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REVIEW ARTICLE **OPEN ACCESS**

A Concise review on Multiple Unit Pellet System (MUPS)

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ABSTRACT
Multiparticulate drug delivery systems primarily manifest as oral dosage forms, comprising tiny isolated units demonstrating distinct features, particularly in terms of release patterns as well as the bioavailability of drugs. Granules, pellets, microsphere, microcapsule, and minitablets are examples of these systems. Among these, pellets provide great design freedom for formulating, and developing various oral dosage forms like sachets, suspensions, capsules, and tablets. The creation of multiparticulate tablets through the compaction of multiple unit pellets represents a cutting-edge, yet challenging technology. These multiparticulate tablets combine the merits of traditional tablet and pellets-fill with capsules into a single medication, even though their manufacturing entails several complexities. Oral multiparticulate products comprise subunits or pellets coated with polymers, embedded within an inert matrix of excipients. They are designed to address challenges associated with administering capsules, enhance the chemical and physical stability of suspensions, provide consistent discharge patterns and even distribution within the gastrointestinal tract, contrasting with regular tablets. This review outlines the attributes of a perfect MUPS, explores diverse MUPS therapeutic uses, discusses hurdles and critical factors must be taken into account during tablet manufacturing procedure to ensure effective MUPS manufacturing.
Keywords : *MUPS, Dosage forms, Pellets, Core, Polymer coating*.

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INTRODUCTION

Multiple Unit Pellet Systems (MUPs refers to a class of drug delivery systems consisting of multiple discrete units or pellets that contain the active pharmaceutical ingredient (API) or drug. These units are usually small in size and are designed to be administered orally. MUPs have various merits over unit dosage forms, as they improved drug release profiles, reduced risk of dose dumping, and enhanced patient compliance [1].

Multiple Unit Pellet Systems (MUPs) offer significant advantages in pharmaceutical and other industries:

I. **Controlled Drug Release:** Enables precise and sustained drug release for optimal therapeutic effects with minimized side effects.
II. **Enhanced Bioavailability:** Improves drug dissolution and absorption, maximizing the efficacy of poorly soluble drugs.
III. **Versatile Dosing:** Allows incorporation of different drugs or doses into a single dosage form, suitable for fixed-dose combinations and personalized medicine.
IV. **Taste Masking:** Masks the unpleasant taste of drugs, enhancing patient acceptability, particularly for vulnerable populations.
V. **Reduced Variability:** Minimizes variability in drug release, ensuring consistent drug performance and predictable therapeutic effects.
VI. **Improved Patient Adherence:** Easy administration and less frequent dosing enhance patient compliance with medication regimens.
VII. **Formulation Versatility:** Can be formulated into various dosage forms, adaptable for diverse drug delivery routes.
VIII. **Extended Stability:** Unit-based nature leads to improved stability, extending the shelf life of medications [2].

When compared to traditional or immediate-release dosage forms, modified-release dosage forms (MRDF) have demonstrated to be more effective treatment choices. The primary objective of Modified-Release Drug Formulations (MRDF) for oral administration regulate drug release, minimizing adverse effects from high peak concentrations while maintaining therapeutic levels for longer [3].MRDF maintains stable plasma levels, leading to predictable responses, reduced side effects, and potentially better cost-effectiveness [4]. Two forms exist: single-unit (one tablet/capsule) and multiple-unit (discrete particles in one unit). Multiple-unit systems offer advantages like better distribution, improved bioavailability, reduced toxicity, and flexibility for dosage adjustments and drug combinations. Overall, MRDF, especially multiple-unit systems, is increasingly favored for new drugs due to enhanced therapeutic outcomes and cost-effectiveness [5,6]. The manufacturing process of numerous unit dosage forms, invented in the 1950s, comprises pellets, granules, micro-particles, mini-tablets, and mini-depots, offering variable release characteristics. "MUPS" stands for Multiple-Unit Pellets System, referring to pellets compacted into tablets [7]. Pellets are agglomerates of drug and inert excipients, providing controlled-release properties. The pellet synthesis involves agglomeration and coating for modified release dosage forms. Compressing coated pellets into multiparticulate tablets poses challenges due to potential coating fractures and drug degradation [8]. Optimizing formulation variables and processing factors is crucial to achieve successful compaction with minimal defects to the polymer coat or pellets. The review focuses on techniques, formulations, and rationale for using multi-particles in solid dosage forms [9].

