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ADVANCED MULTIPLE UNIT CONTROLLED RELEASE FLOATING BEADS: A REVIEW

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ABSTRACT

The aim of writing this review on floating beads is to compile the recent literature with special focus on the novel technological advancements in floating drug delivery system to achieve gastric retention. Floating beads are often used for controlled drug release as they have gastroretentive property without affecting the gastric emptying rate. Floating beads drug delivery systems are mainly based on non-effervescent system. Floating beads is useful for several categories of drugs which act locally in stomach, poorly soluble in alkaline pH, having narrow absorption window, unstable in intestine or colonic environment and primarily absorbed in stomach. It is expected that floating beads may enhance the pharmacotherapy of drugs. Floating beads are formulated for various drugs those which are available for treatment of diseases like gastric ulcers, duodenal ulcers, zollinger-ellison syndrome, hypertension and gastro esophageal reflux disease etc. The advantages, limitation, types, method of preparations, evaluation techniques and applications of floating beads are covered in detail.

KEYWORDS: Floating beads, Gastroretentive, Gastric time, Gastric emptying, Buoyancy.

INTRODUCTION

Conventional oral dosage forms such as tablets, capsules provide a specific drug concentration in systemic circulation which do not release at the constant rate for prolonged period of time. Controlled release drug delivery system (CRDDS) provides drug release at a

precontrolled, predictable rate either systematically or locally for intended duration of time and optimizes the therapeutic effect of a drug by controlling its release into the body with lower and less frequent dosing.[1]

NOVEL DRUG DELIVERY SYSTEM

Development of newer drugs and medicines will be the goal of scientists across the world. In order to achieve satisfying results, a drug has to be properly formulated in proper dosage form. It is a well-known fact that the conventional release dosage form when taken frequently in a day can maintain drug concentration levels in therapeutically effective range. Recently, several technical progress have led to the growth of various Novel Drug Delivery Systems (NDDS) that could revolutionized method of drug delivery and hence could supply definite therapeutic benefits.[2]

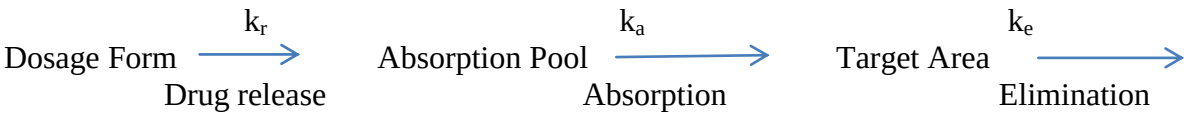

Fig. 1: Conventional Dosage Form Release.

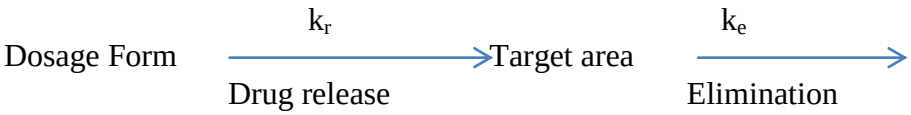

Fig. 2: Novel Drug Delivery Release.

An oral drug delivery system provides a uniform drug delivery can only partly fulfil therapeutic and biopharmaceutical needs, as it doesn't take into describe the site specific absorption rates within the gastrointestinal tract, therefore there is essential requirements for developing delivery system that release the drug at the right time, at the specific site and with the required rate.

The most important objective for the development of controlled release dosage forms systems is to furnish an extended duration of action and thus assure greater patient compliance.[2]

Controlled Gastroretentive Drug Delivery System

Controlled release drug delivery system (CRDDS) provides drug release at a precontrolled, predictable rate either systematically or locally for intended duration of time and optimizes the therapeutic effect of a drug by controlling its release into the body with lower and less frequent dosing[1] in Fig.3.

Controlled-release drug delivery system is capable of achieving the benefits like maintenance of therapeutic amount of drug concentration in blood with controlled release rate for an extended time period, enhancement of activity of duration for short half-life drugs, elimination of side effects, reducing the fluctuations of drug concentration and frequency of dosing, it optimized therapy and better patient compliances.[3,4]

The oral path is progressively being used for the delivery of therapeutic agents because the minimum cost of the therapy and ease of administration lead to high levels of patient comfort. More than 50% of the drug delivery systems available in the market are oral drug delivery systems.[5] The successful growth of oral controlled drug delivery systems requires knowledge of the following characteristics of the system, namely.

