** This is a short transitory period of about 0 to 5 minutes, and the contractions dissipate between the Last part of phase III and quiescence of phase I.

The fasted-state emptying pattern is independent of the presence of any indigestible solids in the stomach. Patterns of Contractions in the stomach occur such that solid food is reduced to particles of less than 1mm diameter that are Emptied through the pylorus as a suspension. The duration of the contractions is dependent on the physiochemical Characteristics of the ingested meal.[33]

6.3 Different features of stomach

Gastric pH: Fasted healthy subject 1.1±0.15 Fed healthy subject 3.6 ± 0.1

Volume: Resting volume is about 25-50 mm.

Gastric secretion: Acid, pepsin, gastrin, mucus and some enzymes about 60 ml with approximately 4 mmol of Hydrogen ions per hour.

Effect of food on Gastric: About 3 liters of secretions are added to the food. Gastro intestinal transit time.[34]

7. ADVANTAGES OF GASTRO -RETENTIVE DRUGS DELEVERY SYSTEM

1. Improvement of bioavailability and therapeutic efficacy of the drugs and possible reduction of dose e.g. Furosemide
2. Maintenance of constant therapeutic levels over a prolonged period and thus reduction in fluctuation in Therapeutic levels minimizing the risk of resistance especially in case of antibiotics.

E.g. b-lactam antibiotics (penicillins and cephalosporin)

3. For drugs with relatively short half life, sustained release may result in a flip- flop pharmacokinetics and also Enable reduced frequency of dosing with improved patient Compliance.
4. Controlled, slow delivery of drug form gastro retentive dosage form provides sufficient local action at the Diseased site, thus minimizing or eliminating systemic exposure of drugs. This site specific drug delivery Reduces undesirable Effects of side effects.[35]

8. DISADVANTAGE OF GASTRO -RETENTIVE DRUGS DELEVERY SYSTEM

1. Systems has limitation, that they require high Level of fluids in stomach for floating and working Efficiently. So more water intake is prescribed with such Dosage form.
2. In supine posture (like sleeping), floating dosage form May swept away (if not of larger size) by contractile Waves. So patient should not take floating dosage form Just before going to bed.
3. Drugs having stability problem in high acidic Environment, having very low solubility in acidic

Environment and drugs causing irritation to gastric Mucosa cannot be incorporated into GRDDS.

9. Approaches for gastro retention[37]

To improve the retention of an oral dosage form in the Stomach various approaches have been developed, it Includes floating systems and non-floating system Floating systems includes effervescent systems and non-effervescent systems, these systems have the bulk Density lower than the gastric fluid. Non Floating systems include bio adhesive systems, swelling Systems, high density systems, expandable systems.

