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Floating Drug Delivery System

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Abstract: *Any drug delivery system is aimed to achieve desired concentration of the drug in blood or tissue, which is therapeutically effective and non-toxic for a prolonged period. Recent pharmaceutical research and development focuses on the formulation of floating drug delivery system (FDDS). FDDS have low density systems that float over the gastric contents in stomach and remain buoyant in the stomach for a prolonged period of time without affecting the gastric emptying rate due to buoyancy force. Various approaches such as low density systems , swelling and expanding systems, bioadhesive systems, high density systems or other delayed gastric emptying devices have been discovered. This review composition gives detailed information on the pharmaceutical basis of their design, advantages and disadvantages, ideal candidates, classification, methods of preparation, in vitro and in vivo evaluation parameters, etc.*

Keywords: Floating drug delivery systems (FDDS), gastric residence time, buoyant, Effervescent system, Non effervescent system

I. INTRODUCTION

Floating drug delivery systems (FDDS) are constructed to retain the drug in the stomach and applicable for medicines with poor solubility and low stability in intestinal fluids. The base behind FDDS is making the lozenge form less thick than the gastric fluids to make it float on them. FDDS are hydro- dynamically controlled low- viscosity systems with sufficient buoyancy to float over the gastric contents and remain buoyant in the stomach without affecting the gastric evacuating rate for a prolonged period of time. The residual system is voided from the stomach with the release of the medicine. This results in enhanced gastric residence time and good control over plasma drug concentration oscillations. (1)The principle of buoyant medication offers a simple and practical approach to achieve increased gastric residence time for the lozenge form and sustained medicine release. Dragging the gastric retention of a delivery system is desirable for achieving the lesser remedial efficacy of the medicine substance under certain circumstances. For example, medicines which show better immersion at the proximal part of the gastrointestinal tract and medicines with low solubility and get degraded in alkaline pH set up effective in dragging gastric retention. In addition, for sustained medicine delivery to the stomach and proximal small intestine in treating certain ulcerative conditions, protract gastric retention of the remedial half and hence offer multitudinous advantages including bettered bioavailability and remedial efficacy with reduction of dosing frequency.(2)

Advantages of floating drug delivery system:

1) Simple and conventional technique for formulation.
2) Site-specific drug delivery.
3) Controlled delivery of drugs.
4) Delivery of drugs for residual action at a specific site in the stomach.
5) Improved drug absorption with increased GRT and excess duration of contact of dosage regimen at its target site.
6) Minimizing irritation of GIT mucosa by the drugs with slow release rate.
7) In treating gastroesophageal reflux disorders (GERD).
8) Ease of administration with higher patient compliance.

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Disadvantages of floating drug delivery system:

1) The major disadvantage of a floating system is due to the necessity of a sufficient level of gastric fluids to float without a sink. However, this limitation can be overcome by coating the dosage form with bio adhesive polymers that easily adhere to gastric mucosa.
2) The drugs those get significantly absorbed throughout gastrointestinal tract, with significant first-pass metabolism, are desirable candidate predominantly.
3) Certain drugs present in the floating system may causes irritation to gastric mucosal linings.
4) Gastric emptying of floating systems may occur at random and highly dependent on its dimensions. Therefore patients should not have dosage prior going to bed.

Gastro Retentive Drug Delivery Devices

These are primarily controlled release drug delivery systems, which gets retained for longer period of time in stomach, therefore helping in immersion of medicine for the intended duration of time, which in turn improves bioavailability by reducing medicine destruction, and perfecting solubility of medicines that are less answerable at high pH terrain. It also helps in achieving original delivery of medicine in the stomach and proximal small intestine. G.R.D.D bias can be useful for the spatial and temporal delivery of numerous medicines.(3)

Ideal properties of drug for gastro forgetful medicine delivery systems:

- Drug which act locally in the stomach.
- Drug which get primarily absorbed in the stomach.
- Drugs which are inadequately answerable at alkaline pH.
- Drug with a narrow remedial window of immersion.
- Drugs which are absorbed fleetly from GI tract.
- Drugs that degrade in the colon.(4)

Classification of Floating Drug Delivery Systems

(A) Effervescent System Floating Drug Delivery System

These are particular drug delivery system made up of matrix type and a swellable polymer similar as methylcellulose and chitosan along with effervescent compositesviz. sodium bicarbonate, tartaric acid, citric acid. These are formulated in such a specific way as once it comes in contact with gastric juice; co2 gets delivered with ruse in blown hydrocolloid to give buoyancy for lozenge form. The base of the delivery system is on swellable asymmetric triadic layer tablet approach design.(2)

