ABSTRACT
The number of products based on new drug delivery systems has significantly increased in the past few years, and this growth is expected to continue in the near future. Tablet dosage form is most convenient and relevant dosage form. Innovation in tablet dosage form can be made to provide product of higher “selectivity” for the drug for medical treatment. At present, there are so many existing drug delivery technologies that a total compilation is not within the scope of this article. Yet an attempt is being made to compile some of the most successfully marketed drug delivery technologies. The present review focuses on innovation in tablet system. Various systems like OSDrC concept, Accu-break technology, DiffCORE technology, GEOMATRIX technology, Tab in Tab technology are summarized in this article. Evolution of an existing drug molecule from a conventional form into said technology can significantly improve its performance in terms of patient compliance, safety, and efficacy.

KEYWORDS: OSDrC concept, Accu-break technology, DiffCORE technology, GEOMATRIX technology, Tab in Tab technology.

INTRODUCTION [1, 2, 3, 13, 26, 28]
Tablet is defined as a compressed solid dosage form containing medicaments with or without excipients. It comprises a mixture of active substances and excipients, usually in powder form, pressed or compacted from a powder into a solid dose. The excipients can include diluents, binders or granulating agents, glidants (flow aids) and lubricants to ensure efficient tableting; disintegrants to promote tablet break-up in the digestive tract; sweeteners or flavours to enhance taste; and pigments to make the tablets visually attractive. A polymer
coating is often applied to make the tablet smoother and easier to swallow, to control the release rate of the active ingredient, to make it more resistant to the environment (extending its shelf life), or to enhance the tablet's appearance.

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.

They vary in shape and differ greatly in size and weight, depending on amount of medicinal substances and the intended mode of administration. It is the most popular dosage form and 70% of the total medicines are dispensed in the form of Tablet. All medicaments are available in the Tablet form except where it is difficult to formulate or administer.

**The advantages of the Tablet dosage form**
- They are unit dosage form and offer the greatest capabilities of all oral dosage form for the greatest dose precision and the least content variability.
- Cost is lowest of all oral dosage form.
- Lighter and compact.
- Easiest and cheapest to package and strip.
- Easy to swallowing with least tendency for hang-up.
- Sustained release product is possible by enteric coating.
- Objectionable odour and bitter taste can be masked by coating technique.
- Suitable for large scale production.
- Greatest chemical and microbial stability over all oral dosage form.
- Product identification is easy and rapid requiring no additional steps when employing an embossed and/or monogrammed punch face.

**Disadvantages of Tablet dosage form**
- Difficult to swallow in case of children and unconscious patients.
- Some drugs resist compression into dense compacts, owing to amorphous nature, low density character.
Drugs with poor wetting, slow dissolution properties, optimum absorption high in GIT may be difficult to formulate or manufacture as a tablet that will still provide adequate or full drug bioavailability.

Bitter testing drugs, drugs with an objectionable odor or drugs that are sensitive to oxygen may require encapsulation or coating. In such cases, capsule may offer the best and lowest cost.

In this review we will discuss about advanced tableting techniques used by pharmaceutical industry.

List of some Tableting techniques currently used by Pharma companies
1. OSDrC Tablet Concept (One step dry compression coating )
2. Accu-break Technology for Controlled release Tablets
3. DiffCORE Technology For modified Release Tablets
4. The GEOMATRIX technology
5. Tab in Tab Technology.

1. OSDRC TABLET CONCEPT (ONE STEP DRY COATED)\textsuperscript{[4,15,26,28]}

Pharmaceutical coatings are an essential tool to achieve the desired formulation of pharmaceutical dosage forms. Coatings are applied to achieve superior aesthetic property of a dosage form (e.g. color, texture, mouth feel and taste masking), physical and chemical protection for the drugs in cores, and modified drug release characteristics. Coating techniques mostly used in pharmaceutical industry are aqueous or organic coating, which present some disadvantages: time consuming, stability for heat labile and hydrolysis of degradable drug and polluted environment problem. Thereby, non-solvent coating is introduced as alternative coating technique to overcome these disadvantages. Non-solvent coatings have been categorized as press coating, hot melt coating, supercritical fluid spray coating, electrostatic coating, dry powder coating and photocurable coating (Bose and Bogner, 2007). Among these techniques, compression coating is the absolute dry coating without solvent and heat use. Additonally, compression coating has no limitation for the cores and hence overcomes the adhesion problem found in spraying methods. Tablets with cylinder or special shapes can be press-coated.

