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Original Article

Fast Dissolving Tablets: Formulation Strategies, Disintegration Mechanisms, and Emerging Innovations

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ABSTRACT

Fast-dissolving tablets (FDTs), also known as orally disintegrating tablets, have emerged as an advanced oral drug delivery system designed to improve patient convenience, compliance, and therapeutic effectiveness. These tablets rapidly disintegrate in the oral cavity without the need for water, making them especially beneficial for pediatric, geriatric, dysphagic, and bedridden patients. The rapid disintegration of FDTs is primarily driven by formulation factors such as superdisintegrants, porous tablet structures, and hydrophilic excipients that enhance saliva penetration and tablet breakup. Recent developments in excipient technology and manufacturing techniques have significantly improved the performance of FDTs. Methods such as direct compression, freeze-drying, spray drying, sublimation, and moulding are widely employed to produce tablets with optimal porosity and mechanical strength. Advanced patented technologies further enhance taste masking, stability, and rapid drug release. In addition to improving patient acceptability, FDTs may contribute to a faster onset of action and, in some cases, improved bioavailability through pre-gastric absorption. FDTs are now used across multiple therapeutic areas, including analgesics, antiemetics, antihistamines, cardiovascular agents, and central nervous system drugs. Ongoing research is exploring natural polymers, novel superdisintegrants, and nanotechnology-based approaches to further optimize tablet performance. Overall, fast-dissolving tablets represent a significant innovation in oral drug delivery, combining patient-centred design with pharmaceutical advancements to address modern therapeutic needs.

Keywords: Fast Dissolving Tablets

INTRODUCTION

Fast-dissolving tablets (FDTs), also referred to as orally disintegrating tablets (ODTs) or mouth-dissolving tablets, represent one of the most innovative and patient-friendly oral drug delivery systems developed in recent pharmaceutical research. These solid dosage forms are designed to disintegrate and dissolve rapidly in the oral cavity—typically within seconds to a few minutes—without the need for water, thereby offering significant advantages over conventional tablets and capsules, especially for patient groups with swallowing difficulties such as pediatric, geriatric, psychiatric, and dysphagic populations. The core objective of FDT development is to enhance patient compliance and convenience by enabling simple administration under normal conditions without the prerequisite of liquid intake. This quality is particularly beneficial for individuals who may be traveling, bedridden, or experiencing nausea, where access to water may be limited or swallowing reflexes compromised. Additionally, FDTs contribute to faster onset of therapeutic action and potentially improved bioavailability, as drug absorption can begin through the rich vascular network of the oral mucosa before gastric passage, which may partially bypass first-pass metabolism. Recent review articles emphasize that the success of FDT formulations largely depends on advancements in excipient technology—particularly superdisintegrants—and manufacturing techniques. These include approaches such as direct compression, lyophilization (freeze-drying), spray drying, and patent-protected methods like Zydis and AdvaTab, which aim to achieve rapid disintegration while maintaining acceptable mechanical strength and taste masking. The past five years of research have focused not only on optimizing formulation strategies but also on overcoming persistent challenges such as

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balancing rapid disintegration with structural integrity, taste masking, and stability under environmental stress. Recent studies also explore novel excipients and natural superdisintegrants to further improve dissolution rates and patient acceptability. Overall, FDTs continue to gain prominence in pharmaceutical science due to their therapeutic advantages, market potential, and adaptability to diverse drug molecules, making them a pivotal focus of current and future drug delivery research

Fig 1: A pictorial representation of fast-dissolving tablets

Mechanism of Action of Fast Dissolving Tablets

1. Basic Definition & Functional Principle

Fast dissolving tablets (FDTs), also known as orally disintegrating tablets (ODTs), are solid oral dosage forms designed to rapidly disintegrate and/or dissolve in the oral cavity without the need for water, usually within seconds to under 60 seconds. This rapid disintegration facilitates quick release of the active pharmaceutical ingredient (API), improving onset of action and patient compliance, especially in pediatric, geriatric, and dysphagic patients. Mechanistically, the action of FDTs is not a single "biochemical reaction" like a drug's pharmacological mechanism; instead, it's a physical disintegration and dissolution process driven by excipient behaviour and tablet architecture.

