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Review Article

A Review on Fast Dissolving Tablets Using Natural Superdisintegrants

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Abstract:
Fast dissolving tablets (FDTs) are an advanced oral drug delivery system designed to disintegrate rapidly in the oral cavity without the need for water. They offer significant advantages in improving patient compliance, especially among pediatric, geriatric, and dysphagic patients who face difficulty in swallowing conventional tablets. The rapid disintegration of FDTs is mainly attributed to the presence of superdisintegrants, which facilitate quick tablet breakup upon contact with saliva. Natural superdisintegrants have gained increasing attention as alternatives to synthetic agents due to their biodegradability, low toxicity, cost-effectiveness, and eco-friendly nature. Various natural materials such as Plantago ovata, Lepidium sativum, fenugreek mucilage, and guar gum have shown excellent swelling and disintegration properties. This review highlights the formulation approaches, mechanisms of action, preparation methods, and evaluation parameters of FDTs. It also discusses their wide applications in different therapeutic areas along with challenges such as stability issues, moisture sensitivity, and scale-up difficulties. Overall, natural superdisintegrants provide a promising and sustainable approach for developing efficient and patient-friendly fast dissolving tablets.
Keywords: Fast dissolving tablets, Natural superdisintegrants, Oral drug delivery, Rapid disintegration, Patient compliance, Bioavailability, Tablet formulation, Mucilage.

Introduction

Oral drug delivery remains the most preferred route of administration due to its convenience, non-invasiveness, cost-effectiveness, and ease of patient compliance. Despite these advantages, conventional tablet dosage forms present significant challenges, particularly for pediatric, geriatric, and dysphagic patients who often experience difficulty in swallowing (dysphagia). This limitation can lead to poor medication adherence and reduced therapeutic efficacy [1].

To overcome these issues, fast dissolving tablets (FDTs), also known as orally disintegrating tablets (ODTs), have been developed as an innovative drug delivery system. These tablets are designed to disintegrate or dissolve rapidly in the oral cavity without the need for water, usually within a few seconds to a minute, thereby enhancing patient convenience and compliance. Additionally, FDTs may provide a faster onset of action as the drug becomes

readily available for absorption, either in the oral cavity or after swallowing [2,3].

A critical component responsible for the rapid disintegration of FDTs is the superdisintegrant. Superdisintegrants are specialized excipients that facilitate the breakup of tablets into smaller fragments upon contact with saliva [4]. They act primarily through mechanisms such as swelling, wicking (capillary action), and deformation recovery, which collectively enhance the penetration of fluid into the tablet matrix and accelerate disintegration. The selection and concentration of an appropriate superdisintegrant play a vital role in optimizing the performance, disintegration time, and overall effectiveness of FDT formulations [5].

Advantages of Fast Dissolving Tablets

- Improved patient compliance (especially pediatric & geriatric)
- No need for water
- Rapid onset of action
- Enhanced bioavailability
- Convenient administration during travel or emergencies
- Reduced risk of choking [6,7]

Limitations of FDTs

- Poor mechanical strength
- Hygroscopic nature
- Taste masking challenges
- Packaging issues (require special packaging like blister packs)

Superdisintegrants: Role and Mechanism

Superdisintegrants are a vital class of excipients used in the formulation of fast dissolving tablets (FDTs) to ensure rapid disintegration and dissolution of the dosage form. Their primary function is to facilitate the immediate breakup of the tablet matrix when it comes into contact with saliva or aqueous fluids. This rapid disintegration enhances the surface area of the drug, thereby promoting faster dissolution and improved bioavailability [8]. In addition to improving the onset of action, superdisintegrants also contribute to better patient compliance by reducing the time required for the tablet to disintegrate in the oral cavity. The efficiency of a superdisintegrant depends on its concentration, compatibility with other excipients, and physicochemical properties such as swelling capacity, hydration ability, and particle size [8,9].

Mechanisms of Action

Superdisintegrants act through a combination of different mechanisms, which collectively promote rapid tablet disintegration:

Swelling

In this mechanism, superdisintegrant particles absorb water rapidly and swell to a significant extent. This swelling generates internal pressure within the tablet matrix, leading to its rupture and disintegration into smaller fragments.

