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Floating Drug Delivery Systems for Gastric Retention: Advances, Mechanisms, and Applications:

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ABSTRACT: :

Especially in the framework of controlled and sustained release, the evolution of floating drug delivery systems (FDDS) has altered the approach to drug delivery for diseases involving the gastrointestinal tract. FDDS are designed to stay buoyant in the stomach for extended periods, so improving drug bioavailability, extending therapeutic effects, and increasing patient compliance. This work discusses the floating drug delivery systems for gastric retention in terms of their mechanisms, formulations, developments, and applications

Keywords:Floating Drug Delivery Systems (FDDS),Gastric Retention Time (GRT),Buoyancy

Introduction:

Given its simplicity, oral drug delivery is among the most often used techniques of drug administration. But, poor drug absorption is frequently caused by the difficulties related to the rapid gastric emptying rate and short drug residence duration in the stomach. By raising the therapeutic efficacy of oral drugs and extending gastric retention time (GRT), floating drug delivery systems (FDDS) have been an effective tool.

Mechanisms of Floating Drug Delivery Systems

FDDS's main idea is the development of a system able to stay buoyant in the stomach. Including a buoyant component lets the drug delivery system float on the stomach contents, therefore lowering the speed at which the system exits the gastric environment. FDDS floats by various means, including:

1. Effervescent Mechanism: This is the addition of effervescent chemicals such sodium bicarbonate that react with stomach acid to produce gas, so generating bubbles that allow the system float.
2.This mechanism allows the system to float by combining low-density polymers or hydrogels less dense than gastric fluids.
3.A hydrodynamically balanced system is one that uses hydrophilic polymers that swell upon contact with gastric fluids to increase the volume of the formulation, so boosting its buoyancy and allowing it to remain afloat in the stomach.

Formulations and Materials Used in FDDS

FDDS formulations are created from several materials, including synthetic excipients, natural gums, and polymers. The most often used chemicals are: :

Polymers: Often used are polymers including hydroxypropyl methylcellulose (HPMC), sodium alginate, and chitosan since they can produce gel matrices supporting stomach retention.

Effervescent Agents: Often, sodium bicarbonate, citric acid, and tartaric acid react with stomach acid to produce CO2, so raising buoyancy.

These substances, exposed to stomach fluids, swell and provide the mechanical strength required for buoyancy as well as allow drug release over time.

Advantages of Floating Drug Delivery Systems

1. Improved Bioavailability: FDDS extend the drug's residence time in the stomach, so enhancing its absorption, especially for drugs that are poorly absorbed in the intestines.

   2. Controlled Drug Release FDDS provide the possibility of controlled drug release over long periods, so guaranteeing constant therapeutic effects and lowering the dosing frequency.

3. Site-Specific Drug Delivery: Especially for drugs that work locally in the gastric region such antacids and proton pump inhibitors, the prolonged gastric retention time enables targeted drug release in the stomach.
3. Site-Specific Drug Delivery: FDDS's extended action can help to improve patient compliance to treatment plans by lowering the need for several doses.

Applications of Floating Drug Delivery Systems:

- Usually advised for acid reflux and ulcers, antacids and proton pump inhibitors (PPIs) are FDDS promises long-lasting stomach action, therefore offering prolonged symptom relief.
- FDDS helps drugs used to treat stomach infections, such those for Helicobacter pylori eradication, by keeping efficient drug levels for longer periods.
- Incorporating nonsteroidal anti-inflammatory medications (NSAIDs) into FDDS for continuous release helps to reduce side effects such stomach irritation.
- FDDS are also used to deliver medications for chronic gastrointestinal diseases such Crohn's disease or irritable bowel syndrome, so enabling targeted release in the stomach or upper intestines.

Challenges and Limitations:

Though FDDS shows great potential, its formulation and clinical use still present many challenges.

1. Patient Variability: FDDS performance in particular patients can be significantly affected by individual differences in gastric emptying time.
2Including drugs into FDDS formulations calls for careful analysis of drug-polymer interactions and the possibility of active pharmaceutical ingredient (API) degradation under acidic conditions.
3.Since it needs rigors quality control to guarantee consistency in buoyancy and drug release, producing FDDS can be more difficult than producing traditional oral dosage forms.

Recent Advances and Future Directions

Recent FDDS technology developments have concentrated on enhancing the stability, accuracy, and adaptability of these systems. Among the creative ideas:
Polymers reacting to pH changes or temperature fluctuations are being investigated to offer even more controlled release profiles.
Combining FDDS with other drug delivery systems, such mucoadhesive systems or osmotic pumps, to further improve therapeutic results.
Integrating nanocarriers into FDDS could let more exact drug targeting and higher medication loading capacity, therefore creating new possibilities for the control of complicated diseases.

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