

# An Overview on Tablet Dosage Form Evaluation

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**Abstract:** Tablet dosage forms remain the most widely utilized oral solid dosage (OSD) system in pharmaceutical science due to their precision, stability, and cost-effectiveness (Upperton Pharma Solutions). This overview examines the transition from conventional compression to advanced manufacturing technologies like 3D printing and continuous manufacturing. As of 2026, the field is pivoting toward personalized medicine and AI-driven formulation to address bioavailability challenges and patient-centric needs. As of 2026, the transition in tablet dosage forms has moved beyond theory into large-scale implementation. The pharmaceutical industry is currently witnessing a "Digital-Physical Convergence," where data-driven design meets high-precision hardware. Here is an expanded look at the current landscape of tablet technology. AI-Driven Formulation Development: The traditional "trial and error" method of choosing excipients is being replaced by machine learning frameworks. Predictive Quality: AI models now organize raw-material properties and process data to predict Critical Quality Attributes (CQAs)—such as hardness, friability, and disintegration time—without the need for extensive physical prototyping. Digital Twins: Companies like Johnson & Johnson use digital twin models to replicate production environments. These virtual clones allow engineers to test "what-if" scenarios, reducing validation time and preventing equipment failure on the actual line. Continuous Manufacturing (CM) vs. Batch Processing: The industry is rapidly pivoting toward CM to solve the inefficiencies of traditional batch methods.

**Keywords:** Tablet Dosage Form, Compression Physics, 3D Printed Tablets, Personalized Medicine, Controlled Release, Continuous Manufacturing

## I. INTRODUCTION

Tablets are solid unit dosage forms containing one or more active pharmaceutical ingredients (APIs) and functional excipients (Upperton Pharma Solutions). They are primarily administered orally and designed to deliver a specific dose of medication with high reproducibility (Filo, 2026).

In the modern landscape, the integration of digital twins and artificial intelligence (AI) is transforming the traditional "batch" manufacturing model into a more efficient, real-time optimized process. The "End-to-End" Advantage: In CM, raw materials are continuously fed into a single integrated line that handles blending, granulation, drying, and compression. This reduces production time from weeks to hours.

Overcoming Bioavailability Barriers: With nearly 90% of new drug candidates being poorly water-soluble (BCS Class II/IV), formulation science has evolved. Amorphous Solid Dispersions (ASD): Transforming crystalline drugs into an amorphous state to "force" better solubility.

Nano-Enabled Systems: Incorporating drug nanocrystals into tablets to increase the surface area and dissolution rate. Oral Peptides: 2026 marks a breakthrough in delivering large molecules (like GLP-1 agonists) orally by using specialized chemical enhancers that protect the peptide from gastric enzymes.

### Mechanism of Tablet Formation

The formation of a tablet involves the mechanical compression of a powder or granular blend.

- **Compression Physics:** Applied force reduces the volume of the powder, leading to particle rearrangement, elastic/plastic deformation, and finally, the formation of inter-particulate bonds.