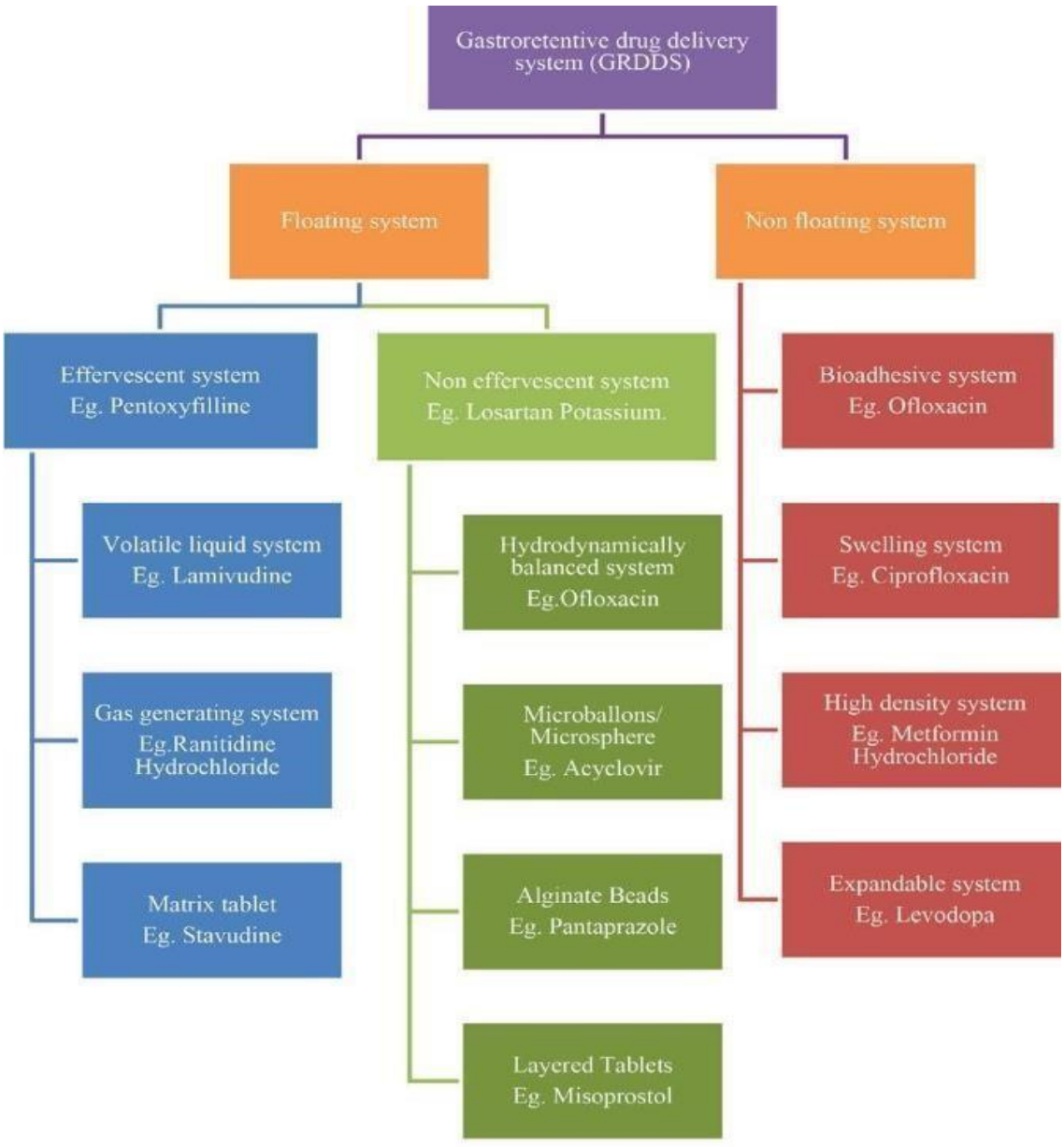

Fig. No. 7: Approaches Gastroretentive drug delivery systems.

10. TYPES OF GASTRORETENTIVE DOSAGE FORMS

Floating systems are low-density systems that have Sufficient buoyancy to float over the gastric contents And remain in the stomach for a prolonged period. While the system floats

over the gastric contents, the Drug is released slowly at the desired rate which results In increased GRT and reduces fluctuation in plasma Drug concentration. The floating drug delivery system And bio adhesive drug delivery are widely used Technique for gastro retention and floating systems in Particular has been extensively researched, mainly Because the floating system does not adversely affect.