Wicking (Capillary Action)

Wicking involves the penetration of liquid into the porous structure of the tablet through capillary forces. Superdisintegrants enhance the hydrophilicity of the tablet, allowing water to be drawn inside, which weakens intermolecular bonds and facilitates disintegration.

Deformation Recovery

During tablet compression, particles of the superdisintegrant may get deformed. Upon contact with water, these particles tend to regain their original shape, resulting in an expansion force that contributes to the breakup of the tablet [10].

Electrostatic Repulsion

Some superdisintegrants generate repulsive forces between particles when hydrated. This electrostatic repulsion helps in pushing particles apart, thereby aiding in rapid disintegration of the tablet.

Natural Superdisintegrants

Natural polymers are increasingly used as superdisintegrants in fast dissolving tablets due to their safety, biocompatibility, and wide availability. These materials are obtained from plant, animal, or microbial sources and serve as effective alternatives to synthetic agents. Their

ability to swell, absorb water, and promote rapid tablet disintegration makes them suitable for FDT formulations [11].

Advantages

- **Biodegradable:** Easily broken down in the body without harmful residue
- **Non-toxic**: Safe for human use with minimal side effects
- **Economical**: Low cost compared to synthetic superdisintegrants
- **Easily available**: Readily sourced from natural materials
- **Eco-friendly:** Environmentally safe and sustainable [10,11]

Common Natural Superdisintegrants Used in FDTs

Plantago ovata (Isabgol Husk)

Plantago ovata, commonly known as Isabgol husk, is widely used as a natural superdisintegrant due to its high swelling index and excellent water absorption capacity. Upon contact with saliva, it rapidly swells and facilitates quick tablet disintegration. Its natural origin, effectiveness, and easy availability make it a preferred choice in fast dissolving tablet formulations.

Lepidium sativum (Garden Cress Seed)

Lepidium sativum seeds produce a mucilaginous substance when hydrated, which plays a key role in tablet disintegration. It exhibits good water absorption and swelling properties, thereby enhancing the breakup of tablets. Its natural availability and efficiency make it suitable for use in FDT formulations [12].

Fenugreek Seed Mucilage (Trigonella foenum-graecum)

Fenugreek seed mucilage is a natural polymer known for its high viscosity and swelling ability. When exposed to aqueous media, it forms a gel-like structure that aids in tablet disintegration. Its biocompatibility and effective swelling behavior contribute to its use as a superdisintegrant in fast dissolving tablets [13].

Guar Gum

Guar gum is a natural polysaccharide obtained from guar seeds and is widely used due to its hydrophilic nature. It exhibits good swelling and binding properties, which help in rapid tablet disintegration. Its cost-effectiveness and natural origin make it an attractive alternative to synthetic superdisintegrants.

Locust Bean Gum

Locust bean gum, derived from the seeds of the carob tree, acts as an effective natural superdisintegrant. It improves tablet disintegration by absorbing water and swelling, leading to faster dispersion of the tablet. It is also known for enhancing the overall performance of FDT formulations [14].

Banana Powder

Banana powder is a natural source rich in starch, which contributes to its swelling and water absorption properties. It promotes rapid disintegration of tablets by facilitating quick uptake of saliva. Due to its natural origin and ease of availability, it is increasingly explored in FDT formulations.

Preparation Methods of FDTs

Direct Compression

Direct compression is the simplest and most widely used method for the preparation of fast dissolving tablets. In this technique, the drug is mixed uniformly with excipients such as superdisintegrants, diluents, and lubricants, and then directly compressed into tablets without any granulation step.

The presence of superdisintegrants ensures rapid water uptake and quick tablet disintegration. This method is highly preferred due to its low cost, fewer processing steps, and suitability for heat- and moisture-sensitive drugs. However, it requires powders with good flowability and compressibility to produce tablets of uniform quality.

Wet Granulation

Wet granulation involves the addition of a liquid binder to the powder blend to form granules, which are then dried and compressed into tablets. This method improves the flow properties, compressibility, and uniformity of the formulation, making it suitable for poorly flowing drugs. It also enhances the mechanical strength of tablets. However, the use of heat and moisture during the process may degrade sensitive drugs, and the method is relatively time-consuming compared to direct compression [12,13].

