

UPDATES AND CHALLENGES OF TABLETS

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Abstract

The study of medicine is both a science and an art. There are no compounded pills in it. And bandages; it addresses life's fundamental processes, which must be comprehended before they may be directed. Pharmaceutical oral solid dosage forms have been utilised extensively for decades, mostly due to their ease of administration and suitability for systemic drug delivery. The tablets may be produced directly from powders, granule pellets, or multiple units covered in film. Nowadays, tablets are the most widely used dosage form, making up over 70% of all manufactured ethical pharmaceutical formulations. Tablets are solid pharmaceutical dosage forms that can be moulded or compressed and contain medicinal ingredients with or without appropriate diluents. Tablets can therefore be essentially divided into two categories: compressed tablets and moulded tablets. Directly compressible tablets, chewable tablets, and tablet triturates, among others, are further categories for compressed tablets.

Keywords: Compressor, compaction, Punches, Solid dose, Tablet, capsules, sticking, picking.

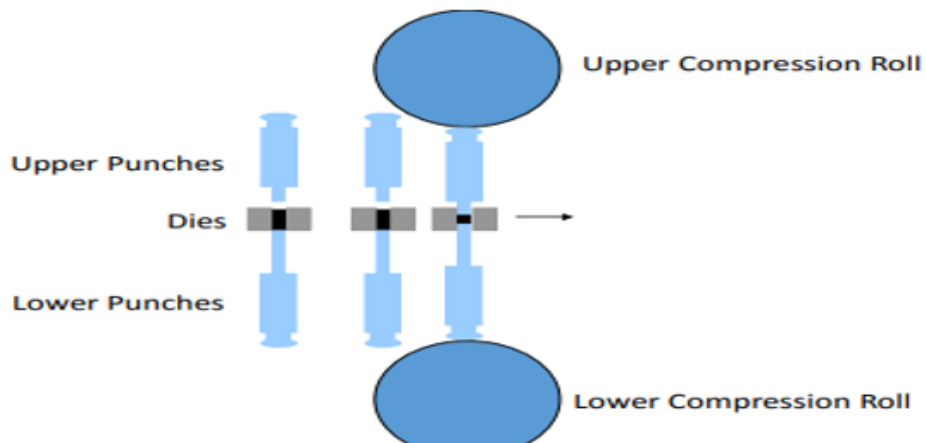
INTRODUCTION: -

A tablet (also known as pill) is a pharmaceutical oral dosage form (oral solid dosage, or OSD) or solid unit dosage form^[1]. Tablets may be defined as the solid dosage form of medicament or medicaments with suitable excipients^[2]. It comprises a mixture of active substance and excipients, usually in powder form, pressed or compacted from a powder into a solid dose^[3].

THE TABLETING PROCESS:

- A powder flows into a die (established capacity) and is compacted by 2 punches to form a densified compact.
- Densification leads the powder atoms into close contact.
- Powder atoms that cannot any more shelter the used load (force) distort (change organized).
- The consolidation of piece deformity and densification results in bond composition between the powder atoms making a dose^[4].
- The shape and capacity of the medicine is contingent upon the shape and intensity of the punches.

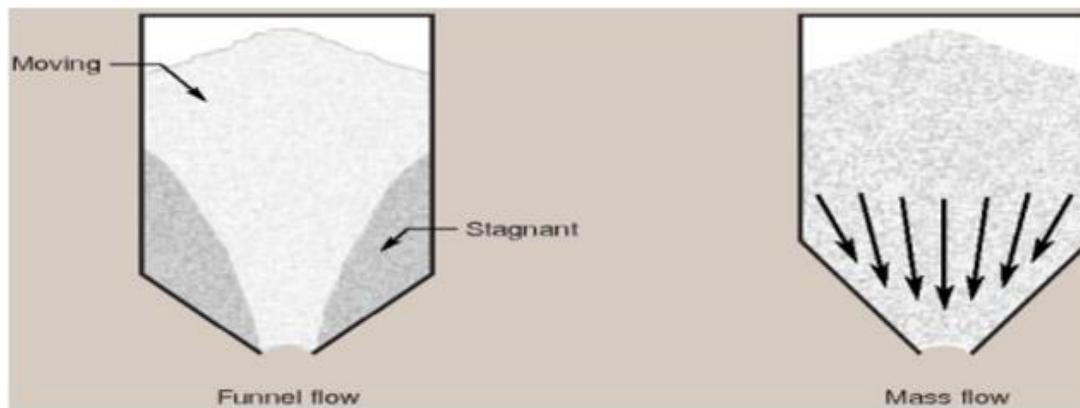
Image-1:[Tablet punching machine]