1. The physiochemical characteristics of the drug
2. Anatomy and physiology of GIT and characteristics of dosage forms.[6]

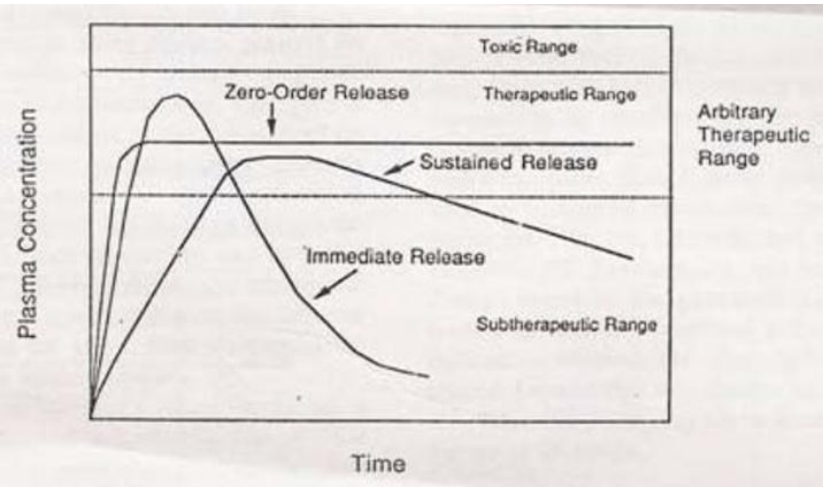

Fig. 3: Drug level verses time profile showing differences between zero order, controlled releases, slow first order sustained release and release from conventional dosage form.

Good fundamental understanding of the anatomic and physiological characteristics of the human GIT is required to modulate the gastrointestinal transit time of a drug through Floating Drug Delivery System (FDDS) for maximal gastrointestinal absorption of drugs and site-specific delivery.[7]

GASTRORETENTIVE DRUG DELIVERY SYSTEMS (GRDDS)

Dosage forms that can be retained in stomach for longer periods of time are called gastro retentive drug delivery systems (GRDDS). Gastric emptying of dosage forms is an extremely

variable process and ability to prolong and control emptying time is a valuable asset for dosage forms, which reside in the stomach for a longer period of time than traditional dosage forms. Gastro retention helps to achieve better availability of new products with new therapeutic possibilities and considerable benefits for patients.

GRDDS are suitable and beneficial for such drugs by improving their

- absolute bioavailability,
- therapeutics efficiency,
- increase gastric residence time (GRT),
- possible reduction of the dose,
- Reduces drug waste and improves solubility for drugs that are less soluble in a high pH environment.[1]

Floating drug delivery system

Floating drug delivery system was described by Davis (1968). These are low-density based systems with sufficient buoyancy to float over the gastric contents. While the system is floating on the gastric substance, the drug is discharge slowly at the unvarying rate from the system. After release of drug, the remaining system is move out from the stomach. This result in an increased GRT, reduce fluctuation of drug and thus enhances bioavailability. Many floating systems have been generated based on granules, powders, beads, hollow microspheres, capsules, tablets and laminated films.[8,9]

Mechanism of floating drug delivery systems

Floating drug delivery systems (FDDS) have bulk density less than gastric fluids, so they remains buoyant in the stomach without affecting the gastric emptying rate for a long period of time. While the system is floating on the gastric contents, the drug is released slowly at the required rate from the system as shown in Fig.4.

However, besides a minimum gastric content required to allow the proper achievement of the buoyancy retention principle, a minimum level of floating force (F) is also required to keep the dosage form dependable buoyant on the surface of the repast. To evaluate the floating force kinetics, a novel apparatus for determination of outcome weight has been reported in the literature. The apparatus work by measuring continuously the force equivalent to F (as a function of time) that is needed to keep the submerged object. The aim floats better if F is on

the higher positive side as shown in Fig.4. This apparatus helps in optimizing FDDS with respect to stability and endurance of floating forces produced in order to inhibit the cons of unforeseeable intra gastric buoyancy capability variations.[4,5]

F = F buoyancy – F gravity
F = (Df – Ds) gv

Where, F is total vertical force, Df is fluid density, Ds is object density, v is volume and g is acceleration due to gravity.