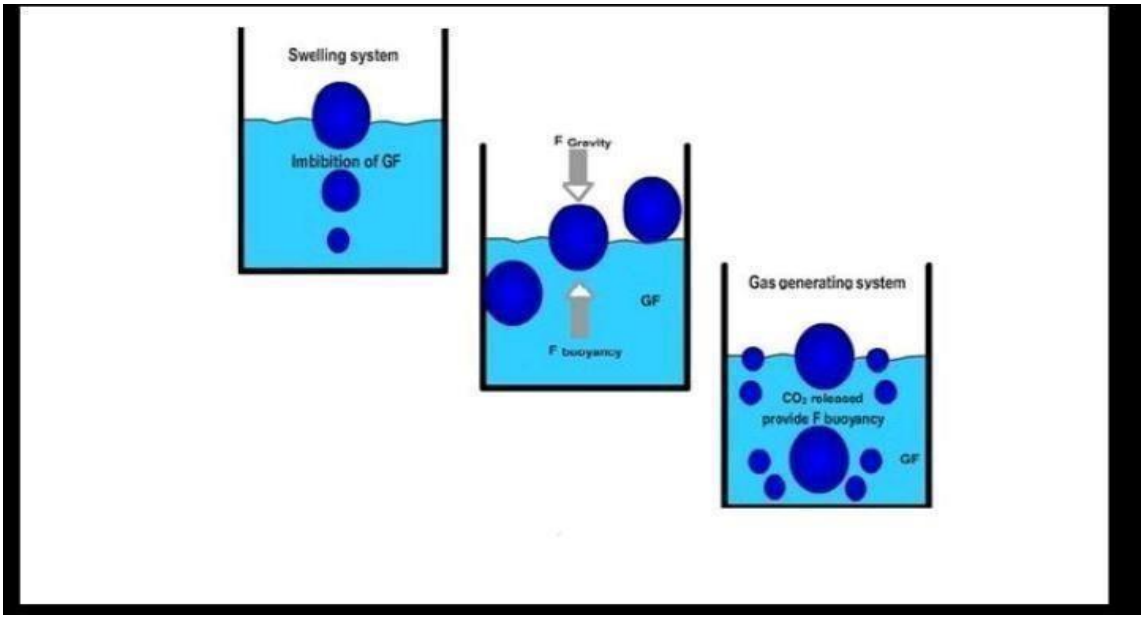

Fig. No. 4: Mechanism of Floating System.[39]

11. Floating systems can also be Classified a

1. Effervescent system and
2. Non-effervescent systems.

1. Effervescent System[39]

Floatation of a drug delivery system in the stomach Filled with vacuum, air, or an inert gas. Gas can be Introduced into the floating chamber by the volatilization Of an organic solvent (e.g., ether or cyclopentane) or by The CO2 produced as a result of an effervescent reaction between organic acids and carbonate–bicarbonate salts. Effervescent system can also be classified as:

a) Volatile liquid containing system
b) Gas generating system
c) Matrix tablet

A) Volatile Liquid Containing System

This type of system consists of two chambers separated By an impermeable, pressureresponsive, movable Bladder. The first chamber contains the drug and the Second chamber contains the volatile liquid. The GRT of A drug delivery system can be sustained by incorporating An inflatable chamber, which contains a liquid e.g. ether, Cyclopentane, that gasifies at body temperature to cause The inflatation of the chamber in the stomach.[40]

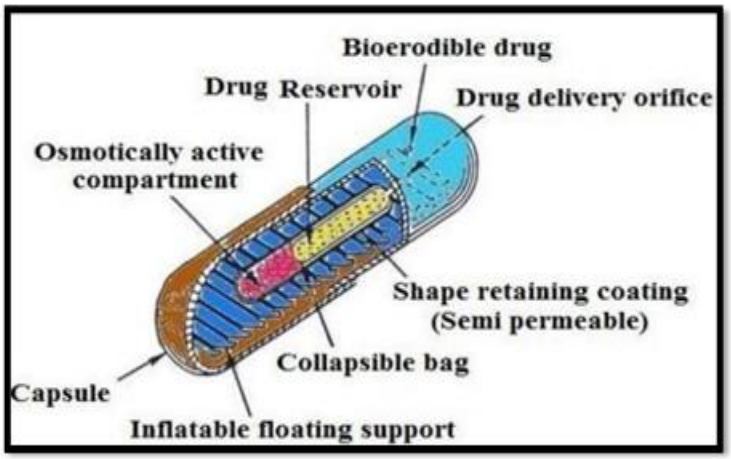

Fig. No. 5: Volatile liquid containing system.[42]

B) Gas generating system

Floatability can also be achieved by generation of gas Bubbles. CO2 can be generated in situ by the Incorporation of carbonates or bicarbonates, which react With acid- either the natural gastric acid or coformulated As citric or tartaric acid.. An alternative is to Incorporate a matrix with entrapped of liquids, which Forms a gas at body temperature. These approaches have Been used for single and multiple unit system.[43]

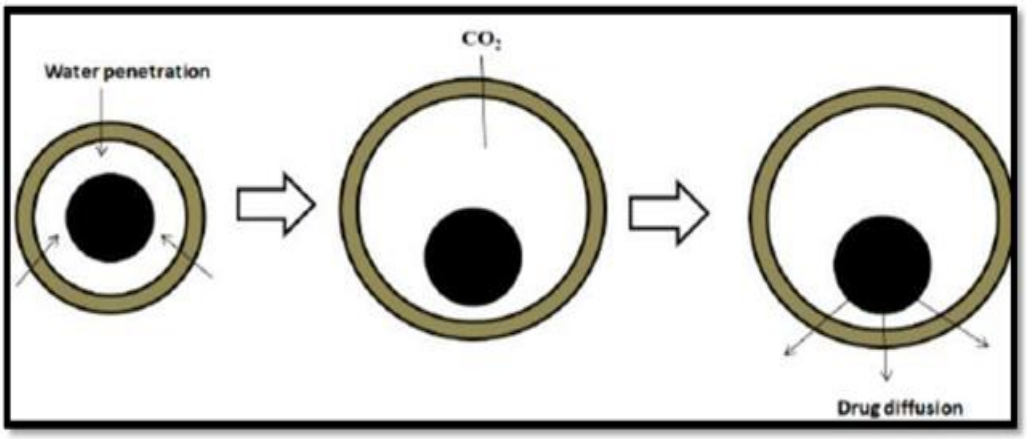

Fig. No. 6: Gas generating system.

