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Journal of General Medicine and Clinical Practice

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Short Communication

Microballoons/ Hollow Microspheres: A Novel Approach in Gastro-Retention Floating Drug Delivery System (Fdds)

Abbaraju Krishna Sailaja, Nidha Begum,

Department of pharmaceutics, RBVRR Women's college of pharmacy, Osmania University, Hyderabad

***Corresponding Author:** Abbaraju Krishna Sailaja, Resonant Medicine, Omer, Israel.

Received date: April 25, 2025; Accepted date: May 08, 2025; Published date: June 16, 2025

Citation: Abbaraju Krishna Sailaja, Nidha Begum, (2025), Microballoons/ Hollow Microspheres: A Novel Approach in Gastro-Retention Floating Drug Delivery System (Fdds), *J. General Medicine and Clinical Practice,* 8(6); **DOI:10.31579/2639-4162/271**

Abstract

Gastroretentive 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. Micro Ballons and their applications in targeted drug delivery was highlighted. 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 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 novel approaches in GRDDS research and its implications for the advancement of drug delivery science.

Kew Words: gastro retentive drug delivery system (grdds); bio-adhesive; mucoadhesive; floating drug delivery system

Introduction

Micro balloons, also known as hollow microspheres, represent a promising approach in gastroprotective drug delivery systems due to their unique ability to remain buoyant in the gastrointestinal tract for prolonged periods. These low-density, spherical particles are typically composed of biodegradable polymers and encapsulate active pharmaceutical ingredients within a hollow core, facilitating sustained drug release and improved bioavailability. The floating capability of micro balloons enhances the residence time of drugs in the stomach, making them particularly effective for drugs with a narrow absorption window, poor solubility in intestinal fluids, or local action in the gastric region. Various techniques such as solvent evaporation, emulsion diffusion, and spray drying are employed for their preparation, allowing for the optimization of particle size, drug loading efficiency, and release kinetics. This technology holds significant potential for enhancing therapeutic efficacy, minimizing dosing frequency, and improving patient compliance in the treatment of chronic conditions [1-2]

Mechanism Of Floating Micro balloons

The gel formers, polysaccharides, and polymers in micro balloons hydrate when they come into contact with gastric fluid, creating a colloidal gel barrier that regulates the rate at which fluid enters the device and, in turn, the release of drugs. The gel layer is kept intact by hydrating the nearby hydrocolloid layer as the dosage form's outer surface dissolves. The swollen polymer traps air, which reduces density and gives the micro balloons buoyancy. However, in order to properly achieve buoyancy, a minimal amount of stomach content is required. Newer technologies include glacier floating balloons, acrylic resins, eudrilid, polyethylene oxide, cellulose acetate, polystyrene floatable shells, and polycarbonate floating balloons [3,4]

Applications of floating microballoons:

- Gastro retentive floating microspheres are effective in the reduction of major adverse effects of gastric irritation.
- Floating microspheres are very effective approach in delivery of drug that have poor bioavailability because of their limited absorption in the upper git
- The higher dose of drugs can be reduced due to increase in gastric retention time which lead to low dose frequency.

List Of Polymers Used in Hollow Microballoons

Cellulose acetate, Chitosan, Eudragit, Acry coat, Methocil, Polyacrylate, Polyvinyl acetate, Carbopol, Agar, Polyethylene oxide, Polycarbonates, Acrylic resins and Polyethylene oxide, etc. [5-6]

Methods Of Preparation of Microballoons

"**Microballoons**" (also known as **hollow microspheres**) are used in drug delivery systems for controlled and sustained release, especially for gastro-retentive systems. These methods typically involve creating hollow, low-density particles that can float in gastric fluids [7].