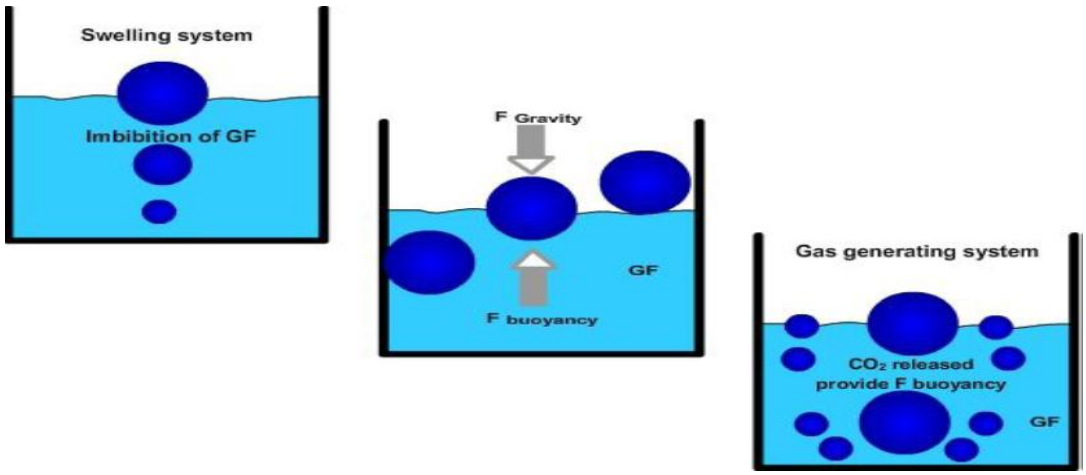

Fig. 4: Mechanism of Floating System, GF= Gastric Fluid.

Classifications

It can be classified into two systems which have been used for the design of floating dosage forms of single and multiple units.[10,11]

Single Unit

- Effervescent
- Non- effervescent

Multiple Units

- Effervescent
- Non- effervescent

Single unit

Single unit dosage forms are easiest to formulate but it is suffered from the risk of losing their effects too early due to their all-or-none emptying from the stomach and thus they may cause high variability in bioavailability and local irritation because of large amount of drug

delivered at a particular site of the gastro intestinal tract.[12] Example: Floating Tablet, Floating capsule.

Multiple unit

Multiple unit dosage forms may be an attractive alternate since they have been shown to avoid the 'all-or-none' gastric emptying nature of single unit systems. It reduces inter and intra-subject variability in drug absorption and as well as lower the dose dumping.[13] Various multiple unit floating systems have been developed by using effervescent and swellable polymers.

Example: Beads, Microspheres, Carrier systems.

Alginate beads

Multiple unit floating dosage forms have been prepared from freeze-dried calcium alginate. Spherical beads of approximately 2.5 mm in diameter were prepared by dropping a sodium alginate solution into aqueous solution of calcium chloride, affecting a precipitation of calcium alginate. These beads was then separated, snap frozen in liquid nitrogen and freeze dried at 40°C for 24 h, leading to formation of porous system that maintained floating force for over 12 h.[14]

GASTRORETENTIVE BEADS

Beads are distinct spherical microcapsule that works as the solid substrate on which the drug is coated or encapsulated in the core of beads. Beads can provide controlled release properties. Furthermore, bioavailability of drugs formulated in beads has been enhanced.

Gastroretentive beads fulfills the challenge of development of gastro retentive drug delivery system is not just to sustain the drug release, but also to prolong gastric residence of the dosage forms until all the drug is completely released at the desired period. The multiparticulate dosage forms have many advantages over single unit preparations, including:

- Uniform dispersion in the GI tract,
- Uniform drug absorption,
- Less inter- and intra-individual variability,
- No chances of dose dumping,
- Improve flow property,

- More flexible formulation processes.