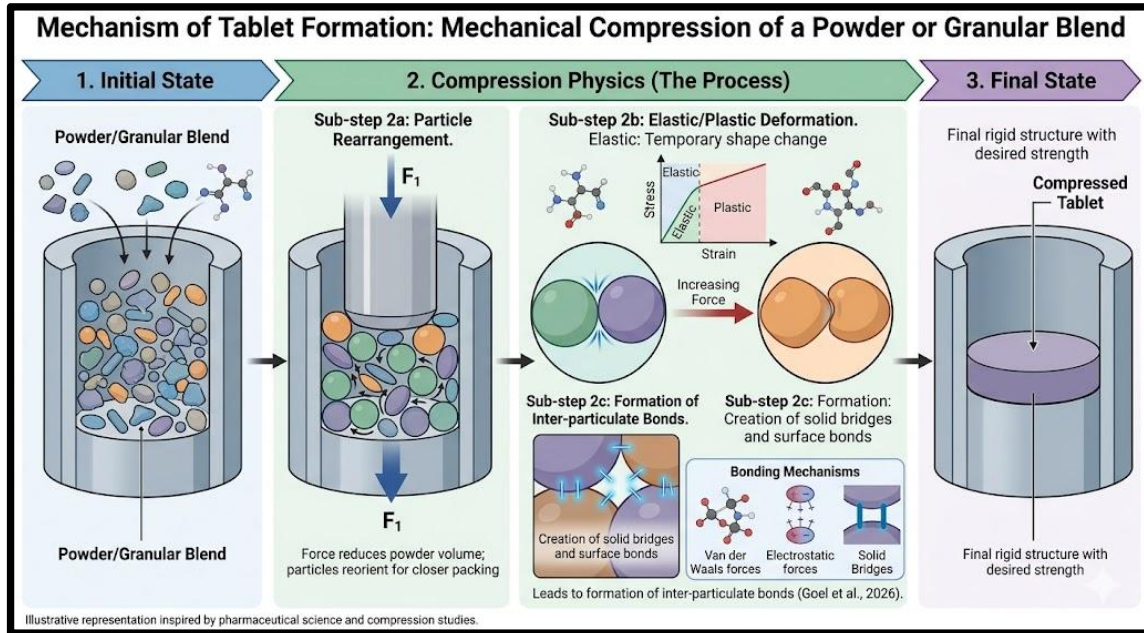


Fig.1 Mechanism Of Tablet Formation

**The Role of Excipients:**

- **Fillers/Diluents:** Add bulk (e.g., lactose, microcrystalline cellulose).
- **Binders:** Ensure cohesive strength (e.g., PVP, starch).
- **Disintegrants:** Facilitate tablet breakup in the GI tract (e.g., croscarmellose sodium).
- **Lubricants/Glidants:** Improve flow and prevent sticking (e.g., magnesium stearate) (MilliporeSigma).

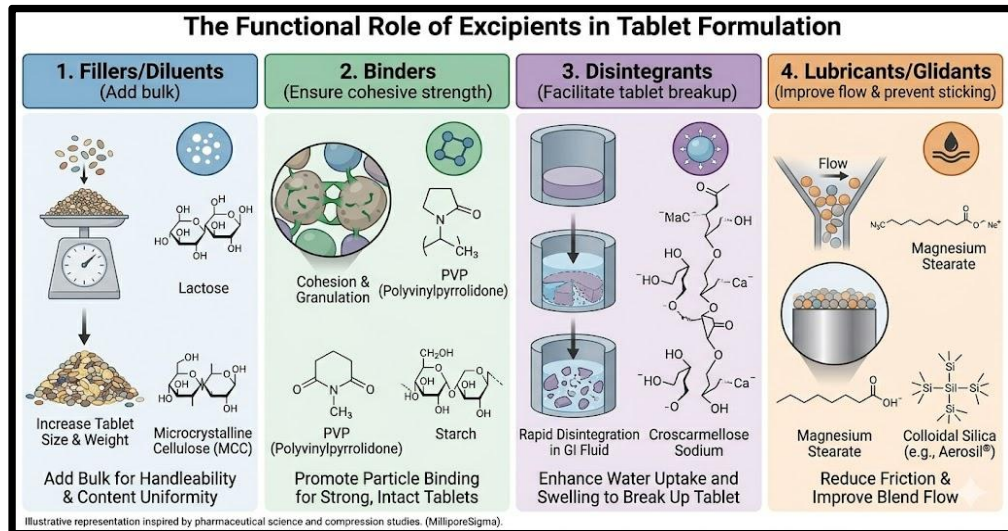


Fig.2 Role Of Excipients



### Types of Tablets

Tablets are categorized by their route of administration and release profile:

1. **Immediate Release (IR):** Designed to disintegrate and release the drug rapidly upon ingestion (Upperton Pharma Solutions).
2. **Extended/Sustained Release:** Formulated with polymers (like HPMC) to release the API at a predetermined rate (Upperton Pharma Solutions).
3. **Effervescent Tablets:** Contain organic acids and carbonates that release  $CO_2$  in water to facilitate rapid dissolution and improve palatability (IJPRA, 2026).
4. **Orodispersible/Mouth-Dissolving:** Disintegrate in the oral cavity within seconds without water (IJPRA, 2026).
5. **Enteric-Coated:** Designed to bypass the stomach and dissolve in the alkaline environment of the small intestine to protect the API or the gastric mucosa (Filo, 2026).
6. **Sublingual and Buccal:** Placed under the tongue or against the cheek for direct systemic absorption through the oral mucosa (Upperton Pharma Solutions).

### New Dosage Forms and Recent Advances

The industry is moving beyond standard compressed units toward sophisticated delivery systems:

- **3D Printed Tablets (Printlets):** Allow for complex internal structures, such as the "DuoCaplet," which can house multiple drugs with different release profiles (e.g., paracetamol and caffeine) (Goyanes et al., 2025).
- **Amorphous Solid Dispersions (ASD):** Utilized for BCS Class II and IV drugs to overcome poor solubility and enhance bioavailability (Tabletscapsules.com, 2026).
- **Nano-Enabled Tablets:** Incorporating drug nanocrystals or polymeric nanoparticles to improve the dissolution of poorly soluble molecules (IJPRA, 2026).
- **Oral Peptides:** New formulations (e.g., for GLP-1 agonists) that use specialized excipients to protect moisture-sensitive peptides, transitioning away from injections (Tabletscapsules.com, 2026).

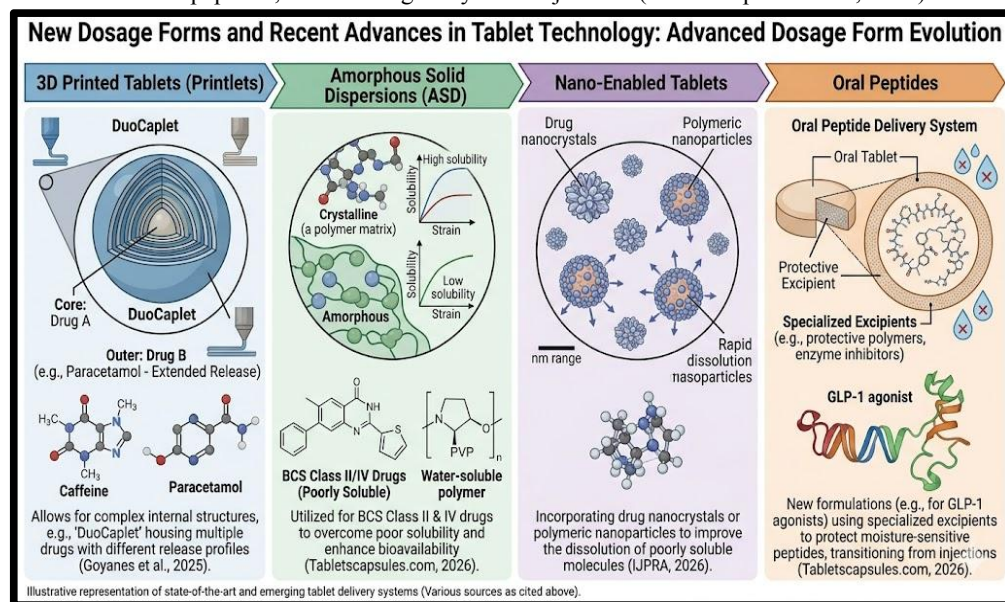


Fig.3 New Dosage Forms and Recent Advances



## Advantages And Disadvantages

### Advantages

- Precision:** Provides highly accurate dosing
- Stability:** High chemical and physical stability; long shelf life
- Cost:** Most economical form for large-scale production
- Compliance:** Easy to carry, identify, and self-administer