Process flow for OSDrC
Three individual hoppers containing bulk powders\textbullet Excess powder is removed between each layer.
First two layers receive a light compression. Thieving mechanisms at each stage to continuously monitor process. The core and coat were prepared in the schematic sequence of the OSDRC process (Fig. 1). First, the lower-outer layer was formed by pre-compression from the upper-center punch. Then, the lower-center punch was slid down and the upper-center punch was moved up. The powder for the core was filled and pre-compressed by the upper-center punch. Finally, the lower-outer punch was slid downward and the powder for the 2nd outer layer was filled and compressed by the upper and lower punches in which the center punches are unified with the outer punches. This system can be assembled onto the turn table of a rotary tableting machine and can make a dry-coated tablet in a single turn. By using the OSDRC-system, compression-coated tablets with a side outer coat thickness of 1 or 0.5 mm can prepared (Ozeki et al., 2004).

Figure 1: Process flow for OSDrC

Figure 2: Basic cross-sectional view of an OSDrC tablets
Advantages of Osdrc Tablets

A) Supports single-step manufacturing of pharmaceutical products
   a. Ultimate one-step compression system Permits commercial scale production of conventional cored tablets
   b. Requires no separate core preparation or supply
   c. Permits production of a broad spectrum of high-quality formulations at low cost
   d. Potential replacement for sugar- or film-coated tablets.

B) Accurate & Flexible Control Technology
   a. Allows accurate and flexible central positioning of cores in surrounding coat
   b. Allows positioning of any number of cores
   c. Allows positioning in various configurations
   d. Permits release control by varying either the positioning of core or thickness of coating
   e. Permits commercial-scale production of cored tablets without misaligned cores.

C) Poor-Compressibility Encasing Technology
   a. Allows incorporation of core ingredients with poor Compressibility.
   b. Allows incorporation of pharmacological agents with poor Compressibility (e.g. pure API with a flow aid).
   c. Incorporation of pellets in the core permits use as a replacement for capsules.
   d. Permits development of oral rapid disintegration tablets (ODT) and various other innovative formulations.

D) Simplified manufacturing process

E) No solvents required

F) Low manufacturing cost

G) Simplified process control

2.0 Accu-Break Technology For Controlled Release Tablets\textsuperscript{[6,7,8,28]}

Accu-Break Pharmaceuticals, Inc. (ABP) is on a mission to develop innovative pharmaceutical tablet technologies to fulfill the unmet medical need for accurate, customizable solid oral dosing. The idea behind Accu-Break Technologies is simple: to create tablets that can be swallowed whole or, if desired, easily subdivided by hand into exact smaller doses. The unprecedented functionality enables patients and caregivers to safely split tablets, including controlled release tablets, to achieve inbetween or lower than marketed
doses—an important feature for medications that frequently undergo titration and/or dose adjustment.

Like the idea, the technology is simple. The company has rearranged the inactive ingredients to create a multilayer tablet that contains both a drug-free layer, and an active drug layer(s). The drug-free layer, comprised of excipients, serves as a break region, and partial doses are obtained by splitting the tablet through this layer. The tablet structure enables risk-free tablet splitting, avoiding inaccurate doses, loss of mass, and product waste. The technologies can be applied to immediate release (IR) and controlled release (CR) formulations, as well as combinations of medications and different formulations. This has important implications for CR medications, as most current CR dosage forms are available as either capsules or unscored tablets that are unsuitable for splitting due to potential changes in the release kinetics when the dosage form is modified.

**Process of manufacturing of Accu-break Technology**

From a technical perspective, implementing this technology is simple. Accu-Break tablets are manufactured on commercially available multilayer compression equipment, making it low cost and low risk.

**Figure 3: Accu-Break Technology combines two layers within the tablet: an active layer containing the drug and a drug-free layer. The active layer is pre-divided into smaller doses and scored such that the break occurs through the drug-free layer.**

**Advantages of Accu-break Technology**

a. Physicians and patients have the convenience of multiple prescriptions in one and the flexibility of dose-adjustable tablets with 100% accuracy.

b. Tablets are easily split into exact smaller doses, minimizing wasted tablets.
c. Caregivers and patients can adjust the dose with confidence that they are obtaining the intended dose, rather than an unpredictable one.

3.0 DiffCORE TECHNOLOGY FOR MODIFIED RELEASE TABLETS \[9,10,28\]
DiffCORE technology used to develop a once-a-day modified release combination product. The DiffCORE technology controls drug release from a tablet core through apertures in a functional barrier coating.

The extended release formula is based on GSK’s DiffCORE™ technology. This consists of a modified release eroding core, coated with an enteric coat that has two apertures drilled through it on either side of the tablet face. The combination of apertures and core allow drug release to start in the stomach and continue at a sustained rate over a period of approximately 12-15 hours. This release profile enables the serum levels of lamotrigine to increase gradually, and takes advantage of the fact that regional permeability studies have shown that this drug is readily absorbed anywhere between the stomach and the ascending colon. Inactive ingredients include hypromellose and methacrylic acid copolymer dispersion.