POWDER FLOW:-

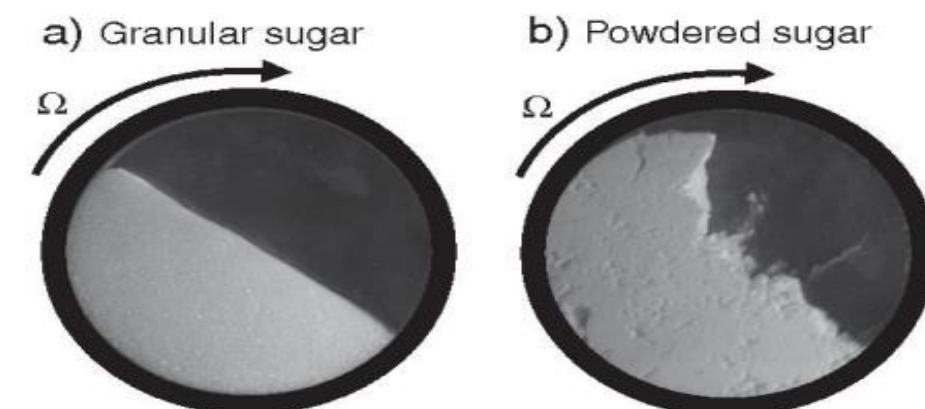
- Capsule pressure (& the dose) is conditional the amount of powder gushing into the withers
- Weak flow will lead to:
 - 1) Trouble of powder withdrawing the storage
 - 2) Tablet burden alternative

Image-2:[Rheo meter]



POWDER FLOW: -

Image-3: [Rotary machine]



- Pill magnitude is determined established the capacity of the wither
- Powder or material being tableted must flow rapidly and consistently into the expires to guarantee reproducibility of tablet or pellet weights^[6] (particularly for high-speed presses)
- The powder condescend possibility not single out surely (e.g., from the storage to the expires or on account of machine quivering.
- Determinants moving flow: particle diameter, shape, mass, surface traits (e.g., coarseness, dampness content), charge.^[7]

Powder flow: Considerations: -

• Particle size

- The larger the particle sizes the better the flow.
- Less inter-particulate surface interactions^[8].

• Particle shape

- The more spherical the particle, the better the flow. Spheres, cubes will have the best flow^[9].

• Granulation (agglomeration)-

Is a common approach to addressing powder flow issues in tableting^[10].

POWDER COMPACTION:

Considerations: -

Compression = decline in volume; pieces gain as possession from someone's death closer contact (on account of the pressure applied a piece punches)^[11].

Compaction = compression + increased mechanical strength (e.g., hardness) due to inter-particulate bonding^[12].

- Inter-particulate bonds are formed when particle is brought in close contact by compression
- Some of these bonds are broken after compression {e.g., from elastic recovery and the force experienced by the tablet upon ejection from the die (e.g., friction).

• Poor bonding between particles; too much elastic recovery; or high friction at die wall during ejection can lead to either capping; lamination, or poor tablet formation^[13].

FORMULATION-1:

EXCIPIENTS: -

Raw material	Function
API (the drug)	Therapeutic effect
Filler	Provide bulk
Binder	Hold the powder particles together
Lubricant	To facilitate tablet ejection from the die
Disintegration	To facilitate rapid drug dissolution and absorption
Glidant	Improve powder flow
Anti-adherent	Prevent sticking onto the punches
Others	e.g., wetting agents; coloring agents

FORMULATION -2:

3 KEY EXCIPIENTS: -

Issue	Solutions
Binder	Increasing binder levels may: 1) Increase tablet hardness (to a certain level) 2) Decrease the rate of drug release
Lubricant	Increasing lubricant levels may: 1) Decrease the rate of drug release 2) Decrease tablet hardness
Disintegrant	Increasing disintegrant levels tends to increase the rate of drug release

TABLET PRESS:

PROCESS VARIABLES: -

- 1) Compression Force (pressure)—Increasing the pressure increases the mechanical strength (hardness) of the tablets (and vice versa) ^[14].
 - 2) Press Speed—The faster the press speed (RPMs), the shorter the dwell time (the time the powder is under peak compression pressure) ^[15].
 - 3) Pre-compression—A smaller compression roll before the main compression roll that can provide a small amount of powder densification prior to main compression.
 - 4) Tablet Thickness
- Tablet Weight (adjustable, but fixed by the dose of API)

FORCES EXPERINCED BY:

A mechanical tool called a tablet press compresses material into tablets of consistent shape and weight. Pharmaceuticals, nutraceuticals, cleaning supplies, industrial pellets, and cosmetic goods can all be made into tablets using a Tablet press ^[16].