2. Core Mechanisms Involved in Rapid Disintegration

Studies and recent reviews consistently point to multiple physical mechanisms that contribute to the rapid breakup of tablets in the oral cavity once saliva contacts them:

A. Swelling of Superdisintegrants

Superdisintegrants such as crospovidone, sodium starch glycolate, croscarmellose sodium, and others rapidly absorb saliva and swell, generating internal stress that physically disrupts the tablet matrix. This swelling force is considered one of the primary drivers of tablet breakup.

Active uptake of water → expansion → pressure inside tablet → structural disruption.

B. Capillary Action / Water Wicking

Hydrophilic disintegrants create capillary pathways within the tablet that draw saliva deep into the core. This wicking replaces air in pores with fluid, weakening interparticle bonds and hastening disintegration. Critical first step before swelling can initiate fully.

C. Deformation Recovery

During compression, some disintegrant particles undergo deformation. Once wetted, they recover their original shape, expanding and aiding tablet breakup. This mechanism is particularly relevant for disintegrants like crospovidone that do not swell extensively.

D. Particle/Particle Repulsion

Entrapped water increases electrostatic repulsion between particles, especially in non-swelling

disintegrants. Repulsive forces help break intermolecular attractions within the tablet matrix.

E. Heat of Wetting & Effervescence (Supporting Mechanisms)

Heat of wetting: small exothermic energy release on water uptake creates local stresses that contribute to breakup.

Effervescence: reaction of certain excipients (e.g., bicarbonates with acids) generates gas (CO_2), further helping disintegration.

These mechanisms are not universal but can significantly speed up disintegration in specific formulations.

3. Dissolution After Disintegration

Once the tablet rapidly breaks apart, two overlapping processes occur:

A. Rapid dispersion of drug particles

Tablet breakup releases fine particles into the saliva, greatly increasing surface area available for dissolution.

B. Dissolution in saliva & absorption pathways

Some drugs dissolve in saliva and may be absorbed across the oral mucosa (sublingual/buccal) bypassing first-pass metabolism. For many drugs, most of the dissolved API is swallowed and absorbed via the GI tract, but the increased surface area still accelerates systemic uptake.

4. Excipient & Formulation Strategies That Drive the Mechanistic Action

The rapid disintegration and dissolution of FDTs depend heavily on formulation design:

Superdisintegrant Selection & Concentration

Effective superdisintegrants are chosen based on their swelling capacity, porosity, and interaction with saliva. Optimal levels (~1–10%) balance rapid disintegration with mechanical strength.

Technologies like lyophilization, spray drying, or specialized co-processed excipients generate highly porous structures that facilitate water uptake and faster breakup.

Hydrophilic Soluble Components

Ingredients like mannitol improve wettability and mouthfeel while assisting fluid penetration.

5. Summary Mechanistic Pathway (Typical FDT in Mouth)

Saliva contact → capillary penetration into tablet pores.

Superdisintegrants absorb water → swelling and pressure build-up.

Deformation recovery and particle repulsion further break tablet into smaller fragments.

Rapid dissolution of fragments in saliva → drug release.

Swallowed API enters systemic circulation faster due to increased surface area and possible mucosal absorption

Methods of Preparation of Fast Dissolving Tablets (FDTs)

Fast-dissolving tablets (also called orally disintegrating tablets or ODTs) are designed to disintegrate or dissolve rapidly in the oral cavity without water, improving compliance and the onset of action. The key to manufacturing FDTs is creating a highly porous structure with formulation and processing choices that support rapid wetting and breakup.

1. Direct Compression (DC)

Description: The simplest and most widely used method due to ease of processing at an industrial scale.

Process: The drug, superdisintegrants, fillers, sweeteners, and other excipients are blended and directly compressed using standard tablet punches.

Advantages: Low cost, fewer process steps, minimal equipment.