TYPES OF GASTRORETENTIVE FLOATING BEADS

Effervescent Beads

- Floating Beads

Non-effervescent Beads

- Calcium Alginate / Pectinate Beads
- Alginate Beads with Air Compartment
- Oil Entrapped Gel Beads
- Casein-Gelatin Floating Beads

Effervescent beads

Floating beads or porous alginate beads based on ion-exchange resin

This system comprised of ion exchange resin beads loaded with bicarbonate and a negatively charged drug tagged to resin. Porous alginate beads are prepared by incorporating CO_2 gas generating agents like $NaHCO_3$ and $CaCO_3$. Bicarbonates are merged with stirring into aqueous solution of sodium alginate and then mixture is added to solution of calcium chloride with 10% acetic acid. So due to acetic acid and bicarbonate, CO_2 gas is generated and simultaneously gelling of beads are occurred by calcium ions and CO_2 which goes out from beads during stirring and creating porous structures in calcium alginate floating beads.

Non-effervescent beads

Calcium alginate / pectinate beads

Freeze dried spherical beads of calcium alginate approximately 2.5 mm in diameter are formed by dropping sodium alginate solution into aqueous solution of calcium chloride, causing a precipitation of calcium alginate. So due to chemical reaction gelation take place and forms solid spherical gel beads. These beads were then separated; snap frozen in liquid nitrogen and freeze dried at $40^{o}C$ for 24 h leading to formation of porous system. The resultant weight of beads is less giving buoyancy up to 12 h.

Similar to alginate, pectin can also be used for preparing gel beads. Combination of both means calcium-alginate-pectinate gel beads, which make fasten drug release as compare to

only calcium pectinate beads. Calcium alginate beads are also prepared with incorporation of chitosan polymer so that it can include air in beads.

Alginate beads with air compartment: These are also calcium alginate beads but the difference is that the calcium alginate core is separated by air compartment from a coating membrane calcium alginate or mixture of calcium alginate and Poly Vinyl Alcohol (PVA).

During the preparation of calcium alginate beads before drying process the beads are coated with the coating solution which may be the mixture of calcium alginate and PVA, and then they are dried.

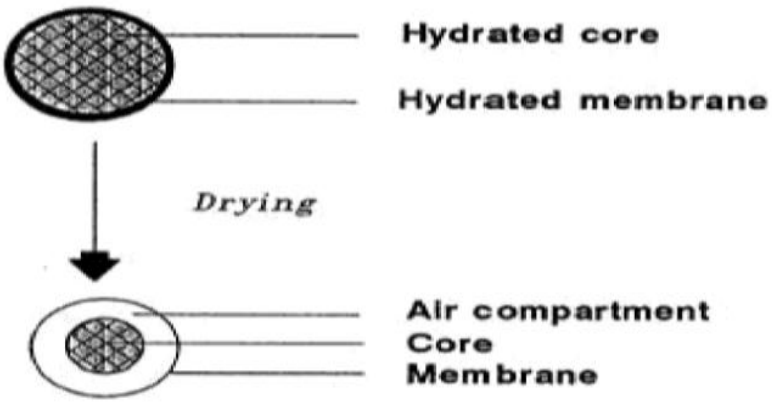

Fig. 5: Alginate beads with air compartment.

During the process of drying it makes the air compartment which creates buoyancy. PVA is incorporated in coating mixture for improving membrane permeability as PVA is water soluble additive cause the leaching from membrane and making pores in membrane.

Oil entrapped gel beads

Vegetable oil is utilized as floating carrier as they are light in weight and hydrophobic in nature and is used for floating by including it into gel matrix of beads. Oil entrapped beads are prepared by both calcium alginate bead and calcium pectinate beads.

Pectin has some emulsification property, so aqueous solution of pectin is mixed with edible oil. Emulsion is obtained by homogenization. This emulsion is extruded into calcium chloride solution to form beads which are kept for further process of separation, washing and drying.

Casein-gelatin floating beads

Casein has emulsifying property and thus cause air bubble incorporation that behave as air reservoir for floating system. Beads are prepared by adding solution of casein and gelatin in deionized water at 60°C to the preheated mineral oil. The dispersion stirred to obtain emulsion and temperature is reduced to 5°C by rapid cooling and previously cooled acetone is added to get solid beads which dried under vacuum.

Floating is due to air entrapments demonstrate by preparing non floating beads which are prepared similarly from a solution mixture of casein and gelatin previously treated at decrease pressure to completely remove air bubbles.