Spray Drying

Spray drying is a technique in which a liquid solution or suspension containing the drug and excipients is rapidly dried using hot air to produce fine, porous particles. These particles have a large surface area and low density, which enhances water penetration and leads to faster disintegration of tablets. This method is useful for improving solubility and dissolution rate but requires specialized equipment and careful control of processing conditions.

Freeze Drying (Lyophilization)

Freeze drying, also known as lyophilization, is a sophisticated method in which the formulation is first frozen and then subjected to vacuum to remove water by sublimation. This results in a highly porous and lightweight tablet structure that disintegrates almost instantly upon contact with saliva. Although this method provides excellent disintegration and rapid drug release, it is expensive, time-consuming, and produces fragile tablets that require specialized packaging such as blister packs [15].

Sublimation

Sublimation is a technique in which volatile substances like camphor, menthol, or ammonium bicarbonate are incorporated into the tablet formulation during compression. After tablet formation, these substances are removed by sublimation, leaving behind a porous structure. This porosity enhances the penetration of saliva into the tablet, resulting in rapid disintegration. The method is simple and effective but requires careful handling to ensure complete removal of volatile agents.

Post-compression Parameters

Hardness

Hardness is a critical parameter that reflects the mechanical strength of a tablet and its ability to withstand handling, transportation, and storage without breaking. It is usually measured using instruments such as Monsanto, Pfizer, or digital hardness testers and expressed in kg/cm². For fast dissolving tablets, hardness must be carefully optimized because excessive hardness may delay disintegration, whereas insufficient hardness may lead to tablet breakage. Thus, a balance is required to ensure both adequate strength and rapid disintegration [16].

Friability

Friability is used to assess the resistance of tablets to abrasion and mechanical stress. It is determined using a friabilator, where a pre-weighed sample of tablets is rotated at a specific speed for a fixed time. After the test, tablets are reweighed, and percentage weight loss is calculated. Ideally, the friability should be less than 1%, indicating good mechanical integrity. Higher friability values suggest poor binding properties and a risk of tablet damage during handling.

$$\%\ Friability = \frac{Initial\ weight - Final\ weight}{Initial\ weight} \times 100$$

Weight Variation

The weight variation test is performed to ensure uniformity of dosage units. In this test, a specific number of tablets are weighed individually, and their average weight is calculated.

Each tablet weight is then compared with the average to determine the percentage deviation. The results must comply with pharmacopeial limits. This test is essential because it indirectly reflects uniform distribution of the drug and excipients within the formulation [13,14].

Disintegration Time

Disintegration time is one of the most important parameters for fast dissolving tablets. It measures the time required for a tablet to break down into smaller particles when placed in a suitable medium, usually water or simulated saliva. The test is performed using a standard disintegration apparatus. For FDTs, the disintegration time is generally expected to be within a few seconds to one minute. Rapid disintegration ensures quick drug release and improved patient compliance.

Wetting Time

Wetting time is an important parameter that indicates how quickly a tablet can absorb moisture and initiate disintegration. It is determined by placing a tablet on a folded tissue paper soaked in water and recording the time taken for complete wetting. A shorter wetting time indicates better water absorption capacity and faster action of superdisintegrants, which is desirable for FDT formulations.

Drug Content Uniformity

Drug content uniformity ensures that each tablet contains the required amount of active pharmaceutical ingredient (API) within specified limits. In this test, tablets are crushed and dissolved in a suitable solvent, and the drug content is analyzed using methods such as UV-visible spectroscopy or HPLC. Uniform drug distribution is essential to maintain consistent therapeutic efficacy and to avoid dose variation.

***In-vitro* Dissolution Study**

In-vitro dissolution studies are performed to evaluate the rate and extent of drug release from the tablet in a controlled environment.

The test is carried out using USP dissolution apparatus (Type I or Type II) with a suitable dissolution medium maintained at 37±0.5°C. Samples are withdrawn at regular intervals and analyzed for drug content. Faster and complete drug release is desirable in FDTs, as it indicates improved bioavailability and rapid onset of action [15].

Applications of Fast Dissolving Tablets (FDTs)

Fast dissolving tablets have gained wide acceptance across multiple therapeutic categories due to their rapid disintegration, ease of administration, and enhanced patient compliance. These dosage forms are particularly beneficial in pediatric, geriatric, and dysphagic patients, as well as in conditions requiring quick onset of action.