Formulation Role: Choosing appropriate disintegrants (e.g., crospovidone, croscarmellose sodium) and porous excipients (e.g., mannitol) is critical.

Notes: Improved disintegrants and co-processed excipients have made DC especially suitable for FDTs.

2. Freeze Drying / Lyophilization

Description: Commonly used where very fast disintegration is needed.

Process: A drug/excipient solution or suspension is frozen and then sublimed under low pressure, removing water and creating a very porous matrix.

Advantages: Ultra-rapid disintegration due to high porosity.

Limitations: Expensive, time-consuming, and tablets may be fragile.

Typical Use: Often for heat-sensitive drugs or small-molecule APIs.

3. Tablet Moulding Method

Description: Creates a porous matrix by moulding rather than compressing tablets.

Process: A hydro-alcoholic binder solution with drug and excipients is poured into molds and dried, leaving tablets with built-in porosity.

Advantages: Good for heat-sensitive drugs and allows rapid dissolution.

Disadvantages: Often results in lower mechanical strength unless binders are optimized.

Variants: Inclusion of polymers (e.g., agar, soluble sugars) can improve structure.

4. Mass Extrusion

Description: Produces elongated excipient/drug extrudates that are cut to size as tablets.

Process: A mass of drug and excipients is plasticized with a solvent system and extruded, then sectioned.

Advantages: Produces tablets with good uniformity and rapid disintegration.

Utility: Better control of shape/size compared to moulding.

5. Spray Drying

Description: A porous powder is made by spray drying a solution or dispersion of drug/excipients.

Process: The liquid feed is atomized into hot drying air; solvent evaporation yields fine porous particles for tablet compression.

Advantages: Enhanced surface area and porosity support rapid dissolution.

Suitable For: Heat-sensitive drugs when parameters are controlled.

6. Sublimation

Description: Uses a volatile ingredient to create porosity.

Process: A volatile substance (e.g., camphor, ammonium bicarbonate) is mixed with drug/excipients and dried; the volatile component sublimes leaving voids.

Advantages: Improves porosity and thus disintegration.

Considerations: Requires careful choice of volatile agent.

7. Nanotization / Nanoparticle Techniques

Description: Reducing drug particle size to the nanometer range to enhance surface area and dissolution.

Process: Nanoparticles are prepared (e.g., precipitation or milling), then incorporated into tablets.

Effect: Increased dissolution rate and improved uniformity.

Notes: More research reported recently as a formulation enhancement, but used in combination with traditional tablet manufacturing.

8. Patented / Advanced Commercial Technologies

Beyond basic methods, industry-specific platforms have been developed and patented in recent years to consistently achieve rapid disintegration with commercial robustness:

• Pharma burst Technology

Dry blending with co-processed excipients to yield tablets that dissolve in ~30–40 seconds. Excipient systems optimized for porosity and rapid wetting.

• Lyoc® Technology

Combines oil/water emulsions and freeze-drying, using inert fillers to control porosity and structural integrity. Tailored more for sensitive APIs.

• Flashtab Technology

Uses taste-masked microgranules prepared by techniques like coacervation or microencapsulation, then compressed normally. Provides palatable, rapid-release tablets with improved taste profiles

9. Spherical Agglomeration?

Spherical agglomeration (also called spherical crystallisation) is a particle engineering technique where fine crystals of a drug are transformed into larger, spherical aggregates in a controlled crystallization medium. These spherical particles usually show improved flowability, compressibility, solubility, and dissolution characteristics, making them very suitable for manufacturing FDTs by direct compression without complex granulation steps. Provides palatable, rapid-release tablets with improved taste profiles.

Key Points from Recent Reviews

Direct compression remains the most widely used industrially due to economic and simplicity benefits.

Freeze drying / lyophilization still dominates when maximum disintegration speed and porous structure are required but has practical limitations. Advanced patented technologies (e.g., Pharma burst, Lyoc, Flashtab) combine formulation science with industry expertise to optimize rapid dissolution and manufacturability.

