

A Comprehensive Review on Floating Drug Delivery System (FDDS)

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ABSTRACT

Floating Drug Delivery Systems (FDDS) represent a promising approach for the controlled release of drugs, particularly for drugs that have a narrow absorption window in the gastrointestinal tract. These systems are designed to float in the stomach, offering sustained drug release and improving bioavailability. FDDS ensure a prolonged gastric residence time (GRT), which allows for more efficient drug absorption. This review explores the design, mechanisms, applications, and challenges of FDDS, as well as various formulation strategies, such as the use of hydrocolloids, gas-generating agents, and low-density materials to enhance buoyancy. The article highlights the recent advancements in FDDS technology, emphasizing its potential to improve therapeutic efficacy and patient compliance, especially for drugs with specific absorption sites.

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INTRODUCTION

Floating Drug Delivery Systems (FDDS) have emerged as a promising solution to improve the oral bioavailability of drugs that have limited solubility or a narrow absorption window in the gastrointestinal tract (GIT). These systems are engineered to remain buoyant in the stomach, extending the gastric residence time (GRT) of the drug and facilitating a continuous release of the active pharmaceutical ingredient (API). This controlled release provides improved drug absorption and enhanced therapeutic outcomes. FDDS are particularly advantageous for drugs that need to be retained in the stomach for

extended periods, ensuring that they are slowly released and absorbed. The floating mechanism, often relying on low-density materials, hydrocolloids, and gas-generating agents, allows the dosage form to remain afloat in the stomach, promoting sustained release over time. As a result, FDDS help to minimize fluctuations in drug levels, thereby reducing side effects and enhancing overall therapeutic efficacy [1]

While FDDS offer significant advantages, such as improved bioavailability and patient compliance, they face challenges such as

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variability in gastric pH and inter-individual differences in gastric emptying times. Additionally, large-scale production of these systems can be complex and costly, requiring specialized equipment and expertise [2]. Despite these challenges, FDDS represent a cutting-edge development in pharmaceutical technology, with the potential to revolutionize the delivery of various drugs, especially those with narrow therapeutic windows.

Mechanism of Floating Drug Delivery Systems

The buoyancy of FDDS is achieved through various mechanisms that depend on the specific formulation of the system. The most widely used mechanism is the effervescent system, wherein gas-generating agents, such as sodium bicarbonate and citric acid, are incorporated into the dosage form. After contact with gastric fluids, these agents react to release carbon dioxide, forming gas bubbles that decrease the overall density of the dosage form. This reduced density enables the system to float on the stomach contents, hence prolonging its residence time [3]. This effervescent mechanism allows for controlled and sustained drug release, as the system remains in the stomach for an extended period, enhancing absorption[4-6].

Another widely utilized mechanism is the non-effervescent system, which relies on hydrophilic polymers like hydroxypropyl

methylcellulose (HPMC). These polymers absorb water from the gastric fluids, causing them to swell and form a gel-like structure. This increases the volume of the dosage form, which subsequently lowers its density, allowing it to float. The gel barrier that forms also controls the drug release rate, thus providing a sustained therapeutic effect over time. Non-effervescent systems are often used when effervescent systems may be unsuitable, such as for drugs that are sensitive to pH changes or require a more controlled release profile [7].

Some formulations combine both effervescent and non-effervescent systems to achieve enhanced floating stability and controlled release. The use of both mechanisms ensures a more reliable and prolonged gastric residence time, even under varying stomach conditions, thereby optimizing the therapeutic outcome [8, 9].

Applications of FDDS

Floating Drug Delivery Systems offer significant advantages for various therapeutic applications, particularly for drugs that exhibit poor bioavailability due to a narrow absorption window in the GIT. These systems are highly effective in[10, 11]:

1. Antacids: FDDS are effective for drugs like antacids that require prolonged action in the stomach. The ability to stay afloat ensures continuous release and greater therapeutic

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efficacy by maintaining a local high concentration of the drug in the stomach, reducing the need for frequent dosing [12].