The primary objectives of developing a multiparticulate final dosage form are achieving an optimal dissolution profile, targeted release sites, and taste masking [10]. Multiparticulate formulations offer advantages such as precise control over drug release, reduced variability, targeted delivery, fixed-dose combinations, timed release of multiple APIs, dosage adjustment through pellet count, and catering to pediatric and geriatric populations [11]. Figure 1 Shows examples of MUPs dosage form that include coated starting pellets in oral suspensions., sachet, tablets and capsule with multiple-unit pellets.

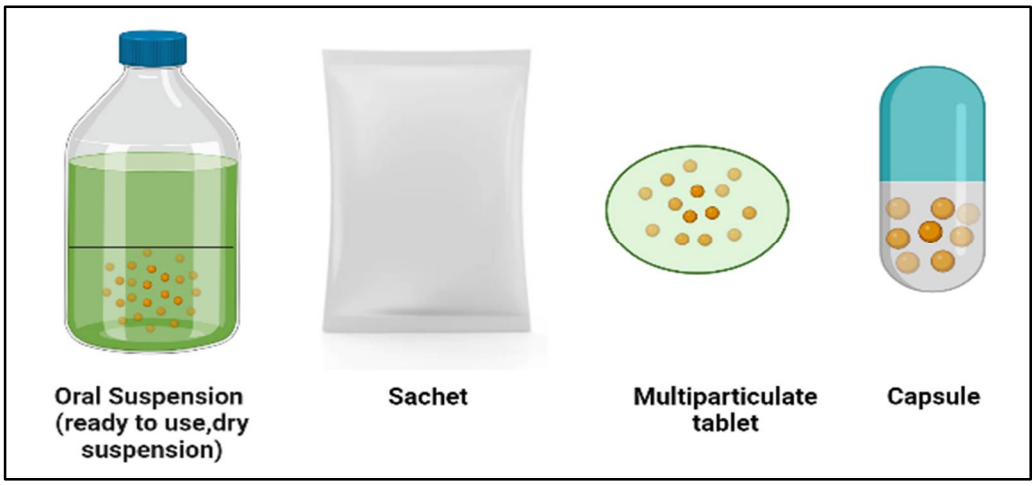

Figure 1: Pellets flexibility in creating diverse dosage forms.

Pellets utilized as solid forms of medication

MUPS are medicinal formulations comprising numerous small discrete units like granules, beads, pellets, microspheres, mini-tablets, and microcapsules. Each form offers specific advantages based on formulation processes, allowing flexibility in designing drug delivery systems. Although having technologically challenging, and pricey to make, pellet dosage forms are mostly used due to their sophisticated drug delivery system with superior benefits compared to single unit dosage forms[12]. Pellets are small powdery aggregates or granule of the active pharmaceutical ingredients and excipients, formed through pelletization techniques to spheres or pellets that can be coated with modified-release medication. This process enhances flowability, mixing properties, and improves the physical and chemical properties of the powder. Pellets can be easily incorporated into various oral dose types as depicted in figure 1, including sachets, liquid suspensions, gelatin (hard shell) capsules, or disintegrating tablets that rapidly release their pellet substance in the stomach[13]. Pellets play a crucial role in producing oral controlled-release dosage forms with specific release patterns, such as delayed release, sustained release, gastro-resistant, or targeted drug delivery. Various modifications can be applied to the pellets, including using different polymer coatings or forming matrix pellets, to achieve the desired release characteristics while also enhancing physical characteristics, chemical stability, and patient acceptability [14].

Formulation and Growth Mechanism of Pellets

To enhance any pelletization technique, it is crucial to comprehend the fundamental tools involved in pellet creation and development. Several key processes contribute to the enlargement and growth of pellets, namely nucleation, coalescence, stacking, abrasion transfer, and size reduction. During nucleation, the powder, consisting of the active pharmaceutical ingredient (API) and an appropriate polymer, is moistened using a suitable solvent system. Coalescence takes place when two well-formed nuclear entities collide, resulting in the formation of a larger particle. Layering involves adding materials sequentially to existing nuclei. Abrasion transfer refers to the transfer of materials from one particle to another, disregarding the direction of transfer. However, the attrition mechanism can cause well-formed particles to decrease in size [15].