C) Matrix Tablet

These dose forms have hydrocolloids that create gels, allowing the delivery Mechanism to float on the contents of the stomach. These could consist of one, two, or three layers.

A) To create single layered matrix tablets, the medicine is intimately mixed with gel-forming hydrocolloids, Which expand when in contact with stomach secretions and retain a bulk density lower than that of the Secretions.[44]

B) One rapid release layer and one sustained release layer are present layered tablets The sustained Release layer absorbs gastric fluids and creates a bulk density lower than that of GI fluids, allowing the Medicine to remain in the stomach for a longer amount of time. The immediate release layer releases the First dose of the drug.[45]

C) Tri-layered tablets have three layers: one for continuous release, one for quick release, and one for gas Generation, which aids in system flotation.[46]

2. Non effervescent systems[47]

Non- effervescent systems incorporate a high level (20–75 % w/w) of one or more gel-forming, highly swellable, Cellulosic hydrocolloids (e.g. hydroxyethyl cellulose, Hydroxypropyl cellulose, hydroxypropyl methylcellulose (HPMC), and sodium carboxymethyl cellulose), Polysaccharides, or matrixforming polymers (e.g., Polycarbophil, polyacrylates, and polystyrene) into Tablets or capsules. Upon coming into contact with Gastric fluid, these gel formers, polysaccharides and Polymers hydrate and form a colloidal gel barrier that Controls the rate of fluid penetration into the device and Consequent drug release.

The following Approaches used in designing intragastric floating Systems.[48]

a) Hydrodynamic ally balanced system
b) Microbial loons and microsphere
c) Alginate beads
d) Layer tablet

A) Hydrodynamically balanced system

These systems incorporate drugs with gel-forming hydrocolloids that are designed to remain buoyant in the stomach Contents. This prolongs GRT and increases the quantity of medication that reaches its absorption sites in solution form, Which leads to faster Absorption. These are singledose formulations that comprise one or more gel-forming hydrophilic Polymers. HPMC (hydroxy propyl methyl cellulose), hydroxypropyl.[49] The use

of fatty excipients results in low-density formulations, which reduce erosion. Madopar LP.s Based. Hydro dynamically balanced intragastric delivery are explain in figure.[50]

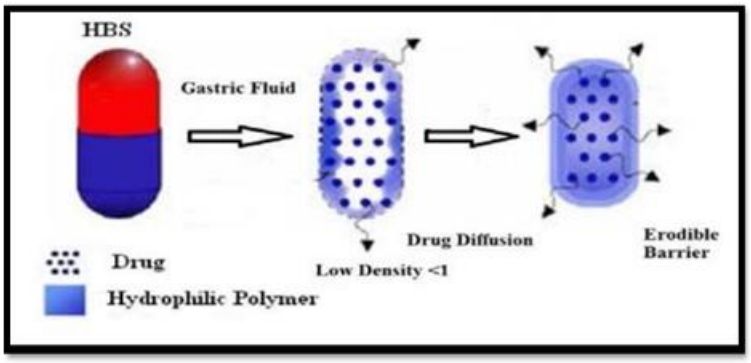

Fig. No. 7: Hydrodynamically balanced system.[51]

B) Balloons/ Microsphere

To increase the GRT of the dosage form, micro balloons or hollow microspheres with medication. Polycarbonate, Cellulose acetate, calcium alginate, Eudragit S, agar, low methoxylated pectin, and other polymers are frequently utilized To create these systems. Polymer amount, plasticizer polymer ratio, and formulation solvent all affect buoyancy and Medication release from dosage forms. For more than 12 hours, these tiny balloons floated nonstop on the surface of an 6Acidic dissolving medium containing surfactant. Because hollow microspheres combine the benefits of superior floating And multiple-unit systems, they are now regarded as one of the most promising buoyant.[52]