Here are common methods for preparing microballoons:

1. Solvent Evaporation Method: **- Most widely used** technique. Drug and polymer are dissolved in a volatile organic solvent (e.g., ethanol, dichloromethane). The solution is emulsified into an aqueous phase containing a stabilizer (like PVA). Upon evaporation of the solvent, the polymer precipitates and forms hollow microspheres.
2. Emulsion Solvent Diffusion: -Similar to solvent evaporation, but uses a mixture of water-miscible and immiscible solvents. Drug and polymer are dissolved in a mixture of solvents (e.g., ethanol + dichloromethane). This organic phase is then poured into water containing a surfactant. Solvent diffusion causes precipitation and formation of micro balloons. It can be employed for heat sensitive drugs
3. Spray Drying Method: **-**Drug and polymer are dissolved or suspended in a solvent. This solution is atomized into a hot drying chamber. Solvent evaporates quickly, forming micro balloons.
4. Thermal-Induced Phase Separation: - In this method Polymer is dissolved in a suitable organic solvent at elevated temperature. Drug is added to the solution. The mixture is cooled, leading to phase separation. Micro balloons are collected, filtered, and dried.
5. 5. Freeze Drying (Lyophilization): - Often used as a post-processing step to enhance the floatability and stability of microballoons. Prepared microspheres are frozen and then subjected to vacuum drying. his helps to maintain their hollow structure [9,10].

Characterization Parameters:

- Particle size and morphology (SEM)
- Buoyancy/Floating time
- Drug loading and encapsulation efficiency
- In vitro drug release
- Density
- Stability studies

Advantages of microballoons:

Superior to single unit floating dosage form as that microsphere's releases drug uniformly and there is no risk of dose dumping[11].

- Avoidance of gastric irritation.
- Minimized adverse activity at the colon.
- Flexibility in dosage form design.
- Improves patient compliance by decreasing dosing frequency.

Disadvantages of microballoons:

- FDDS is not a good fit for medications that irritate the stomach mucosa. ex-NSAIDS, a few antibiotics, tetracyclic antidepressants, digoxin, theophylline, corticosteroids, iron, and oral contraceptives.
- Drugs which are absorbed along the entire git, which undergo first pass metabolism may not be desirable. Ex: Nifedipine.
- They are not good candidates for medications that have issues with stomach solubility or stability. For example, ranolazine [12]

Novel Techniques for Preparation of Fdds

1.Insitu Gel Systems:

These systems form a gel upon contact with gastric fluids. In situ gelling systems typically used polymers like Carbopol, sodium alginate and Gellan gum that undergo a gelation process in the acidic PH of the stomach. The gel formed provides buoyancy and can release the drug over an extended period [13].

2. Nanotechnology -Based Floating Systems

Nanoparticles and nanocarriers:

Advances in nanotechnology allow for the formulation of ultra small floating nanoparticles or nanocarriers that can achieve both buoyancy and controlled drug release. Liposomes, solid lipid nanoparticles, and Nano emulsions have been studied as possible candidates for floating systems [14].

Nanoscale floating systems:

The systems can provide a more uniform and controlled release profile due to their enhanced surface area and improved drug solubility.

3.Gastroretentive Hydrogels

Hydrophilic Hydrogels**:**

These polymers absorb water in the stomach and expand, forming a gel like structure that aids in buoyancy and slows down the drug release. Research is exploring smart hydrogels that respond to PH, temperature or ionic strength, improving the precision of drug delivery.

4.Floating Microspheres:

These are small spherical particles that contaon gas filled cavities and polymeric materials. Upon ingestion, they float on the stomach surface and slowly release the drug.

5.Magnetic Floating Systems:

In this innovative approach, magnetic materials are incorporated into the floating system. A magnetic field is used to control the buoyancy and movement of the system, improving the retention time in the stomach and controlling the release. This is a highly targeted approach and may be useful for localized drug delivery [15].

Conclusion:

To determine the ideal dosage form for a given medication, in vivo investigations are necessary due to the complexity of pharmacokinetic and pharmacodynamic characteristics. Many businesses are concentrating on making this method commercially available. Microballoons, also known as hollow microspheres, represent a promising approach in the development of floating drug delivery systems due to their excellent buoyancy, extended gastric residence time, and controlled drug release characteristics. Their porous structure and low-density profile ensure they remain afloat on gastric fluids, enhancing drug absorption at the desired site and improving bioavailability, especially for drugs with narrow absorption windows or those degraded in the intestine. With advancements in polymer science and formulation techniques, microballoons offer great potential for site-specific delivery, reduced dosing frequency, and improved patient compliance. Continued research and optimization can pave the way for more effective gastroretentive therapies using this innovative platform.

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DOI:10.31579/2639-4162/271