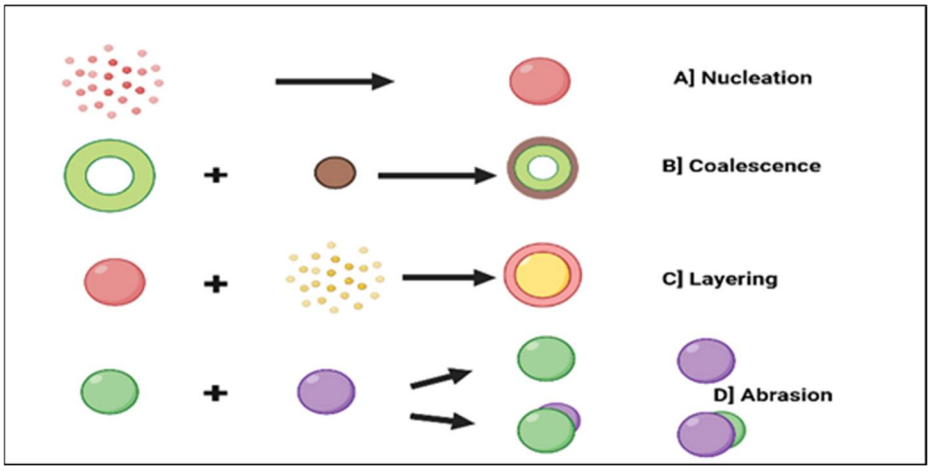

Figure 2: Growth mechanism of pellets

Pellets formation techniques

- **Agitation:** Pellet formation through agitation involves the mechanical movement of solid particles in a liquid medium, leading to the agglomeration of particles. This method is also known as agglomeration or wet granulation.
- **Compaction:** Pellet compaction involves the compression of powder particles into pellets using mechanical force.
- **Layering:** Pellet layering involves building layers of coating material around a core particle. This technique is widely used for controlled-release formulations.
- **Globulization,** also known as spheronization, is a process that involves the formation of spherical pellets from a powder mixture [16].

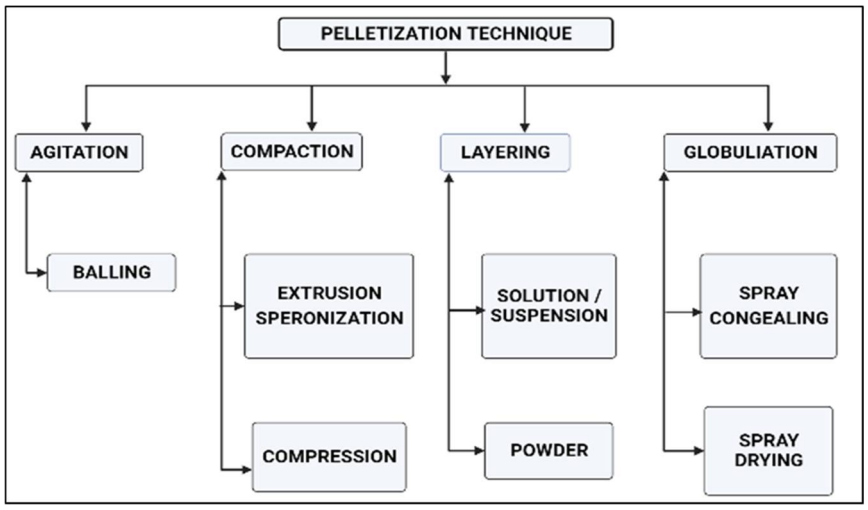

Figure 3: Techniques of pelletization

Characteristics of pellets

Pellets exhibit a consistent a smooth surface and a spherical form, displaying favorable flow characteristics. They have a small size range of 0.5mm to 1.5mm and sufficient physical strength and structural integrity.

These pellets have an acceptable amount of hardness and are not easily broken, making them ideal for efficient coating and avoiding separation during procedures such as capsule filling and tablet compression. The high bulk density of the pellets is critical in guaranteeing constant content and weight distribution. When it comes to coated pellets, they exhibit a uniform and aesthetically pleasing coating thickness, enabling them to achieve the desired drug release characteristics. In essence, achieving such characteristics would define these pellets as being of superior quality [17].

Pharmaceutical rational of pellets

Pellets are a flexible medication delivery medium that allows for a variety of release patterns through various preparation methods. These methods offer sophisticated drug delivery systems that outperform single-unit formulations, providing substantial flexibility in designing and developing oral dosage forms.