Table 1: A small summary on the preparation of fast-dissolving tablets

Method	Key Feature	Pros	Cons
Direct Compression	Simple compression	Cost-effective, scalable	Depends heavily on excipients
Freeze Drying	Highest porosity	Fastest disintegration	Costly, fragile
Tablet Molding	Porous matrix	Good for heat-sensitive drugs	May have low strength
Mass Extrusion	Extruded tablets	Uniform shape, fast	Requires extrusion setup
Spray Drying	Porous fine powder	Enhanced dissolution	Equipment intensive
Sublimation	Porosity via volatile removal	Good disintegration	Needs volatile agent control
Nanotization	Nano-particles	Enhanced dissolution	Additional processing

FDTS Available From (2025-2001)

Table 2. Recent Research and Review Studies on Fast Dissolving Tablets (2001–2025)

Year	Title / Focus	Type	Key Notes
2021	Formulation Evaluation and Characterization of Fast Dissolving Tablets of Rofecoxib	Research	Developed Rofecoxib FDTs using solid dispersion to improve dissolution. (RJTCs Online)
2022	Fast Dissolving Tablets: A Comprehensive Review (International Journal of Research in Pharmacy)	Review	Overview of technological improvements, acceptability, and bioavailability enhancements. (IJRPAS)

2025 (Aug)	A Review on Fast Dissolving Tablet (ResearchGate)	Review	Covers requirements, advantages, limitations, and evaluation methods of FDTs. (ResearchGate)
2025 (2025)	Fast Dissolving Tablets Using Natural Polymers: Comprehensive Review	Review	Focus on natural polymer strategies and mechanisms for FDT formulation. (IJNRPH)
2025 (Nov)	Design, Development & Assessment of Tropisetron Hydrochloride FDTs	Research	Direct compression FDT study for an antiemetic drug with in-vitro evaluation. (RJPT Online)
2024	Advancing Oral Drug Delivery: The Science of Fast Dissolving Tablets	Review	Latest scientific advancements in FDT technologies and patient-friendly delivery. (ScienceDirect)
2024	Design and Development of Fast-dissolving Tablets of Apixaban	Research	FDT formulation using coprocessed excipient for cardiovascular drug. (IJPSN Online)
2025 (Jul)	Optimized Sitagliptin Fast Dissolving Tablets	Research	Systematic statistical optimization of Sitagliptin FDTs aimed at improved oral delivery. (IJPSD Online)
2024	Formulation and Evaluation of Fast Dissolving Sodium Diclofenac Tablet	Research	Study on Diclofenac FDTs with typical excipients and evaluation. (ResearchGate)
2024	Formulation and Evaluation of Fast Dissolving Tablet (Bilastine)	Research	Development of bilastine-based FDT formulation. (ResearchGate)
2025	Formulation & Evaluation of Fast Dissolving Tablet of Valsartan	Research	Utilized mixed hydrotropy to enhance dissolution for antihypertensive FDT. (ResearchGate)
2025	Formulation & Evaluation of FDTs of Lasmiditan	Research	Focused on migraine therapy and rapid disintegration via wet granulation. (ResearchGate)
2025	Design & Optimization of Fast Dissolving Felodipine Tablets	Research	Response surface method to optimize Felodipine FDT properties. (Letters in Applied NanoBioScience)

Applications & Uses of Fast Dissolving Tablets (FDTs)

1. Improved Patient Compliance

Fast dissolving tablets are widely used to improve compliance, especially in patients who have difficulty swallowing conventional tablets and capsules — particularly pediatric, geriatric, and dysphagic patients (difficulty in swallowing). FDTs disintegrate in the oral cavity without water, making them convenient in outpatient and home settings

Use case: Children who cannot swallow large tablets; elderly patients with reduced saliva flow or swallowing reflex

2. Rapid Onset of Action

Because FDTs dissolve quickly in saliva and often allow **pre-gastric absorption**, drugs can enter systemic circulation more rapidly than conventional tablets. This means faster therapeutic effects — important in conditions requiring quick relief.

