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A REVIEW ON FLOATING DRUG DELIVERY SYSTEM FOR GASTRIC RETENTION

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ABSTRACT

The oral route is the most widely accepted method for drug administration due to its convenience and patient compliance. However, it faces significant challenges such as rapid gastric emptying and poor absorption of drugs with a narrow absorption window in the upper gastrointestinal tract. These limitations result in reduced bioavailability and inconsistent therapeutic outcomes. To address these issues, Gastroretentive Drug Delivery Systems (GRDDS) have been developed, among which Floating Drug Delivery Systems (FDDS) are considered highly effective. FDDS are designed to have a density lower than gastric fluid, enabling them to float and remain in the stomach for an extended period. This review discusses the mechanism, classification, formulation components, evaluation parameters, and pharmaceutical applications of FDDS. These systems improve drug bioavailability, provide sustained release, and enhance therapeutic efficiency.

KEYWORDS: Floating Drug Delivery System (FDDS), Gastroretentive Drug Delivery System (GRDDS), Gastric retention, Buoyancy, Controlled drug release, Bioavailability enhancement, Floating lag time, Hydrocolloids, Effervescent systems, Non-effervescent systems, Narrow absorption window, Sustained release.

1. INTRODUCTION

Oral drug delivery is the most preferred route due to its simplicity, cost-effectiveness, and ease of administration. However, conventional dosage forms are associated with limitations

such as short gastric residence time and unpredictable gastric emptying, which affect drug absorption[1,2] Many drugs are absorbed only in specific regions of the gastrointestinal tract, particularly in the stomach or proximal small intestine, known as the narrow absorption window.[3] To overcome these limitations, Gastroretentive Drug Delivery Systems (GRDDS) have been developed to prolong gastric retention.[4] Among these, Floating Drug Delivery Systems (FDDS), also known as hydrodynamically balanced systems, are widely used due to their simplicity and effectiveness.[5] These systems remain buoyant in gastric fluid due to their low density (<1.004 g/cm³), allowing prolonged drug release.[6] The stomach exhibits cyclic contractions known as the Migrating Myoelectric Complex (MMC), which clears gastric contents periodically. Conventional tablets are often expelled before complete drug release, leading to reduced bioavailability.[7] FDDS overcome this issue by maintaining buoyancy and resisting gastric emptying.[8]

2. Classification of Floating Drug Delivery Systems

2.1 Effervescent Systems

Effervescent systems use gas-generating agents to achieve buoyancy. These formulations contain sodium bicarbonate along with organic acids such as citric acid. Upon contact with gastric fluid, carbon dioxide gas is generated, which gets trapped in the polymer matrix and reduces density.[9,10] Examples include floating tablets and in-situ gel systems, which provide rapid buoyancy and sustained drug release.[11,12]

2.2 Non-Effervescent Systems

Non-effervescent systems rely on swelling polymers such as Hydroxypropyl Methylcellulose (HPMC). These polymers absorb gastric fluid, swell, and form a gel barrier that traps air and maintains buoyancy.[13,14] Hollow microspheres (microballoons) are an advanced form of these systems, offering prolonged floating ability and controlled release.[15]

2.3 Single-Unit Systems

Single-unit systems consist of a single tablet or capsule. These are easy to manufacture but may show variability due to premature gastric emptying.[16]

2.4 Multi-Unit Systems

Multi-unit systems consist of multiple small units such as pellets or microspheres. These systems offer better reliability and uniform drug release.[17]

3. Polymers and Excipients

Polymers are essential for maintaining buoyancy and controlling drug release. They must be biocompatible and stable in acidic conditions.[18] HPMC is the most widely used polymer due to its excellent gel-forming ability.[19] Carbopol enhances gel strength and drug release control.[20] Natural polymers such as sodium alginate, chitosan, guar gum, and xanthan gum are also widely used[21,23] Gas-generating agents such as sodium bicarbonate and citric acid are used in effervescent systems.[24] Low-density materials like ethyl cellulose help maintain buoyancy, while hydrophobic substances regulate drug release.[25]

4. Evaluation Parameters

Evaluation of FDDS is essential to ensure performance and reliability.

- **Floating Lag Time (FLT):** Time required for the system to float; should be less than 60 seconds.[26]
- **Total Floating Time (TFT):** Duration for which the dosage form remains buoyant.[27]
- **Buoyancy Force:** Determines floating capability.[28]
- **Drug Release Studies:** Conducted using dissolution apparatus to study release kinetics.[29]
- **Swelling Index:** Indicates hydration behaviour of polymers.[30]

5. Ideal Drug Candidates

FDDS are suitable for

- Drugs with narrow absorption window
- Drugs acting locally in the stomach
- Drugs with pH-dependent solubility
- Drugs unstable in the lower GI tract
- Drugs with short half-life requiring sustained release.

These characteristics ensure maximum therapeutic benefit when formulated as floating systems.[3,21]

6. Pharmaceutical Applications

FDDS are widely used for enhancing bioavailability and achieving sustained drug release.

They improve absorption by increasing gastric residence time and maintaining drug concentration at the absorption site.[5,6] These systems provide controlled release, reducing fluctuations in plasma drug levels and minimizing side effects.[29]

FDDS are also effective for site-specific drug delivery, particularly in treating gastric ulcers, GERD, and *Helicobacter pylori* infections.[21]

7. ADVANTAGES AND LIMITATIONS

ADVANTAGES

- Improved bioavailability
- Controlled drug release
- Reduced dosing frequency
- Enhanced patient compliance
- Site-specific delivery
- Reduced side effects

LIMITATIONS

- Requires sufficient gastric fluid
- Dependent on fed state
- Not suitable for acid-sensitive drugs
- Variability due to physiological conditions
- Complex formulation.

8. CONCLUSION

Floating Drug Delivery Systems represent a significant advancement in oral drug delivery technology. By prolonging gastric residence time and providing controlled drug release, FDDS enhance bioavailability and therapeutic effectiveness. Despite certain limitations, continuous research and development in polymer science and formulation strategies are improving the efficiency of these systems. FDDS hold great potential for future pharmaceutical applications.

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