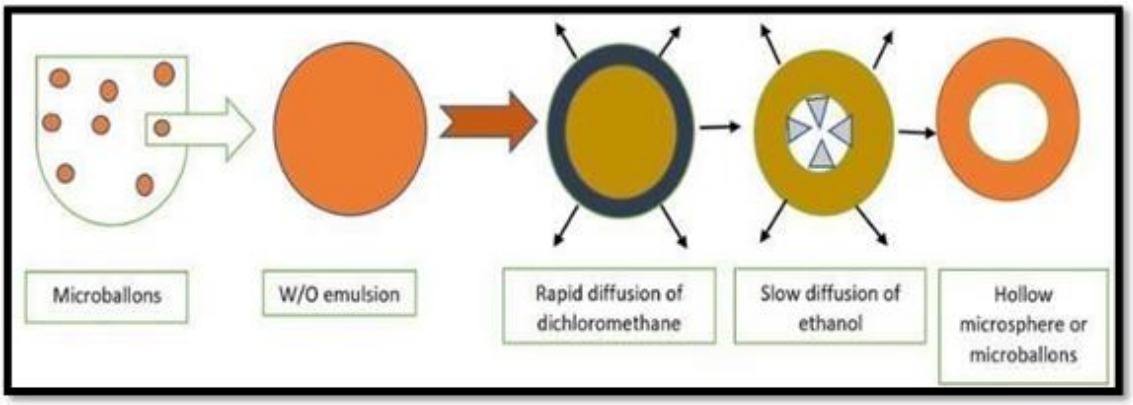

Fig. No. 13: Balloons/ microspheres.

C) Alginate beads

These are the approximately 2.5 mm diameter freeze-dried calcium alginate beads. They were made by dissolving sodium alginate solution into an aqueous calcium chloride solution,

which Precipitated calcium alginate and created a porous system that allowed the system to float on the stomach Contents.[53] These have a floating force that lasts for more than 12 hours because of their porous nature. Comparing these floating beads to solid beads, which had a one-hour residence duration, It exhibits a longer Residency duration of over 5.5 hours.[54]

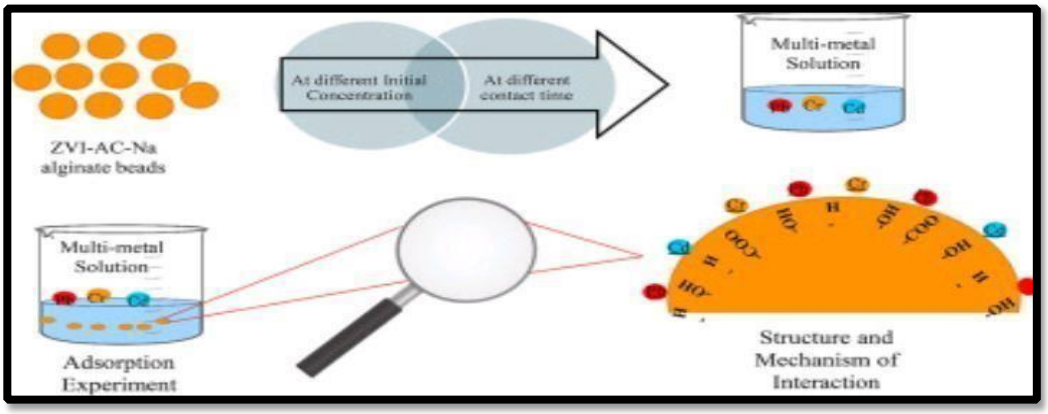

Fig.No8: Alginate beads

D) Layer tablet system[55]

Non-effervescent floating dosage forms include single-layer and bilayer floating tablets. Single layer formulations Combine medication with hydrocolloid to make a gel. However, bilayer floating tablets have two layers.