TECHNIQUES OF PREPARING GASTRORETENTIVE BEADS

Jet cutting method

The Jet Cutting Method, as a technique for the production of spherical beads, allows the production of beads in the range of 0.2–3 mm in diameter even from high viscous fluids (e.g. polyvinyl alcohol solutions) at a high production rate and narrow particle size distributions. It uses mechanical forces to break up liquid jet by rotating cutting wire. Jet is cut in to cylindrical segments those attains spherical shapes. This technique may be useful for various applications in biotechnology, medicine, and chromatography and in the pharmaceutical, chemical or food industry.[15]

Resonance method

It uses vibration applied at a constant frequency to liquid jet resulting in jet break up in to small uniform droplets. Vibration can be applied to liquid reservoir or nozzle. This system can be easily scaled up and system for laboratory and pilot scale are used commercially.

Electrostatic method

Small alginate beads with a narrow size distribution, ranging in size down to about 150 μm, can easily be manufactured by help of the electrostatic bead generator. Electrostatic droplet generation uses electrostatic forces to disrupt a liquid surface at capillary/needle tip forming a charge stream of small droplets. In this way liquid exposed to electrical field, introducing electrical charge to liquid surface and a repulsive outside directed force. An electrostatic voltage of a few kV is set between the needle feeding the polymer solution and the gelling bath. The droplet size is also largely determined by selecting an appropriate nozzle size. This lead to lab scale with 1 needle and production scale with 10 needles are available.[16]

Co-axial air stream method

In this method coaxial air stream pulls droplets from a needle tip into the gelling bath. Coaxial bead generator works on this principle. This instrument generally uses for production of smaller quantities of spherical alginate beads ranging in size down to around 400 μm.

Manual method

At lab scale, dispersed solution of drug is poured into the dispersion medium which is placed on magnetic stirrer. Solution is poured with the help of syringe.

Method of siepmann

Briefly, the lipids are molten at 65°C and mixed well with dispersed drug. The molten dispersion containing the drug was then added to 100 ml pre-chilled water (4°C) at a rate of 5 ml/min via 23 gauge syringe and stirred at 100 rpm on a magnetic stirrer. Finally, the formed beads are filtered through Whatman 41, collected and stored in glass vials.[17]

Example: Cinnarizine beads.

Ion gelation emulsion method

Emulsion gelation method is used to prepare oil entrapped gel beads capable of floating in the gastric condition. The gel beads containing effervescent agent or edible oil are prepared by either being gently mixed or homogenized an oil phase and a water phase containing pectin or casein, and then extruded into calcium chloride solution with gentle agitation at room temperature. The prepared gel beads are then separated washed with distilled water and dried at 37^0 C for 12 h.

Example: oil-entrapped calcium pectinate gel beads.[18]

Ionotropic gelation method

Ionotropic gelation is based on the ability of polyelectrolytes to cross link in the existence of counter ions to form hydrogels. Since, the use of alginates, gellan gum, chitosan, and carboxymethyl cellulose for the encapsulation of drug, ionotropic gelation technique has been widely used for this purpose.[19] The natural polyelectrolytes having a property of coating on the drug core and acts as release rate retardants comprises certain anions on their chemical structure. These anions forms meshwork structure by combining with the polyvalent cations and induce gelation by binding mainly to the anion blocks. Dropping a drug-loaded polymeric solution into the aqueous solution of polyvalent cations produces the hydrogel

beads. These beads are then placed in aqueous solution of 1% glutaraldehyde for about 1 h. Glutaraldehyde is used as a hardening agent. Biomolecules can also be loaded into these hydrogel beads under mild conditions to retain their three dimensional structure.[20,21]

Cross-linked beads are made by using calcium and low methoxylated pectin (LMP), which are an anionic polysaccharide. Beads are dried separately in an air convection type oven at 40°C for 6 h and in freeze dryer to evaluate the changes in bead characteristics due to process variability. Riboflavin (B-2), Tetracycline (TCN) and Methotrexate (MTX) are used as model drugs for encapsulation. Ionic and nonionic excipients are added to study their effects on the release profiles of the beads.[22]