### Disadvantages

- Dysphagia:** Difficulty swallowing for elderly and pediatric patients
- Delayed Onset:** Must disintegrate and dissolve before absorption
- Sensitivity:** Certain APIs are sensitive to moisture or oxygen
- Bioavailability:** Limited for drugs with poor GI absorption or high first-pass metabolism

### Applications

Tablets serve various therapeutic needs across the medical spectrum:

- **Chronic Disease Management:** Sustained-release tablets for hypertension and diabetes ensure steady plasma concentrations.
- **Emergency Medicine:** Sublingual nitroglycerin for rapid onset in angina (Upperton Pharma Solutions).
- **Nutraceuticals:** Large-dose delivery of vitamins and minerals via effervescent or chewable forms (IJPRA, 2026).
- **Targeted Therapy:** Colon-specific delivery for inflammatory bowel disease (Goel et al., 2026).

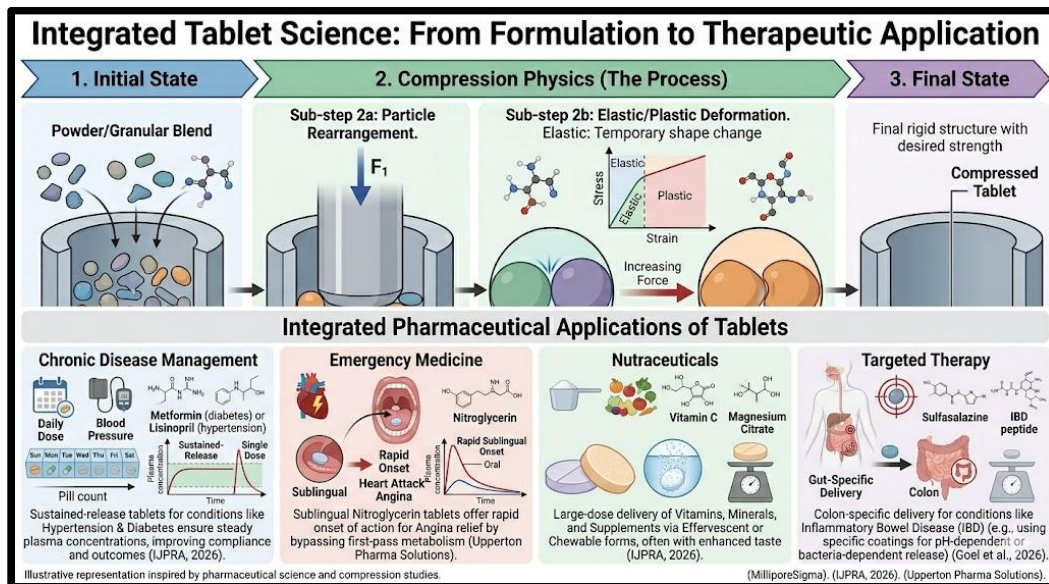


Fig.4 Applications Of Integrated tablet Science



### Future Aspects

By 2026, the tablet landscape is expected to be defined by:

- **Personalized Medicine:** Point-of-care 3D printing of tablets tailored to a patient's specific genomic profile (Pinnacle Life Science, 2026).
- **Continuous Manufacturing:** Shifting away from batch processing to real-time, automated production to reduce waste and human error (Pinnacle Life Science, 2026).
- **AI and Digital Twins:** Using virtual models of the manufacturing floor to optimize energy use and predict product quality before physical production begins (Pharma Advancement, 2026).
- **Sustainability:** Adoption of eco-friendly packaging and solvent-free manufacturing processes to comply with global environmental standards (Pinnacle Life Science, 2026).

### II. CONCLUSION

The science of tablet manufacturing has evolved from simple mechanical compression into a highly sophisticated field of pharmaceutical engineering. Modern tablet production is now characterized by:

- **Mechanical Precision:** The fundamental process remains a transition from loose powder to a solid dosage form through rearrangement, deformation, and bond formation.
- **Formulation Synergy:** Success depends on the strategic use of excipients—fillers, binders, disintegrants.

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