Therapeutic Benefits: The administration of multiple-unit pellet dosage forms orally allows for their widespread distribution throughout the gastrointestinal tract (G.I.T), creating greater surface area that facilitates absorption of drug. Because of the modest drug concentration per pellet, this method maximises medication absorption while minimising irritation to the G.I.T. lining, lowering the danger of dosage dumping. As a result, these pellets enhance the safety, efficacy, and bioavailability of medications, leading to improved patient compliance [18].

Formulation Advantages: Pellets offer formulation flexibility for various oral dosage forms like tablets, capsules, sachets, and suspensions. This flexibility arises from the capacity to design APIs into pharmaceutical formulations with desired release characteristics, providing superior benefits compared to single-unit forms of the same drug. Without changing the formulation process, such dosage forms may be separated into the desired dose strength. Furthermore, they can be coupled to deliver numerous bioactive compounds with different release characteristics in the G.I.T. at the same time. Pellets are especially well-suited for the production of preparations containing acid-sensitive medications, such as proton pump inhibitors, as well as disguising the flavour of unpleasant-tasting pharmaceuticals [19].

Benefits of Technology: Pelletization processes such as layering and extrusion-spheronization provide accurate and homogeneous medication loading onto the pellets. Enhanced flow qualities are beneficial for automated procedures that need precise dosage, such as tablet manufacture, capsule filling, and packing. Minimal dust generation improves production safety. Pellets containing incompatible medications can be manufactured separately and then combined, or pellets containing the same drug but with different release mechanisms can be blended to create novel modified-release formulations [20,21].

Types of MUPS Formulations

In a broad sense, MUPS (Multiple Unit Pellet System) formulations can be divided into two main categories, as depicted in the accompanying figure 4:

I. MUPS involving coated pellets (as shown in Figure 4 {A}): This type of MUPS utilizes polymer coated pellets materials through various pelletization methods to get specific des release profiles. These pellets coated with polymer can then be compressed into multiparticulate tablets, either on their own or along with non-reactive additives.

II. MUPS based on matrix pellets (as depicted in Figure 4): Matrix pellets are particles that originally include excipients that inhibit drug release by integrating them inside the matrix structure of the pellet. In comparison to the compaction of polymer-coated pellets, this category is less prevalent [22, 23].

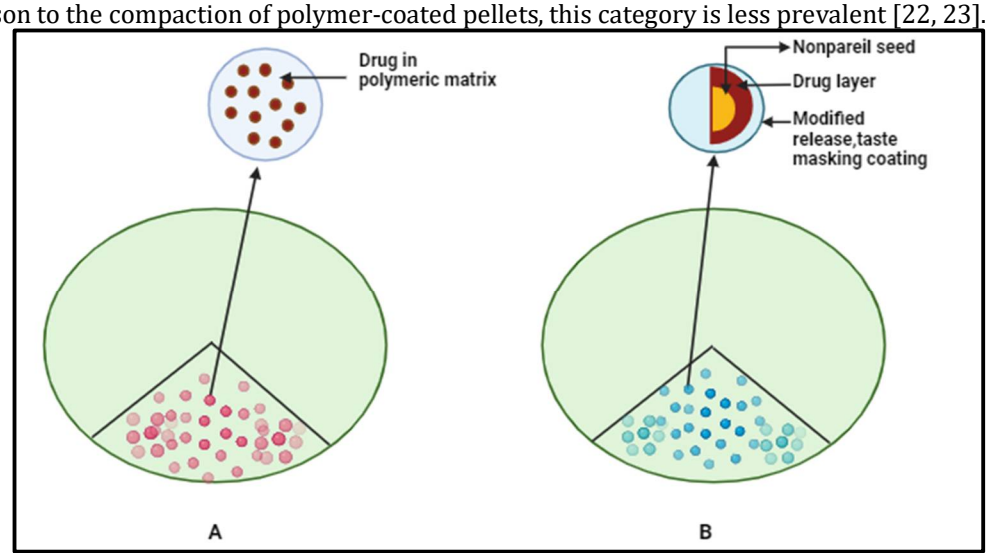

Figure 4: A) MUPS with matrix pellets. B) MUPS with polymer coated pellets.

Components for the Preparation of Neutral Starter Pellets

Various excipients and combinations of excipients are employed to produce neutral starter pellets with specific characteristics:

I. **Sugar:** Sugar is the most common carrier pellet. It's formed into spheres by either powder compaction or coating a sugar crystal with a sucrose and starch syrup, where the sucrose content doesn't exceed 92%. The sphericity of the pellet depends on the size of the original sugar crystal, as the sugar-starch coating must fully cover the crystal to create a sphere[24].