Polyelectrolyte complexation technique

The quality of hydrogel beads prepared by ionotropic gelation method can also be enhanced by using polyelectrolyte complexation technique. The mechanical strength and permeability barrier of hydrogels can be enhanced by the addition of oppositely charged another polyelectrolyte to the ionotropically gelated hydrogel beads. For instance, addition of polycations allows a membrane of polyelectrolyte complex to form on the surface of alginate beads.[23,24] Large numbers of natural and chemically modified polyelectrolytes have been investigated and a schematic diagram of the preparation of hydrogel beads through ionotropic gelation and polyelectrolyte complexation is shown in below.[20]

Polyelectrolyte solution [alginate (-)/Gellun gum (-)/CMC (-) + Drug] 5% HPMC phthalate as a coating material

↓

Added drop wise under magnetic stirring by 21 G needle

↓

Calcium chloride solution (+) Chitosan solution (+)

↓

Hydrogel beads

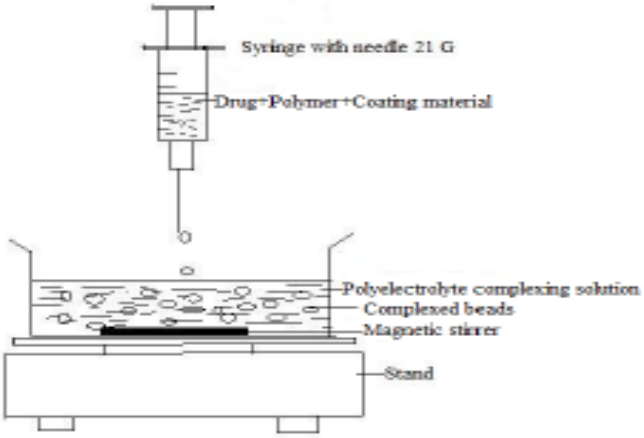

Fig. 6: Schematic diagram of the preparation of hydrogel beads by ionotropicgelation and polyelectrolyte complexation.

Evaluation of floating beads

Percentage yield

The percentage yield of the Floating beads is determined for drug and is calculated using the following equation.[25,26,27]

Yield=M/Mo×100

Where M = weight of beads

Mo = total expected weight of drug and polymer.

Micrometrics properties

Floating beads are characterized by their micrometric properties such as particle size, tapped density, compressibility index, true density and flow properties.[28] Particle size is measured by an optical microscopy and mean particle size was calculated by measuring 200 to 300 particles with the help of calibrated ocular micrometer. True density is determined by liquid Displacement method, tapped density and compressibility index are calculated by measuring the change in volume using a bulk density apparatus; angle of repose is determined by fixed funnel method. The nature of Floating beads is confirmed by scanning electron microscopy.

The compressibility index was calculated using following formula:

$I = Vb – Vt / Vb \times 100$

Where, Vb is the bulk volume and Vt is the tapped volume. The value given below 15% indicates a powder with usually give rise to good flow characteristics, whereas above 25%

indicate poor flow ability. True density is determined using a Helium densitometer. Porosity (e) is calculated using the following equation:

e = {1−(tapped density/true density)}×100

Angle of repose of the floating beads is determined by the fixed funnel method.

Angle of repose

Angle of repose method was employed to assess the flow ability. Beads were allowed to fall freely through the funnel fixed at 2 cm above the horizontal flat surface until the vertex of conical pile just touched the tip of the funnel. The angle of repose (θ) was determined by formula. $\theta = \tan^{-1}(h/r)$ where, h =cone height of beads, r= radius of circular base formed by the beads on the ground.[29,30] The average diameter of twenty dry beads was determined randomly using a calliper in triplicate.[31]

Bulk density

It is ratio of mass to bulk volume. Bulk density may influence dissolution and other properties and depends on the particle size, shape and tendency of particles to adhere together. Bulk density of formulated beads was found by taking a known mass of beads in a 5 ml graduated measuring cylinder. The cylinder was dropped three times from a height of one inch at an interval of two seconds. The bulk density was calculated by following equation.

Bulk density (ρb) = M / Vb

Where, ρb = Bulk density,

M = Weight of the powder,

Vb = Bulk volume.