2. Antihypertensive Drugs: Drugs used in the management of hypertension, such as calcium channel blockers and angiotensin receptor blockers, benefit from FDDS by maintaining a consistent release of the active ingredient. This continuous release helps regulate blood pressure throughout the day, enhancing therapeutic effects and reducing side effects [13].

3. Antibiotics: Floating systems are particularly beneficial for antibiotics that require high local concentrations in the stomach or upper intestines to improve absorption. This sustained release mechanism ensures adequate drug concentrations, improving the overall therapeutic efficacy and minimizing side effects [14].

4. Pain Management Drugs: FDDS are ideal for drugs that require controlled release for long-lasting effects, such as pain management medications. By providing sustained relief, FDDS improve patient compliance by reducing the frequency of dosing [15]

These applications show the potential of FDDS to improve patient compliance and therapeutic outcomes, especially for drugs that are poorly absorbed or need extended release for efficacy.

Challenges and Limitations of FDDS

Despite the advantages, several challenges exist in the development and application of FDDS. A significant challenge is the variability in gastric emptying time among individuals. Gastric emptying rates vary based on factors like age, diet, and health conditions. This variation can affect the efficiency of FDDS, as inconsistent gastric residence times may prevent optimal drug release and absorption [16]. Another issue is the sensitivity to gastric pH, which can fluctuate not only between individuals but also within the same individual at different times of the day. The pH variation can influence the release rate of the drug, as the floating system may not function effectively under certain pH conditions [17]. The complexity in manufacturing FDDS is another concern. Ensuring uniformity and quality in large-scale production requires specialized equipment, and slight variations in formulation can lead to significant differences in performance. This makes the production process more challenging and costly compared to conventional dosage forms [18-21].

Finally, not all drugs are suitable for FDDS. Drugs that require rapid absorption or are absorbed throughout the GIT may not benefit from the prolonged residence time FDDS offer, limiting their applicability.

Advancements in FDDS

Recent advancements in FDDS have focused on improving the performance, stability, and bioavailability of these systems. One significant advancement is the use of nanotechnology, which has enabled the development of floating systems with enhanced stability and tailored drug release profiles. Nanomaterials, such as nanoparticles and nanoemulsions, are increasingly being used to improve the formulation of FDDS, leading to more effective and targeted drug delivery [17]. Advanced coating techniques are also being explored to control the release of drugs more effectively and prevent premature floating failure. These coatings ensure that the drug remains protected until it reaches the desired site of action, further enhancing therapeutic outcomes [22].

Moreover, the integration of FDDS with other controlled-release systems, such as pulsatile or osmotic release mechanisms, has expanded the potential applications of these systems. Combining multiple release mechanisms offers more precise control over drug release timing and location, thus enhancing therapeutic efficacy, especially for drugs with site-specific absorption [23].

CONCLUSION

Floating Drug Delivery Systems represent a significant advancement in oral drug delivery, particularly for drugs with limited solubility or

absorption in the gastrointestinal tract. By enhancing gastric residence time and offering controlled release, FDDS improve bioavailability, reduce side effects, and increase patient compliance. However, challenges such as variability in gastric emptying times, pH sensitivity, and the complexity of large-scale production remain. Ongoing research into new materials, technologies, and manufacturing processes will likely address these issues, further advancing FDDS technology. The integration of novel controlled-release mechanisms holds the potential to make FDDS an even more versatile and effective tool in the development of personalized and efficient drug delivery systems.