(I) Gas Generating Systems

Low- density FDDS is grounded on the release of co2 upon contact with gastric fluids after oral administration. The accoutrements are formulated in such a way that after entering in the stomach, co2 is liberated due to response with acidic gastric content and which get entangled in the gel- grounded hydrocolloid. It produces an upward stir of the dosage form and maintains its buoyancy. Eventually it causes drop in specific graveness of dosage form and hence performing into a pier on the chime. The co2 generating factors are mixed within the tablet matrix in a single layer or multi-layered form to produce gas generating medium in hydrocolloid layer, and the medicine in the other layer results into a sustained release effect.(2) Bilayer or multilayer systems have also been designed in which medicine and excipients can be formulated singly, and the gas generating unit can be incorporated into any of the layers of multiple unit systems, which avoids the' all- or- nothing' evacuating process encountered in single unit systems.(5)

(II) Volatile Liquid Containing Systems (Osmotically Controlled Drug Delivery System)

This is an osmotically controlled floating system in which a device comprised of a concave deformable unit in convertible collapsed form. Casing would be attached to its deformable unit and internally divided into a first and alternate chamber separated by an impermeable, pressure sensitive portable unit. The first chamber generally contains

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an active medicine, while the alternate an unpredictable liquid, similar as cyclopentane or ether get wracked at a physiological temperature to produce a gas, enabling the medicine force to float. The unit gets expelled from the stomach, with the help of bioerodible draw that allowed the vapour to escape.(2) Volatile liquid containing systems by incorporating an inflatable chamber, the gastric residence time of a medicine delivery system can be sustained which contains a liquid i.e. cyclopentane and ether, and gasifies at body temperature to beget the affectation of the cube in the stomach.(6)

(B) Non-effervescent FDDS

Non-Effervescent Floating drug Delivery Systems comprises a gel- forming (or) swellable cellulose type of hydrocolloids made up of polysaccharide along with matrix forming polymers like polycarbonate, polymethacrylate, and polystyrene. The routine expression system involves the mixing of the medicine with gel forming hydrocolloids that swell in contact with gastric fluid upon oral administration and maintains the integrity of shape and a bulk viscosity hedge, the air trapped by blown polymer confer buoyancy to the dosage forms.(2)

(I) Colloidal Gel Barrier Systems (Hydrodynamic Balanced Systems)

These systems are suitable to maintain their low viscosity, while the polymer hydrates and builds a curdled barrier at external face. The air trapped by blown polymer maintains viscosity lower than unity and confers buoyancy. The medicine is released sluggishly from blownmatrix. This system prolongs gastric retention time and maximizes the quantum of medicine that reaches its immersion point in the result form. It basically contains medicine with gel-forming hydrocolloids to remain buoyant on the stomach content. Such a system incorporates one or further gel-forming cellulose type hydrocolloide.g. hydroxypropylmethylcellulose(HPMC), polysaccharides and matrix forming polymers similar as polycarbophil, polystyrene, and polyacrylate. Upon contact with gastro- Intestinal (GI) fluid, the hydrocolloid in the system hydrates to induce a colloid gel barrier to its girding.(7)

(II) Microporous Compartment Systems

This technology incorporates the encapsulation method of a medicine reservoir inside a microporous cube along with pores at top and bottom walls. The peripheral wall of the medicine force cube is fully sealed to help any direct contact of the gastric face with the undissolved medicine.(2) In the stomach, the floatation chamber composed of entangled air causes the delivery system to float over the gastric content. Gastric fluid enters through the orifice, to the extent that it prevents theirs live from the medicine and carrier the dissolved medicine for nonstop transport across the intestine for absorption.(8)

(III) Floating Microspheres/Micro Balloons

Hallow microspheres also are known as micro balloons are considered as a most effective buoyant system. It's composed of central hallow space inside the microsphere. Hallow microsphere is loaded with a medicine in their external polymer shelf are fabricated by a new solvent prolixity system for conflation. The microballoons are concave microspheres which incorporates medicine and the medicine release can be controlled at a desired rate. Microballoons are floating microspheres which floats over the gastrointestinal fluid as the viscosity of microballoons is lower than the viscosity of the gastrointestinal fluid. This floating system helps to treat numerous gastrointestinal conditions similar as ulcers, GERD, Zollinger- Ellison conditions. Targeted medicine delivery can be achieved with the use of microballoons.(9)