Tapped density

Tapped density helps to determine packing geometry and flowability. Tapped density is the volume of powder determined by tapping using measuring cylinder containing weighed amount of sample. Tapped density of beads was calculated by following equation.[32,33]

Tapped density (ρt) = M/Vt

Where, ρt = Tapped density,

M = Weight of the powder,

Vt = Tapped volume.

Carr's compressibility index: This is an important property in maintaining uniform weight. It is calculated using following Equation.[32,33]

$$\text{Carr's index} = \frac{(\text{Tapped density} - \text{Bulk density})}{\text{Tapped density}} \times 100$$

Hausner's ratio

Hausner's ratio less than 1.25 indicates good flow property and greater than 1.5 indicates poor flow property whereas between 1.25 and 1.5 denote need of glidant that will normally enhance flow property. Hausner's ratio can be calculated by formula.[32,33]

$$\text{Hausner's Ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

Morphology study

Scanning Electron Microscopy (SEM) was performed to characterize the surface of formed beads. Beads were mounted directly onto the sample stub and coated with gold ion and analyze for surface morphology.[34]

Particle size analysis

The particle size of drug loaded formulations were measured by an optical microscope fitted with calibrated ocular and stage micrometer and particle size distribution was calculated. 50 particles in five different fields were examined.[35]

Entrapment efficiency

Accurately weighed quantities of approximately 300 mg of beads were placed in 25 ml of 0.1 N HCl. The solution was centrifuged using the centrifuge at 4200 rpm for 30 min, the supernatant layer of the liquid was assayed by UV– spectroscopy at 266 nm. The encapsulation efficiency was Determined by the following equation.[36,37]

$$\text{Encapsulation efficiency} = \frac{\%\ \text{Drug of formulation} \times \text{Total weight of the dried beads}}{\text{Amount of drug loaded} - \text{Drug loss in the gelation media}}$$

Swelling studies: Swelling studies for beads was performed in dissolution media (0.1 N HCl). The swelling index was calculated using the formula.[36]

$$\text{Swelling index} = \frac{Wg - Wo}{Wo} \times 100$$

Where, Wo= the initial weight of beads,

Wg = the weight of beads in the swelling medium.

Floating properties

Fifty beads were placed in 500 ml of 0.1 N HCl media. The floating properties of beads were evaluated in a dissolution vessel [USP Type II dissolution tester]. Paddle rotation speeds of 0 and 100 revolutions per min were tested. Temperature was maintained at 37 ±0.5 ºC. The percentage of floating samples was measured by visual observation.[36]

Determination of floating time

Specified weight (50 mg) of floated beads was placed in a beaker containing 100 ml of buffer 1.2 pH. The number of floating beads on the buffer surface was evaluated at fixed time intervals. The floating time was considered as the time at which the 100% of the beads floated. All the data are the average of at least three determinations.[38]

***In-vitro* release studies for floating beads**

The in-vitro dissolution studies were carried out using USP XXIV Dissolution Apparatus No.2 (type) at 50 rpm. The dissolution medium consisted of 0.1 N HCL for 12 h (900 ml) maintained at 37 ±0.50. The release studies were conducted in triplet. Adequate of sample 5 ml were withdrawn at specific time interval and drug content was determined spectrophotometrically.[37]

Kinetics of *in-vitro* drug release

To study the release kinetics *in-vitro* release data was put in to kinetic models such as zero-order, first order, Higuchi and Korsmeyere Peppas.[39]

Stability studies

The formulated beads in optimized formulation were sealed in vials and kept for 90 days at 40 ºC/75% RH. After 90 days of exposure the beads were studied for drug content determination and *in-vitro* release.[36]

Application of floating beads

Enhanced bioavailability

The bioavailability of riboflavin CR-GRDF is notably increase in comparability to the administration of non-GRDF CR polymeric formulations. There are various different processes, related to absorption and transit of the drug in the gastrointestinal tract which is related to affect the magnitude of drug absorption.[40]

Sustained drug delivery

Oral CR formulations are encountered with problems i.e. gastric residence time in the GIT. Floating beads provide sustained drug release behavior and release the drug over a prolonged period of time. Floating systems are fabricated as a floating controlled drug delivery system.