Use case: Pain relief (analgesics), anti-allergy medications, antiemetics, antihypertensives in acute conditions.

3. Enhanced Bioavailability

Many fast dissolving formulations can avoid or reduce first-pass metabolism by facilitating drug absorption through the oral mucosa. This can lead to enhanced bioavailability and sometimes improved efficacy of the active pharmaceutical ingredient (API).

Use case: Drugs that are extensively metabolized in the gut or liver, such as certain painkillers or CNS agents, may benefit from this property.

4. Convenience & Portability

FDTs can be taken anywhere and anytime without the need for water, increasing convenience for patients in travel, outdoor settings, or for those who lack easy access to fluids.

Use case: Motion sickness medications for travelers, quick relief antihistamines during allergy episodes.

5. Extended Therapeutic Areas

Recent review literature points toward expanding uses of FDTs beyond traditional small-molecule drugs into innovative areas such as:

- **Central nervous system (CNS) disorders**, where rapid action is desirable.
- **Biologics, peptides, and vaccines** — future applications anticipated as formulation and stabilization technologies improve.
- **Research outlook:** While still emerging, FDT formats may be adapted for complex molecules as excipient science advances

6. Taste-Masked & Sensory Enhanced Formulations

Use case: Pediatric formulations where palatability greatly affects compliance.

7. Special Populations & Situations

FDTs are especially valuable in:

- Mentally impaired patients who may not reliably swallow conventional tablets.
- Bedridden or uncooperative patients.
- Busy patients or those without water access (e.g., emergencies).

Table 3: Therapeutic Applications of Fast Dissolving Tablets

Application Area	Examples / Benefits
Patient Compliance	Geriatric, pediatric, dysphagia patients (globalresearchonline.net)
Rapid Therapeutic Action	Acute pain relief, antiemetics, antihistamines (pharmaceuticaljournal.net)
Enhanced Bioavailability	Drugs with significant first-pass metabolism (pharmaceuticaljournal.net)
Convenience/Portability	Travel, outdoor use, no water needed (globalresearchonline.net)
Broader Therapeutic Targets	CNS drugs, biologics (future potential) (pharmaceuticaljournal.net)
Taste Masking / Sensory Improvement	Flavored pediatric formulations (pharmaceuticaljournal.net)
Special Patient Groups	Mentally impaired, bedridden patients (globalresearchonline.net)

CONCLUSION

Fast-dissolving tablets have transformed conventional oral drug delivery by offering a dosage form that combines convenience, rapid action, and improved patient compliance. Their ability to disintegrate quickly in the oral cavity without water makes them highly suitable for special populations, including children, the elderly, and individuals with swallowing difficulties. The success of FDTs lies in the careful selection of excipients, particularly superdisintegrants, and in the use of manufacturing techniques that create a porous yet mechanically stable tablet structure. Technological progress has enabled the development of multiple preparation methods, ranging from simple direct compression to sophisticated freeze-drying and patented commercial platforms. These approaches aim to balance rapid disintegration with adequate strength, stability, and palatability. Taste masking and mouthfeel improvement remain important formulation considerations, particularly for pediatric use. Beyond patient convenience, FDTs may provide faster therapeutic onset and improved drug dissolution, which can enhance treatment outcomes in acute conditions such as pain, allergy, nausea, and cardiovascular emergencies. Emerging research is expanding the scope of FDTs toward natural excipients, co-processed materials, and nanotechnology to further improve drug release characteristics. In conclusion, fast-dissolving tablets represent a promising and evolving drug delivery system with strong clinical relevance and commercial potential. Continued innovation in formulation

science and excipient development will further strengthen their role in future pharmaceutical therapy.

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The pictorial representation included in this article was generated with the assistance of an artificial intelligence (AI) image generation tool for illustrative and educational purposes. The image was created to visually explain the concept of fast-dissolving tablets and does not reproduce any copyrighted scientific figure. The authors confirm that the illustration is original, non-infringing, and intended solely to enhance conceptual understanding.

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