(IV) Alginate Beads/Floating Beads

Multi-unit floating dosage forms have been developed from calcium alginate globular globules of about2.5 mm in periphery and can be fabricated by adding sodium alginate result into waterless result of calcium chloride, performing in the rush of calcium alginate, the globules are farther separated, snap- firmed in liquid nitrogen and indurate- dried at 400 °C for 24 h, leads to generation of a pervious system. This fabricated system would maintain a floating force for over 12 h and these floating globules give a longer hearthstone time of further than5.5h. Floating globules were prepared from a sodium alginate result containing CaCO (3) or NaHCO (3) as gas- forming agents. The result was

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dropped to 1 CaCl (2) result containing 10 acetic acid for CO (2) gas and gel conformation. The goods of gas- forming agents on blob size and floating properties were delved.(10)

(C) Raft-Forming Systems

Raft forming systems produce layer on the highest point of gastric fluids. Then, a gel forming result(for illustration Sodium alginate arrangement containing carbonates or bicarbonates) swells and structures a gooey establishment gel containing entangled CO2 rises on contact with gastric fluid. The system associated with the raft conformation incorporates the development of thick establishment gel in contact with gastric fluids, where in each part of the liquid swells framing a persistent layer called raft. This raft drifts on gastric liquids due to low mass consistence made by the development of CO2. Raft forming systems incorporate alginate gels. (11) The raft in this way shaped buoys on the gastric liquids and anticipates the influx of the gastric substance (for illustration gastric sharp) into the oesophagus by acting as a barrier between the stomach and oesophagus.(12)

List of Drugs Explored in Floating Dosage Forms:

- **Microspheres:** Aspirin, Griseofulvin, P-nitroaniline, Ibuprofen, Ketoprofen, Terfenadine, Tranilast.
- **Granules:** Diclofenac sodium, Indomethacin, Prednisolone.[6,8]FilmsCinnarizine, (capsules)
- **Capsules:** ChlordiazepoxideHCl, Diazepam, Furocemide, L-Dopa and Benserazide, Misoprostol, Nicardipine, Propranolol HCl, Ursodeoxychoric acid
- **Tablets/Pills:** Acetaminophen, Aspirin, Amoxycillintrihydrate, Ampicillin, Atenolol, Captopril, Ciprofolxacin, Chlorpheniramine maleate, Cinnarizine, Furosemide, 5-Fluorouracil, Isosorbidemononitrate, Diltiazem, Isosorbidedinitrate, Nimodipine, Para amino benzoic acid, Prednisolone, Quinidine, VarapamilHCl, Riboflavin, Sotalol.
- **Alginate beads:**Diclofenac sodium, Famotidine, Nevirapine, Riboflavine, Pantoprazole
- **in-situ colloidal gels:** Clarithromycin, Furosemide, Ofloxacin
- **Films:** 5-Flurouracil, Propranolol, Metoprolol

II. METHOD OF PREPARATION

1. **Solvent evaporation method:** Employing solvent diffusion and evaporation ways, a concave inner core was produced with the floatingmulti-particulate cure. After the polymer is immersed into a detergent, it's dissolved into the organic polymer result. The medicine result is latterly homogenized into a waterless medium of PVA to produce O/ W conflation. The organic detergent is also faded or continually stirred as the temperature rises. The pullout of a detergent leads polymer to seize the gout contact with the oil inwater (O/ W), creating a concave chamber and enabling it to float. Among the polymers that are being used in the enhancement of these floating systems include cellulose acetate, polyvinyl acetate, chitosan, acrylate, Eudragit, Methicillin, polyacrylate, polycarbonate, Carbo- polite, polyethylene oxide and agar. The polymer and medicine regulation rate were disintegrated by methylene chloride. In the organic phase that was produced the polypropylene greasepaint was also distributed. In the waterless phase of polyvinyl alcohol (PVA), the performing suspense was also emulsified. Until being dried in a desiccator with enough silica gel, themacro-particles were regulated and washed with cold water; all of these are uneven in form and size and have a pervious structure.(13)
2. **Emulsion solvent diffusion method:** A new technique of diffusion of emulsion solvents is being implemented with micro-balloons (hollow microspheres) in their external polymer shell. A polymer and medicament mixture are injected into an aqueous polymer solution in ethanol methylene chloride (vinyl alcohol). Enclosed methylene chloride evaporates and the microparticles create interior voids.
3. **Ionotropic Gelation Method:** In the vicinity of counter-ionic polyelectrolytes, the inclination to cross link promotes ionotropic gelation, which leads to globules product. Since operation of Chitosan, Alginates, CMC and gellan gum for medicine encapsulation, this system of gelation has been constantly used to beads medications. These anions make mesh- suchlike structures by coupling them with protean cations and engage