REFERENCES

1. Deshpande, A.A., et al., *Development of a novel controlled-release system for gastric retention*. 1997. **14**(6): p. 815-819.
2. Farooqi, S.S., et al., *Phytochemical analysis, GC-MS characterization and antioxidant activity of Hordeum vulgare seed extracts*. 2024. **10**(6).
3. Giri, T.K. and B. Ghosh, *In Situ Gellable Hydrogels for Drug Delivery and Tissue Engineering*. Springer.
4. Naveed, S., et al., *Simple UV spectrophotometric assay of new formulation gentamycin*. J App Pharm, 2014. **6**(4).
5. Alam, S., et al., *Formulation development and assessment of Naproxen sodium tablet (Anti rheumatic agent)*. RADS Journal of Pharmacy and Pharmaceutical Sciences, 2017. **5**(3): p. 30-36.
6. Khan, M., et al., *Formulation development of sugar free antacid chewable tablets for diabetes induced acidity in patients*. Pak. J. Pharm. Sci, 2019. **32**(6): p. 2811-2816.
7. RAJAB, N.A.J.S.R.i.P., *Apixaban ultrafine O/W nano emulsion transdermal drug delivery system: formulation, in vitro and ex vivo characterization*. 2020.

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8. El-Aziz, M.A., et al., *Low density alfuzosin hydrochloride floating tablets: in vitro characterization and in vivo gastroretentive MRI tracking in healthy volunteers*. 2021. **48**(5).
9. Aleem, S., et al., *A Comprehensive Review on Turmeric: Herbal Dosage Forms, Therapeutic Potential and Market Price Comparisons*. 2025. **1**(1).
10. Liaquat, A., et al., *Rheological characterization of composite wheat flours enriched with protein-rich plant sources for nutritional enhancement*. Italian Journal of Food Science/Rivista Italiana di Scienza degli Alimenti, 2026. **38**(1): p. 1.
11. Sadia, H., et al., *Enhancing medication appropriateness: Insights from the STOPP (Screening Tool of Older Persons' Prescriptions) criteria version 3 on prescribing practices among the older adults in Pakistan*. Frontiers in Pharmacology, 2025. **16**: p. 1551819.
12. Sadia, H., et al., *Enhancing medication appropriateness: Insights from the STOPP (Screening Tool of Older Persons' Prescriptions) criteria version 3 on prescribing practices among the older adults in Pakistan*. 2025. **16**: p. 1551819.
13. Thakur, S., et al., *Floating drug delivery system*. 2021. **11**.
14. Farhadnejad, H., et al., *Montmorillonite-famotidine/chitosan bio-nanocomposite hydrogels as a mucoadhesive/gastroretentive drug delivery system*. 2022. **21**(1): p. e127035.
15. Jani, P.H., *Design and Development of PEI Coated Iron Oxide Based Theranostic Nanoparticles for Targeting Brain Tumors*. 2021, Maharaja Sayajirao University of Baroda (India).
16. Shrivastava, P., et al., *Nanotechnology for oral drug delivery and targeting*, in *Nanoengineered biomaterials for advanced drug delivery*. 2020, Elsevier. p. 473-498.
17. Zou, H., et al., *Application of pharmacokinetic-pharmacodynamic modeling in drug delivery: development and challenges*. 2020. **11**: p. 997.
18. Kalhapure, R.S., et al., *Nanocrystals for controlled delivery: state of the art and approved drug products*. 2022. **19**(10): p. 1303-1316.
19. Siddiqui, U.N. and D. Naveed, *Nature's forgotten emulsifier: revisiting the chemistry, application and use of Gum acacia*. International Journal of Trends in Pharmaceutical and Chemical Research, 2025. **3**(1).
20. Naveed, D., H. Sadia, and U.N. Siddiqui, *FROM CRAVINGS TO CARCINOGENESIS: A REVIEW OF SUGAR'S DUAL ROLE IN ADDICTION AND CANCER*. Pakistan Journal of Medical & Cardiological Review, 2026. **5**(2): p. 1086-1100.
21. Naveed, D. and U.N. Siddiqui, *Hyaluronic Acid: Nature's Versatile Biopolymer for Health, Healing, and Beauty*. International Journal of Trends in Health Sciences, 2025. **3**(1).
22. Agarwal, S., A. Thakur, and A.J.M.T.P. Sharma, *Development and evaluation of ketoprofen loaded floating microspheres for sustained delivery*. 2022. **68**: p. 647-652.
23. Ghosal, K., et al., *Novel drug delivery systems based on triaxial electrospinning based nanofibers*. 2021. **163**: p. 104895.