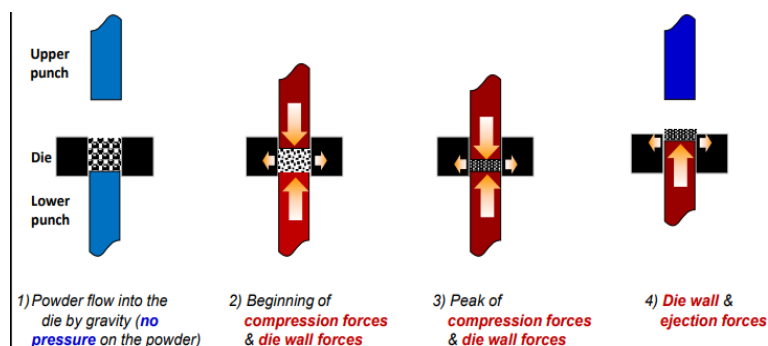
The granulated powder material must be metered into a cavity created by two punches and a die, and the material must then be fused together by applying tremendous power to the punches ^[17].

The combined pressing action of two punches and a die result in the formation of a tablet. The bottom punch is lowered into the die to create a cavity into which the granulated feedstock is introduced in the first step of a typical operation ^[18]. The amount of powder that fills the cavity can be accurately metered by controlling the lower punch's exact depth ^[19]. In order to stop spilling, the surplus is scraped off of the top of the die, and the bottom punch is drawn down and momentarily covered ^[20]. The lid is then taken off, and the upper punch is pulled down to make contact with the powder. High pressure compression rolls apply compression pressure, fusing the granulated material into a firm tablet. Following compression, the lower punch is raised to eject the tablet ^[21].

To ensure a reliable tablet compression process, tablet tooling design is essential. Pharmaceutical tablet compression tool design factors to take into account include the tooling set, head flat, top head angle, top head radius, head back angle, and punch shank ^[22]. The tablet tooling is essential for guaranteeing the size, shape, embossing, and other physical qualities of the tablet that are necessary for identification in addition to ensuring a single dose of medication ^[23].

Tablet presses come in two varieties: single-punch and rotary. The majority of high-speed tablet presses resemble spinning turrets that can accommodate any number of punches ^[24]. The punches' vertical position is controlled by cams that they come into contact with as they rotate around the turret. Punches and dies can be created in a broad range of sizes, shapes, and manufacturer codes to make tablets simpler to break ^[25]. They are often made specifically for each application. A typical modern press may manufacture between 250,000 to over 1,700,000 tablets per hour, depending on the tablet size, shape, material, and press setup ^[26].

Image-5: Tablet punching machine

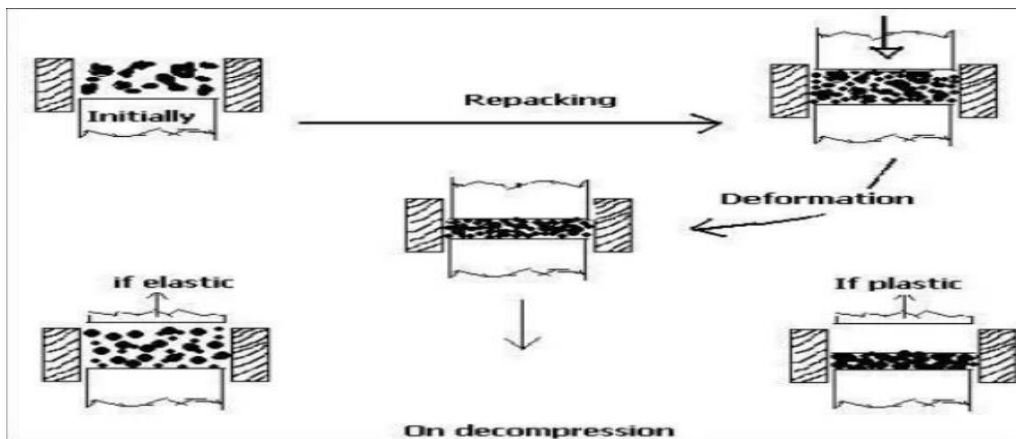


TABLET PRESS:

Ejection & Die-wall Forces: -

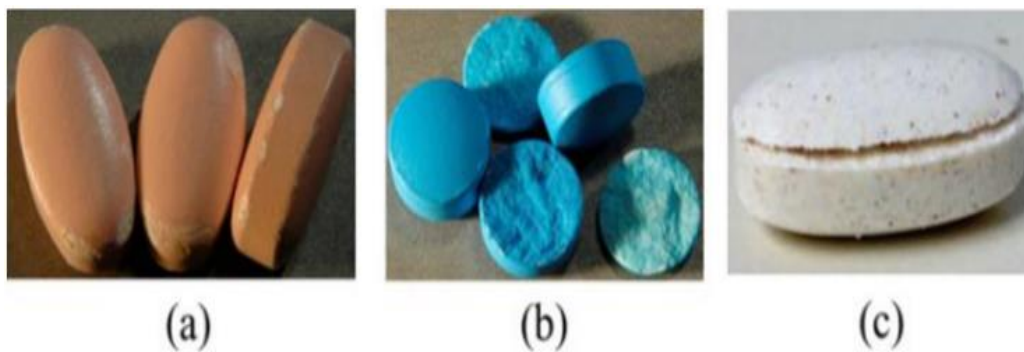
The limitation of a compressed tablet inside a die caused by the radial direction residual die wall stress is what causes the ejection force (Briscoe and Rough, 1998). Therefore, an axial force is needed to overcome the radial constraint and expel the tablet from the die^[27].

Image-6: Decompression of tablets



TABLET DEFECTS: -

Image-7: Different type of tablets & defects



Common tablet defects: (a) chipping (b) lamination, and (c) capping.

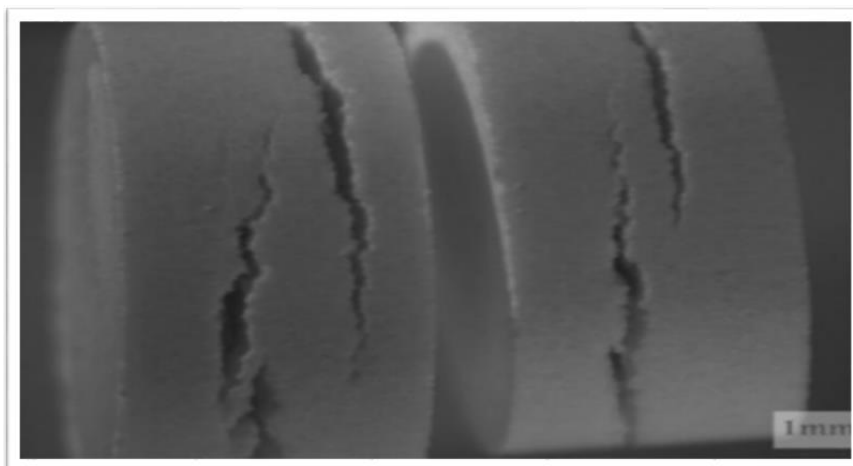
The term "mottling" refers to an uneven colour distribution on a tablet where light or dark areas stand out on an otherwise uniform surface^[28]. This particular tablet flaw shows up when a dry colouring ingredient is used in tablet formulation. Simply put, mottling is a tablet flaw that manifests as dark and bright spots on the tablet's surface^[29].

TABLET DEFECTS:

Capping & Lamination: -

List of issues with tablets Coating Capping Sticking and chipping Picking Cracking / Binding in the die Tablet edging or flashing Mottling high brittleness Weight Dispersion Changes in Hardness deterioration of tablets' hardness Long-Term Hardness (Hardness increases with time) Time of disintegration [30].