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gelation substantially by combining them with anion chunks. Hydrogel globules are created if the medicine-loaded polymer result is dropped into a protean cationic waterless phase.(13)

Evaluation of Floating Drug Delivery Systems

Different parameters that need to be estimated in gastro forgetful phrasings include floating duration, dissolution biographies, specific graveness, content uniformity, hardness, and friability in case of solid dosage forms. In the case of multiparticulate drug delivery systems, differential scanning calorimetry (DSC), particle size determination, inflow properties, face morphology, and mechanical properties are also performed.(14)

A. In Vitro Methods:

1) Floating lag time and floating time: The test for floating time dimension is generally performed in stimulated gastric fluid or0.1 N HCl maintained at 37 0C. It's determined by using USP dissolution apparatus containing 900 ml of0.1 N HCl as dissolution medium at 37° C. The time taken by the dosage form to float is nominated as floating pause time and the time for which the dosage form floats is nominated as the floating or flotation time. The system to check nonstop floating geste contains a stainless steel handbasket connected to a essence string and suspended from a Sartorius electronic balance.A lotus- spread distance could automatically pick up the reading on the balances. Test medium used in floating kinetics measures was 900 ml dissembled gastric fluid(pH1.2) maintained at 37 °C, data was collected at 30 sec interval; birth was recorded and abated from each dimension. Dissolution handbasket had a holder at the bottom to measure the downcast force.(15)

2) Dissolution study: A 100- mL glass beaker was modified by adding a side arm at the bottom of the beaker so that the teacup can hold 70 ml of0.1mole.lit- 1 HCl dissolution medium and allow collection of samples. A burette was mounted above the teacup to deliver the dissolution medium at an inflow rate of 2 ml/ min to mimic gastric acid stashing rate. The performance of the modified dissolution apparatus was compared with USP dissolution Apparatus 2(Paddle). The problem of adherence of the tablet to the shaft of the paddle was observed with the USP dissolution apparatus47. The tablet didn't stick to the agitating device in the proposed dissolution system. The medicine release followed zero- order kinetics in the proposed system. The proposed test may show good in vitro in vivo correlation since an attempt is made to mimic the in vivo conditions similar as gastric volume, gastric evacuating, and gastric acid stashing rate.(16)

B. In vivo method:

1) X-Ray method: X-Ray is a veritably popular evaluation parameter for floating dosage form now a day. It helps to detect dosage form in the g.i.t. and by which one can prognosticate and relate the gastric evacuating time and the passage of lozenge form in the GIT. Then the addition of a radio-opaque material into a solid dosage form enables it to be imaged by X-rays.

2) Gamma-Scintigraphy: Gamma- Emitting radioisotopes compounded into CR- DFs has come the state- of- art for evaluation of gastro retentive expression in healthy lives. A small quantum of a stable isotope is compounded into DF during its medication. The main downsides of gamma- scintigraphy are the associated ionizing radiation for the case, the limited topographic information, low resolution essential to the technique and the complicated and precious medication of radiopharmaceuticals.

3) Gastroscopy: It comprises of peroral endoscopy, used with a fibereoptic and videotape systems. It's suggested that gastroscopy may be used to check visually the effect of prolonged stay in stomach terrain on the FDDS. Alternately, FDDS may be drawn out of the stomach for more detailed evaluation.

4) Ultrasonography: Ultrasonic waves reflected mainly different acoustic impedances across interface enable the imaging of some abdominal organs. Utmost DFs don't have sharp acoustic mismatches across their interface with the physiological terrain. Thus, Ultrasonography isn't routinely used for the evaluation of FDDS. The characterization included assessment of intragastric position of the hydrogels, solvent penetration into the gel and relations between gastric wall and FDDS during peristalsis.(17)

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III. CONCLUSION

Currently available Effervescent and non-effervescent FDDS are formulated on the basis of buoyancy principle and increased gastro retentive time, which is more effective approach to controlled oral drug delivery. FDDS is advantageous for drugs which are absorbed in upper part of GI tract. FDDS promises to be an implicit approach for gastric retention. Although there are various difficulties to achieve prolonged gastric retention, a large number of companies are focusing towards design this technique to make profit.