Site-specific drug delivery systems

These systems are extremely advantageous for drugs that are specifically absorbed from the stomach or the proximal wedge of the small intestine. The controlled, slow delivery of drug to the stomach allows sufficient local therapeutic quantity and limits the systemic exposure to the drug. This reduces side effects that are caused by the drug in the blood circulation.[41] In addition, the extend gastric availability from a site directed delivery system may also reduce the dosing frequency. E.g.: Furosemide and Riboflavin.

Absorption enhancement

Drugs which are having poor bioavailability because of site specific absorption from the upper part of the GIT are probable candidates to be prepared as floating beads, there by maximizing their absorption.

Eradicating helicobacter pylori

Floating beads can greatly improve the pharmacotherapy of stomach through local drug release can leading to high drug concentrations at the gastric mucosa, thus eradicating helicobacter pylori from the sub mucosal tissue of the stomach and making it possible to treat stomach and duodenal ulcers, gastritis and oesophagitis.

Solubility

Floating beads are especially effective in delivery of sparingly soluble and insoluble drugs. It is known that as the solubility of a drug diminish; the time available for drug dissolution get less adequate and therefore the transit time becomes an important factor affecting drug absorption. For weakly basic drugs that are poorly soluble at basic pH, floating beads may prevent chance for solubility to become the rate-limiting step in release by restricting such drugs to the stomach.

Advantages of floating beads

- Less frequent drug administration and the nature of its release kinetics thereby improve the patient compliance and convenience.[42]

- Better drug utilization will improve the bioavailability (absolute bioavailability) and reduce the incidence or intensity of adverse effects, a desirable plasma drug concentration is maintained by continuous drug release.[5]
- Floating multiple units of GRDDS is used to decrease material density and Gastric retention time is increased because of buoyancy.
- Increased absorption of drugs which solubilize only in stomach.
- Drug releases in controlled manner for extended period of time.
- Reduce drug waste
- Site-specific drug delivery to stomach can be achieved.
- Desirable plasma drug concentration is maintained by continuous drug release.
- Floating bead is superior to single unit floating dosage forms as it liberate drug uniformly and there is no chance of dose dumping.
- Avoidance of gastric irritation, because of sustained release effect.
- Better therapeutic effect of short half-life drugs can be achieved.
- Floating beads greatly increase pharmacotherapy of the stomach by local drug release leading to high drug content at gastric mucosa (eradicating Helicobacter pylori from the submucosal tissue of the stomach), producing it capable to treat duodenal ulcers, gastritis and esophagitis and diminish the chances of gastric carcinoma.[43]
- Reduction of fluctuation in the drug blood level.
- Maximum utilization of drug and decrease in the total side effects.[44]
- GRDFs provide maintenance of systemic drug concentration within the therapeutic window.[45]
- Increased safety margin of high potent drug due to better control of plasma level.
- Expulsion of the floating system from stomach after complete release of drug.
- Reduced counter activity of body.
- Minimized adverse activity at the colon.
- Avoidance of gastric irritation, because of sustained release effect.[46]
- Improved therapeutic effect of short half-life drugs can be achieved.
- In GRDDS, especially multiple units such as beads morphology allow a controllable variability in degradation and drug release.[47]

Limitation of floating beads

The release rate of the controlled release dosage form may differ from a variety of elements like food and the rate of transit though gut.

- Controlled-release formulations generally have a higher drug load and thus any loss of robustness of the release characteristics of the dosage form may lead to potential toxicity.
- Dosage forms of this kind should not be crushed or chewed.

CONCLUSION

Based on review we concluded that the floating beads exhibit gastro retentive controlled release property which promises to be a potential approach for gastric retention. Floating beads are low-density, sufficient buoyancy to float over gastric contents and remain in stomach for prolonged period. As the floating bead floats over the gastric content, the drug is released slowly at required rate from the system which generates an enhanced gastric retention with minimum fluctuations in plasma drug concentration. In future by making use of various other strategies, floating beads will find the central place in novel drug delivery, particularly in diseased cell sorting, diagnostics, gene & genetic materials, safe, targeted and effective in vivo delivery and supplements as mini versions of diseased organ and tissues in the body. This would expand absorption by allowing the slowly released drug in the stomach to reach out the upper small intestine (i.e. the sight of absorption) in a form ready for absorption. The floating beads showed better bioavailability characteristic while comparing with commercial conventional drugs.

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CONFLICT OF INTERESTS

There are no conflicts of interest.

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