Image-8: Defected tablet



Possible Cause	Solutions
Excessive fines	Remove fines Optimize granulation
Air entrapment	Use pre-compression Reduce upper punch penetration Reduce press speed Use of tapered dies
Poor bonding	Increase dwell time Optimize granulation (binder) Do not over-dry the granules Optimize lubrication
High ejection force	Optimize lubrication

TABLET TOOLING:

Considerations: -

1. Tablet Tooling Basics:

The sort of dies and punches that will be utilised on tablet compression machines is taken into consideration when designing them. Tooling refers to the dies, punches, and configuration of these items on compression

machines; it is mostly categorised as B and D. The D tooling dies and punches can also be used on the B tooling machine, which is referred to as DB, and the B tooling dies and punches can also have additional specifications as BB and D tooling.

The two main standards are D and B. In the US, the Tableting Specification Manual (TSM) specification is followed, however in Europe, the EU, or "Euro norm" standard, is used^[31]. Although there is not much of a difference between the two specs, they are both highly different.

PUNCH: -

1. Head: The portion of the punch that rotates around the tablet machine's cam track.
2. The flat part of the skull that receives the compression force from the rollers (in upper punches) and establishes the weight and ejection height is known as the head flat (Dwell Flat) (in lower punches)^[32].
3. Outside head Angle: Prior to the head being flat during compression, the area comes into contact with the roller.
4. Inside Head Angle: This region is where the upper punches are lifted after compression and the lower punches are pulled down after ejection.
5. Neck: The space that has been relieved between the head and barrel to make room for the cams.
6. Barrel: Using turret guidelines, this region directs the punch as it moves up and down.
7. Stem: Starting at the tip and extending to the point where the barrel's full diameter starts, the portion of the punch opposite the head is referred to as the stem. Normally, the barrel's full diameter is right above the chamfer if one is present^[33].
8. Suggestion: This establishes size, form, and profile.
9. The tip face of the punch is where the tablet is created. To get quality tablets, a good surface finish is necessary.
10. Working length: The working length is the measurement between the bottom of the cup and the head flat that establishes the weight and thickness of the tablet^[34].
11. Overall length: The distance from the top of the cup to the flat of the head.
12. Key Angle: The angle at which the punch key is in reference to the tablet's form. The tablet's design, take-off angle, and turret rotation all have an impact on where the keys are located^[35].
13. Domed Heads: These increase dwell time, which helps to produce tablets with better hardness.
14. Dwell time is the amount of time punches spend rotating in the machine below the pressure roller.
15. Die bore diameter minus punch tip diameter equals clearance.
16. Difficulty: Typically measured in HRC (Rockwell 'C' scale), with the following ideal readings.

TABLET DEFECTS:

Picking: -

When a piece of the tablet sticks to the punch surface and begins to erode away from the tablet surface, picking occurs. It is a more precise name for product clinging inside the characters, logos, or patterns on the punch faces^[36]. Granules that have not properly dried are compressed. Utilization of scratched punches while compressing tablets^[37].

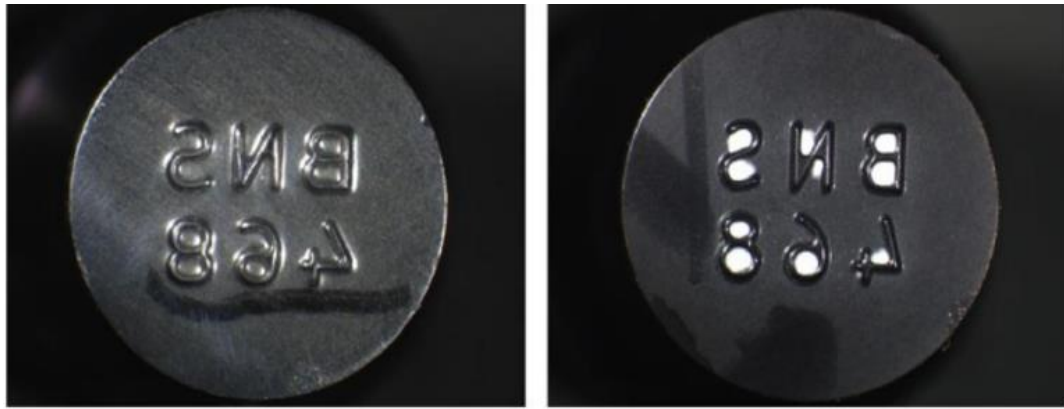


Figure 2. Picking in a tablet logo.

Tablet Defects:

Sticking: -

Sticking is a flaw in which a piece of the tablet's surface sticks to the punch or the die wall as the tablet is being compressed^[38]. Picking The opposite of sticking is picking. The generated tablet has an eroded surface when a portion of the tablet surface sticks to a punch or die wall^[39].