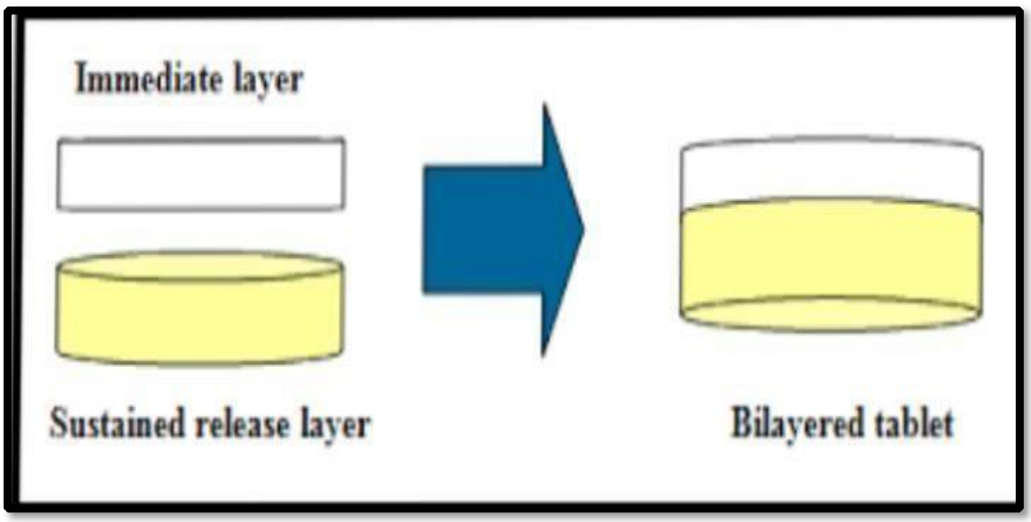

Fig. No. 9: Layered Tablet.

11.2. Non- Floating system[56]

These are the medication delivery methods that stay in the Stomach for an extended amount of time rather than floating. Various methods have been employed to hold The device in the stomach, such as

a. Bioadhesive system
b. Swelling system
c. High density system
d. Expandable system

a) Bioadhesive system

Bio/mucoadhesive systems are those which bind to the gastric epithelial cell surface or mucin and serve as a potential Means of extending the Gastro retention of drug delivery system (DDS).

In the stomach by increasing the intimacy And duration of contact of drug with the biological membrane. A bio/muco-adhesive substance is a natural or Synthetic polymer capable of producingan adhesive interaction based on hydration–mediated, bonding mediated or Receptor mediated adhesion with a biological membrane or mucus lining of GI mucosa.[57]

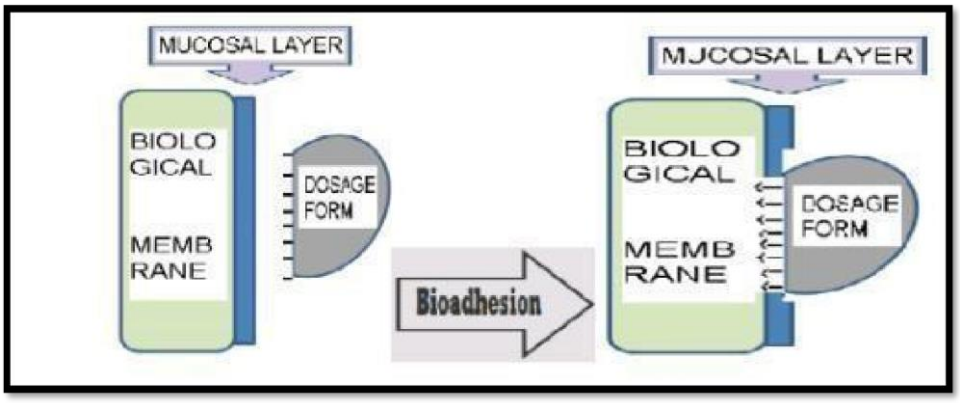

Fig.No.10: Bioadhesive system

b) Swelling systems

These are the dosage forms, which after swallowing, swells to an extent that prevents their exit from the pylorus. Sustained and controlled drug release may be achieved by selection of polymer of proper molecular Weight and swelling of the polymer retards the drug release. On coming in contact with gastric fluid, the polymer Imbibes water and swells.[58]

c) High density systems

These systems with a density of about 3 g/cm3 are retained in the antrum part of the stomach and are capable of Withstanding its peristaltic movements. The only major drawbacks with such systems is that it is technically difficult To manufacture such formulations with high amount of drug (>50%) and to achieve a density of about 2.8g/cm3. It is Necessary to use diluents like barium sulfate, zinc oxide, titanium dioxide, iron powder etc. to manufacture such high Density formulations.[59]

Floating Drug Delivery Systems (FDDS) have a bulk density lower than gastric fluids and thus Remain buoyant in the stomach for a prolonged period of time, without affecting the gastric emptying rate. While the System is floating on the gastric contents, the drug is released slowly at a desired rate from the system. After the Release of the drug, the residual system is emptied from the stomach. This results in an increase in GRT and a Better control of fluctuations in the plasma drug concentrations.[60]