REFERENCES

[1]. Nama M, Gonugunta CSR, Reddy Veerareddy P. Formulation and Evaluation of Gastroretentive Dosage Forms of Clarithromycin. AAPS PharmSciTech. 2008 Feb 7; 9(1):231.

[2]. Niharika MG, Krishnamoorthy K, Akkala M. OVERVIEW ON FLOATING DRUG DELIVERY SYSTEM. International Journal of Applied Pharmaceutics. 2018 Nov 7; 65–71.

[3]. Review Article on Floating Drug Delivery System [Internet]. PharmaTutor. [cited 2023 Jan 24]. Available from: https://www.pharmatutor.org/articles/review-article-on-floating-drug-delivery-system

[4]. Bhosale A, Shinde J, Chavan S. A Comprehensive Review on Floating Drug Delivery System (FDDS). Journal of Drug Delivery and Therapeutics. 2020 Dec 20; 10:174–82.

[5]. Singh S, Chaturvedi S, Agrawal V, Kumari P. Approaches to increase the gastric residence time: Floating drug delivery systems- A review. Asian Journal of Pharmaceutical and clinical research. 2013 Jul 10; 6:1–9.

[6]. Figure 6. Volatile Liquid Containing System (Meenakshi et al., 2015) [Internet]. ResearchGate. [cited 2023 Jan 24]. Available from: https://www.researchgate.net/figure/Volatile-Liquid-Containing-System-Meenakshi-et-al-2015_fig4_324523954

[7]. MICROSPHERES AS HYDRODYNAMICALLY BALANCE SYSTEM [Internet]. PharmaTutor. [cited 2023 Jan 24]. Available from: https://www.pharmatutor.org/articles/microspheres-hydrodynamically-balance-system

[8]. Doon College of Pharmacy, Sunderpur, Saharanpur, U.P., India247001, Hafeez A, Maurya A, Doon College of Pharmacy, Sunderpur, Saharanpur, U.P., India247001, Singh J, Doon College of Pharmacy, Sunderpur, Saharanpur, U.P., India247001, et al. An overview on floating microsphere: Gastro Retention Floating drug delivery system (FDDS). J Phytopharmacol. 2013 Jun 25; 2(1–3):1–12.

[9]. Jpsr12012013.pdf [Internet]. [cited 2023 Jan 24]. Available from: https://www.jpsr.pharmainfo.in/Documents/Volumes/vol12issue01/jpsr12012013.pdf

[10]. Choi BY, Park HJ, Hwang SJ, Park JB. Preparation of alginate beads for floating drug delivery system: effects of CO (2) gas-forming agents. Int J Pharm. 2002 Jun 4; 239(1–2):81–91.

[11]. Panda S, Madhusrota P, Sethi G. Raft Forming System- A Novel Approach for Improving Gastric Retention. J Pharm Sci. 2019; 11.

[12]. R NA, C NA, Z SA. A Short Review on Floating Drug Delivery System. Asian Journal of Pharmacy and Technology. 2022 Aug 10; 12(3):272–6.

[13]. Yadav S, Yadav S, Kumar A, Mishra A. Floating Drug Delivery System an Aid to Enhance Dissolution Profile of Gastric. Journal of Drug Delivery and Therapeutics. 2021 Nov 15; 11(6):286–96.

[14]. Doshi MU, Chivate ND. Floating Drug Delivery Systems, An effective tool for Control Release-A Complete Review. Rese Jour of Pharm and Technol. 2015; 8(9):1320.

[15]. Floating Drug Delivery System - Semantic Scholar€¦ · · 2017-08-27... Floating drug delivery systems, Approaches to Gastro-Retentive Drug Delivery Systems The controlled - [PDF Document] [Internet]. fdocuments.us. [cited 2023 Jan 25]. Available from: https://fdocuments.us/document/floating-drug-delivery-system-semantic-scholar-2017-08-27-floating-drug-delivery.html

[16]. Gohel MC, Mehta PR, Dave RK, Bariya NH. A More Relevant Dissolution Method for Evaluation of Floating Drug Delivery System. Dissolution Technol. 2004; 11(4):22–5.

[17]. Document 13308304 [Internet]. studylib.net. [cited 2023 Jan 26]. Available from: https://studylib.net/doc/13308304