Tablet Defects:

Picking and Sticking: -The sticking problem happens when a formulation's granules stick to the press punch's face. On the other side, picking occurs when the grains adhere to the design that is engraved into the punch tip, such as writing or a logo^[40]. Tablets with flaws are the result of both sticking and selecting. A visual inspection, which is typically done as part of quality control, might spot sticking and picking. However, visual examination takes time and might reduce yield production; nevertheless, many producers are left with little choice^[41]. The operator must modify the press to conform to the product's characteristic characteristics as the batch enters the compression stage^[42]. The tablet press's configuration, operation, tooling, and maintenance can all have an impact on the final product's quality^[43]. The granules occasionally aren't completely dry. In other words, they could have a hard, dry exterior while being moist or wet on the inside. Due to the poorly dried particles' potential to split open during compression and adhere to the punch press surfaces, this can have a significant impact on the tablet's quality. It's crucial to assess the granule drying procedure if this occurs^[44].

TABLET EVALUATION AND CHARACTERIZATION

On the basis of internal (non-pharmacopeial), pharmacopeial standards such as BP, USP, Ph. Eur., Ph. Int., JP, IP, ChP, or other guidelines such as ICH, etc., quality control tests of tablets or evaluation of tablets are systematic assessments of the physical, chemical, mechanical, biological, or microbiological properties of tablets^[46].

SUMMARY:

- 1) Improve the powder flow, compatibility, and formulation composition (raw ingredients and their amounts).
- 2) Enhance tablet press parameters.
- 3) Choosing the right tablet tooling

- 4) Ensure that the tablet press and tooling are maintained properly (change in tooling can result in variability of tablets within a given batch) ^[47].
- 5) Manage humidity.

ADVANTAGES OF TABLETS: -

- The main benefit of the tablet is that, with the exception of situations where preparation or administration are challenging, all medications are available as tablets ^[48].
- When a partial dose of a medication is needed, it is simple to cut or smash the medication into smaller pieces, which is not possible with capsules ^[49].
- No dosage calculation is necessary.
- The tablets are stylish and practical to use.
- They can be beautiful by using various colours on them ^[50].
- The tablets are less expensive than other dosage forms and are practical for production, packaging, handling, shipping, and storage ^[51].
- Tablets often have a low cost per dose due to their simple production method.
- By combining several medications in varying amounts into a single tablet, it is possible to reduce the need for multiple pills ^[52].
- The patient receives a certain dosage of medication from the pill.
- To hide the flavour and smell of bitter medications and components, it might be covered with sweetening substances ^[53].
- There are many different tablet types, including variations in colour, size, form, and dosage.
- The formulation of the tablet can either be for controlled or quick medication release.
- The tablet is more stable than other dose forms since it gives the medication a longer period of stability ^[54].

DISADVANTAGES OF TABLETS: -

- The quality of the tablet can be harmed by atmospheric factors like light, wind, etc.; therefore, it needs to be sealed to be protected.
- Due to the incompatibility of the pharmaceuticals, it is impossible to produce a tablet with a combination of multiple medications; however, granules can be created in a capsule ^[55].
- Due to their low density or amorphous nature, several medications resist compression in a dense compact, making the preparation of this type of tablet challenging ^[56].
- These API are difficult to synthesise and manufacture into tablets because they have poor wetting and sluggish dissolving characteristics ^[57].
- It must be coated with sweetening compounds in order to hide the taste and smell of bitter medications and components, which raises production costs ^[58].
- Children and the elderly should not take the tablets since they find it difficult to do so.
- Patients who have diarrhoea and vomiting should not use it ^[59].
- When taken as tablets, several prescription medications induce stomach ache ^[60].

CONCLUSION

As a solid dosage form, tablets are popular among patients and practitioners alike as they provide a means of self-administration. The formulation of a tablet contains, in addition to the API, various substances to assure proper delivery of the API to the patient. With advancement in technology and increase in awareness towards modification in standard tablet to achieve better acceptability as well as bioavailability, newer and more efficient tablet dosage forms are being developed. The main reasons behind formulation of different types of

tablets are to create a delivery system that is relatively simple and inexpensive to manufacture. Provide the dosage form that is convenient from patient's perspective and utilize an approach that is unlikely to add complexity during regulatory approval process. To understand each dosage form, tablets here are classified by their route of administration and by the type of drug delivery system they represent within that route.

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