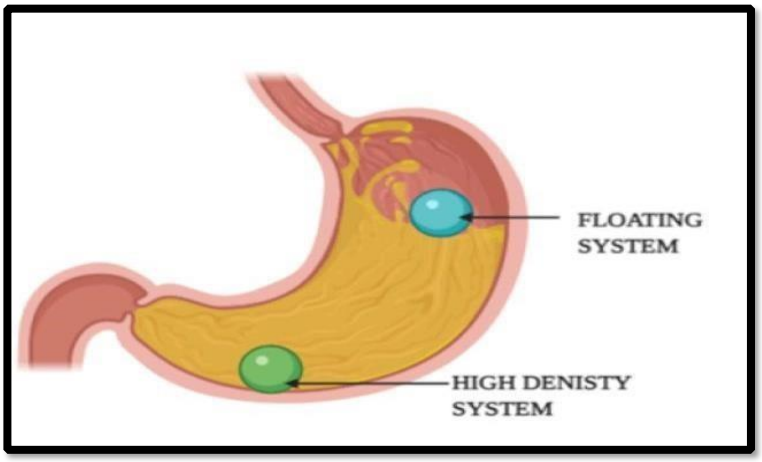

Fig No. 11: High density system.

d) Expandable system

After being swallowed, these dosage forms swell to a size that prevents their passage through the pylorus.[61] Sustained and controlled drug release may be achieved by Selecting a polymer with the proper molecular weight and swelling properties. As dosage form coming in contact With gastric fluid, the polymer imbibes water and swells. The extensive swelling of these polymers is a result of the Presence of physical-chemical crosslink's in the hydrophilic polymer network.[62] A balance between the extent And duration of swelling is maintained by the degree of cross linking between the polymeric chains. A high degree of Crosslinking retards the swelling ability of the system and maintains its physical integrity for a prolonged

period. These Systems also may erode in the presence of gastric juices so that after a predetermined time the device no longer can Attain or retain the expanded configuration.[65] The expansion can be achieved by Swelling system or expanded system.

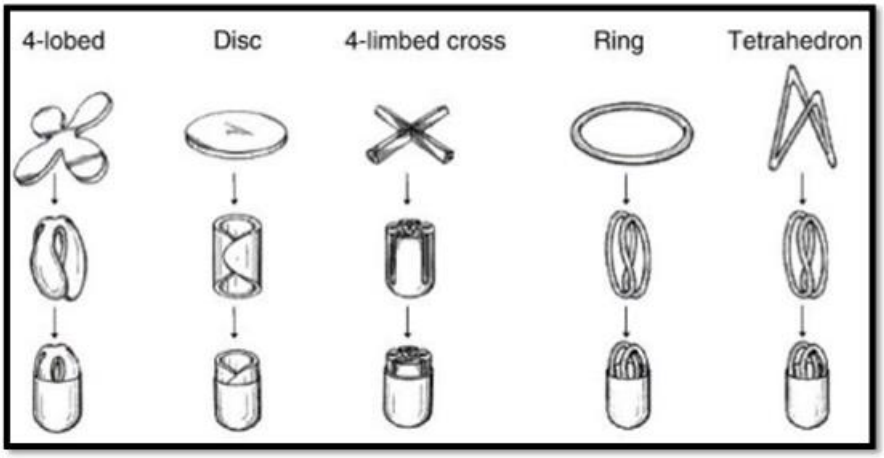

Fig. No. 12: Unfolding System.

12. EVALUATION OF GASTRORETENTIVE DOSAGE FORMS

12.1. Vitro Evaluation[64-65]

1. General tests: These tests include appearance, Hardness, friability, drug content, weight Variation, uniformity of content.

2. Floating systems

a) **Buoyancy Lag Time:** Buoyancy lag time is determined to assess the time Taken bythe dosage form to float on the top of the Dissolution medium, after it is placed in the medium. These parameters can be measured as a part of the Dissolution test.

b) **Floating Time:** The time for which the dosage form continuously floats on the dissolution media is termed as floating time. It is usually performed in Simulated Gastric Fluid maintained at 370°C.

c) Specific Gravity / Density: Density can be determined by the displacement method Using Benzenes displacement medium.

3) Swelling systems[66]

a) Swelling Index: After immersion of swelling dosage form into Simulated Gastric Fluid at 370C, dosage form is removed out at Regular interval and dimensional changes are measured In terms of increase in tablet thickness / diameter with Time.