Anti-allergic drugs:

FDTs are extensively used for antihistamines such as cetirizine, loratadine, and fexofenadine to provide rapid relief from allergic conditions like allergic rhinitis, urticaria, and seasonal allergies. Their fast disintegration ensures quicker symptom control and improved patient convenience, especially during acute allergic reactions [14].

Analgesics:

Analgesic drugs such as paracetamol, ibuprofen, and diclofenac are commonly formulated as FDTs to achieve rapid pain relief. These formulations are particularly useful in conditions like migraine, toothache, and postoperative pain, where quick onset of action is desirable.

Anti-emetics:

FDTs are highly effective for anti-emetic drugs like ondansetron and domperidone, especially in patients suffering from nausea and vomiting. Since these patients may not be able to retain water or swallow conventional tablets, FDTs offer a significant advantage by dissolving directly in the mouth.

CNS drugs:

Central nervous system drugs, including anti-epileptics, antipsychotics, and antidepressants, benefit greatly from FDT formulations. These tablets improve compliance in patients with neurological disorders such as Parkinson's disease, schizophrenia, and epilepsy, where swallowing difficulties and need for rapid drug action are common.

Cardiovascular drugs: FDTs can be used for certain cardiovascular drugs, particularly in emergency conditions like angina or hypertension, where rapid onset of action is required. These formulations allow quick drug availability and may improve therapeutic outcomes in critical situations [16,17].

Challenges and Future Prospects

Challenges

Stability issues:

FDTs often exhibit reduced physical and chemical stability due to their porous structure and the presence of highly water-absorbing excipients. Exposure to environmental factors such as temperature and humidity can lead to degradation, reduced shelf life, and loss of tablet integrity.

Moisture sensitivity:

Due to their hygroscopic nature, FDTs readily absorb moisture from the environment, which can result in premature disintegration, reduced hardness, and compromised quality. This necessitates the use of specialized moisture-resistant packaging such as alu-alu blister packs.

Scale-up difficulties:

The large-scale production of FDTs poses several challenges, including maintaining uniform porosity, consistency in disintegration time, and controlling processing parameters. Advanced techniques like lyophilization require expensive equipment and careful optimization, making industrial scale-up complex and costly [18].

Future Prospects

Development of novel natural polymers:

There is increasing interest in identifying and developing new natural superdisintegrants with superior swelling, biodegradability, and safety profiles. These polymers can provide cost-effective and eco-friendly alternatives to synthetic excipients.

Improved taste masking techniques:

Since FDTs disintegrate in the oral cavity, masking the unpleasant taste of drugs remains a major challenge. Advanced approaches such as microencapsulation, ion-exchange resins, inclusion complexes, and coating technologies are being explored to enhance palatability and patient acceptability [18,19].

Advanced manufacturing technologies:

Emerging technologies such as 3D printing, nanotechnology, and spray freeze drying are revolutionizing the development of FDTs. These techniques offer better control over tablet structure, porosity, and drug release profiles, leading to improved product performance.

Increased use in biopharmaceuticals:

FDTs are being increasingly investigated for the delivery of biopharmaceuticals and poorly soluble drugs. By improving dissolution and absorption characteristics, these formulations can enhance bioavailability and therapeutic efficacy, opening new avenues in drug delivery research [20].

Conclusion

Fast dissolving tablets have emerged as an important advancement in oral drug delivery systems by offering rapid disintegration and improved patient compliance.

The role of superdisintegrants is crucial in ensuring quick tablet breakup and effective drug release. Natural superdisintegrants have gained significant importance due to their safety, biodegradability, and cost-effectiveness compared to synthetic agents. Natural materials such as Plantago ovata, Lepidium sativum, fenugreek mucilage, and guar gum have demonstrated excellent swelling and water absorption properties, making them suitable for FDT formulations. These materials enhance tablet disintegration and improve overall drug performance.

Despite advantages, FDTs face challenges such as moisture sensitivity, stability issues, and difficulties in large-scale production. However,

advancements in formulation techniques and manufacturing technologies are helping to overcome these limitations.

In future, the development of novel natural polymers and improved drug delivery approaches will further enhance the potential of FDTs. Overall, natural superdisintegrants offer a promising, eco-friendly, and effective strategy for developing patient-friendly pharmaceutical dosage forms.

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