![Image of Lamictal XR tablet manufactured with DiffCORE technology](image)

**Figure 4: Image of Lamictal XR tablet manufactured with DiffCORE technology**

**Process of manufacturing of DiffCORE Technology**
Manufacturing process is same till coating of tablets followed by drilling of DiffCORE apertures using proprietary drilling equipment.

**Advantages of DiffCORE Technology**

a. This formulation technology enables rapid development of unique drug delivery profiles with low variability.

b. This formulation can deliver the drug constantly at zero order release rate throughout the GIT with irrespective to any biological factor.

This technology is also can be used to formulate controlled release formulation.
4.0. THE GEOMATRIX TECHNOLOGY [11,12,28]

When a traditional matrix tablet formulation is immersed in the dissolution medium or in biological fluids, solvent penetrates into the dosage form. Before the polymer(s) begin to swell and control the release rate of the drug, a significant portion of the drug, located close to the surface, can dissolve leading to what is known as the burst effect.

Then, the polymer swells and gels, limiting more and more strongly the drug release rate, providing an overall release profile which is proportional to the square root of the time.

In the GEOMATRIX® concept, the surface available for drug release is limited by placebo support platforms (non drug containing excipients) which are almost impermeable at t0 and therefore, sudden and rapid release of the drug cannot occur (no burst effect). Later on, the decrease of release rate from the active layer is compensated by diffusion through the support platform. The final profile obtained is close to a zero order one (see Figure 5).

![Diagram of Matrix and Geomatrix tablets](image)

**Figure 5: Comparison of monolithic and Geomatrix tablets for drug controlled release.**

**Process of manufacturing of GEOMATRIX® Tablet**

Compression of tablet by using Geomatrix technology is done by using trilayer compression machine.

**Advantage of GEOMATRIX® Tablet**

a. **Dual control release**

Various layer arrangements available (bi, trilayer, one, two, three, four faces coated tablets) allow many different release kinetics. Furthermore, drugs can be combined with other active substances to improve effectiveness and be released at different rates.
b. Robust formulation and manufacturing process
Robust formulation GEOMATRIX® tablets formulation was proven to yield In Vitro Profiles independent of pH variations and paddle speed.

c. Proven ease of manufacturing
Manufacturing processes and equipment used are based on well-known tablet technology expertise and scale up from prototype batches to full scale production gives reliable and repeatable In Vitro Release.

d. In vivo reproducibility
Pharmacokinetic studies showed a good reproducibility even when two active grades were compared.

e. Reduced food effect on drug release
Limited exposure of the drug to biological fluids reduces impact of meal on drug bioavailability.

f. Remove initial burst effect

5.0 TABLET IN TABLET TECHNOLOGY [4,13,14,28]
Generally to prepare tablet in tablet formulation two type techniques are used.
A. Tab in Tab Techniques
B. Inlay Tablets Techniques

A. Tab in Tab
This type of tablet has two parts, internal core and surrounding coat. In this type of tablet internal core is completely surrounded by external core.

As shown in fig 6 it will look like a single tablet from outer side but it contain another tablet inside the tablet.

![Figure 6: Tab in Tab](image-url)
Manufacturing Process Tab in Tab Technology

This type of tablet has two parts, internal core and surrounding coat. The core is small porous tablet and prepared on one turret. For preparing final tablet, a bigger die cavity in another turret is used in which first the coat material is filled to half and then core tablet is mechanically transferred, again the remaining space is filled with coat material and finally compression force is applied. This tablet readily lend itself in to a repeat action tablet as the outer layer provides the initial dose while the inner core release the drug later on.(Fig 7) But, when the core quickly releases the drug, entirely different blood level is achieved with the risk of over dose toxicity. To avoid immediate release of both the layers, the core tablet is coated with enteric polymer so that it will not release the drug in stomach while, the first dose is added in outer sugar coating. Even so, coating operation requires interpretation while manufacturing and dawdling the manufacturing process. Sometimes, inner core may be of liquid formulation to provide immediate release of core after the coat gets dissolved.

![Diagram of Tablet in Tablet Process]

**Figure 7: Manufacturing step process of tab in tab**

B. Inlay Tablets

It is a type of layered tablet in which instead the core tablet being completely surrounded by coating, top surface is completely exposed.

This type of tablet will look like a singly tablet from a side only, Internal tablet is not visible from both side of tablet but it is clearly visible from top or bottom surface of the final tablets. (Figure 8).

![Diagram of Inlay Tablets]

**Figure 8: Inlay Tablets**
Manufacturing process Inlay Tablets

It is a type of layered tablet in which instead the core tablet being completely surrounded by coating, top surface is completely exposed. While preparation, only the bottom of the die cavity is filled with coating material and core is placed upon it. When compression force is applied, some coating material is displaced to form the sides and compress the whole tablet.

Advantages of Tablet in Tablet over Layered Tablets

a. We can formulate a single tablet for the combination in which we required immediate & delayed drug release pattern both.

b. We can avoid contact between two incompatible drug molecules completely.

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