12.2. In-Vivo Evaluation[67]

1) Radiology: Barium Sulphate is widely used as Radio Opaque Marker. X-ray is used for examination of internal body Systems. So, BaSO4 is incorporated inside dosage form And X-ray images are taken at various intervals to view Gastric retention.
2) Gastroscopy: Gastroscopy is used to inspect visually The effect of prolongation in stomach.
3) Scintigraphy: Similar to X-ray, emitting materials Are incorporated into dosage form and then images are Taken by scintigraphy. Widely used emitting material is 99 Tc.
4) Ultrasonography: It is not used generally because it Is not traceable at intestine.
5) Magnetic Marker Monitoring: This technique is Radiation less and so not hazardous. In this technique, Dosage form is magnetically marked by incorporating Iron powder inside, and images can be taken by very Sensitive bio-magnetic measurement equipment.[68]

12.3. In vivo evaluation of gastric retention

Analysis of the position of the dosage form in the GIT Involves an imaging technique such as scintigraphy And X-ray. In γ-scintigraphy, a small amount of stable Isotope is compounded in the dosage forms during its Preparation. The inclusion of a γ-emitting radio-nuclide In a formulation allows indirect external observation Using a γ-camera or scinti scanner. For x-ray, barium Sulfate is used as a contrast medium. It helps to locate Dosage form in the GIT by which one can predict and Correlate the gastric emptying time and the passage of Dosage form.[69] In addition, gastroscopy and Ultrasonography studies can be included in the in vivo Evaluation of Gastroscopy comprises of peroral endoscopy, used with a fiber optic and video Systems. Ultrasonography is not routinely used in the Evaluation of GRDDS. In vivo plasma profile can also Be obtained by performing the study in suitable animal Model. [70]

1) Morophology and dimensional analysis: It is done With the aid of scanning electron microscopy and optical Microscope.

2) Percentage yield of microsphere.

3) Entrapment efficiency: The drug is extracted by Suitable method and analyzed to find out the amount of Drug present.[71]

13. APPLICATION OF GASTRO-RETENTIVE DRUGS DELEVERY SYSTEM

- **Decreased adverse at the colon**-The amount of medication that enters the colon is reduced when It is retained in the HBS systems of the belly. Consequently, the drug's unwanted effects on the colon are Likewise avoided.
- **Absorption enhancement**- Pharmaceuticals with low bioavailability due to site specific absorption from the upper portion of the stick are good candidates to be designed as floating drug delivery devices, which Would maximize their absorption. Riboflavin used for Essential nutrients, mouth ulcer and sore throat, Cilostazol Inhibits platelet aggregation, Pregabalin Fibromyalgia, diabetic peripheral neuropathy, post-herpetic neuralgia, and adjunctive therapy for partial onset seizures.[72]
- **Site specific drug delivery systems**- The medication is delivered to The abdomen gradually and under supervision, limiting overall exposure to the drug while delivering Sufficient native therapeutic levels. This lessens the negative impact that the medication has on the blood Circulation. Furthermore, a web-directed delivery system's extended internal organ convenience may reduce The frequency of dosage as well. For instance, B2 and Lasix.[73]
- **Sustained drug delivery**- Sustained and delayed input from CR-GRDF may cause a flipflop in the Pharmacokinetics of medicines with relatively short biological half-lives, allowing for lower dose Frequency.[74]
- **Enhanced Bioavailability**- Compared to the administration of non-GRDF CR polymeric formulations, the Bioavailability of riboflavin CR-GRDF is markedly increased. Numerous mechanisms that are connected To the medication's transit and absorption in the gastrointestinal system work in tandem to affect the amount Of drug absorption.[75]

14. CONCLUSION

Gastro retentive drug delivery system offers a potential Advantage of enhanced bioavailability and controlled Delivery of drug. Gastro retentive drug delivery system. Showed the potential to increase the gastric retention of Drug. Growing understanding of impact of GIT Physiology on drug delivery will ensure development of An increasing number of drug delivery system to Optimize drug delivery of molecules exhibiting regional Variability in drug absorption. The increasing Sophistication of delivery technology will ensure the Development of increase number of gastro retentive drug Delivery to optimize the delivery of molecules that Exhibit absorption window, low bioavailability and Extensive first

pass metabolism. Based on the literature Surveyed, we concluded that Gastro retentive drug Delivery offers various potential advantages for drug With poor bioavailability due their absorption is Restricted to the upper gastrointestinal tract and they can Be delivered efficiently thereby maximizing their Absorption and enhancing absolute bioavailability . Gastro retentive drug delivery system gives maximum Benefit to patient.

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