II. **MCC (Microcrystalline Cellulose):** These neutral starting pellets contain only Microcrystalline Cellulose, made through extrusion-spheronization or direct pelletization.

III. **Polyols**: Polyols like isomalt, xyiltol, and mannitol are produced using a fluid-bed method that swiftly transforms a suspension or solution into pellets. These polyols include Isomalt (GalenIQ 960 from Beneo-Palatinit), xyiltol (Xylinerts from IPS), and mannitol (Mcell from Pharmatrans Sanaq).

IV. **Wax:** Wax-based pellets, like those derived from carnauba wax (C-Wax from Pharmatrans Sanaq), are created using the prilling method. This method provides varying particle sizes and offers a hydrophobic core. The typical range for particle sizes is 850 to 1,250 microns, with melting points of 80°C to 87°C [25].

V. **Silicon Dioxide:** Silicon Dioxide spheres are hard, free flowing spherical masses prepared principally using Colloidal Silicon dioxide with some common excipients with particle sizes ranging from 250 to 1,680 microns. These are insoluble in water with uniform and consistent drug loading and also available in uniform sphere size.

VI. **Porous Pellets:** These are created using various starter ingredients, or combinations thereof, and act as a delivery method for medications. They are porous and allow for substantial drug fractions to be included within their structure [26,27].

Table 1: Commercially available starter spheres

Pellets Core Material	Brand Name (Manufacturer)
Microcrystalline cellulose (MCC)	CELPHERE™ (Asahi Kasei Corporation; Tokyo; Japan); Cellets (IPC Process-Center GmbH; Dresden; Germany); Vivapur® MCC spheres (JRS Pharma GmbH&Co.KG.; Weissenborn; Germany); MCC Pellets MS (Umang Pharmatech Pvt Ltd.; Thane; India)
Sucrose	Pharm-a-spheres (pharm-a-spheres GmbH,Suglets (Colorcon; Bazainville, France); Tornesch, Germany); Vivapharm® Sugar Spheres (JRS Pharma GmbH&Co.KGaA; Weissenborn, Germany); Sugar Pellets (Umang Pharmatech Pvt Ltd; Thane, India).Surinerts (IPC Process-Center GmbH; Dresden, Germany).
Mannitol	Mannitol spheres SANAQ® (Pharmatrans SANAQ; Basel; Switzerland)
Tartaric acid	Tartaric acid pellets (Umang Pharmatech Pvt Ltd.; Thane; India); TAP (IPC Process-Center GmbH; Dresden; Germany); InstaSpheres-TA (Tartaric acid spheres seal coated with hydrophilic polymer-Ideal Cures; Mumbai; India)
Lactose	Lactose pellets LS (Umang Pharmatech Pvt Ltd.; Thane; India)
Starch	Starch Pellets STS (Umang Pharmatech Pvt Ltd.; Thane; India)
Calcium carbonate	Calcium Carbonate Pellets CS (Umang Pharmatech Pvt Ltd.; Thane; India); Calcium carbonate SANAQ® (Pharmatrans SANAQ; Basel; Switzerland)

Fluidized bed layering

In the process of suspension or solution layering, the pure drug is mixed with a binder solution. This results in a homogeneous mixture where the API is either suspended or dissolved within the binder solution. These methods provide the advantage of achieving an exceptionally even and seamless surface on the particles being coated. This layering process involves blending the drug with a binder solution, leading to a consistent surface texture. Although this technique yields uniform results, it necessitates a significant amount of solvent or dispersing agent. Water-based solutions or suspensions are most commonly employed for this purpose [28,29].

CHARACTERISTICS OF PELLETS

Friability Evaluation

The processing of pellets relies on their mechanical attributes. During handling and coating, the generation of dust due to pellet abrasion is undesirable. Ideally, pellets with low friability are preferred for subsequent coating. The assessment of pellet friability is conducted using techniques such as an Erkewa-type tablet friabilator or a turbula mixer, employing fixed time periods and specific-diameter glass beads to induce abrasion. Additionally, the fluidized bed with a Wurster insert can also be employed to measure friability [30].

Surface Morphology

To analyze surface morphology and cross-sectional features of pellets, scanning electron microscopy (SEM) is utilized. Optical microscopy is also used to study the microstructure of pellet surfaces. Some researchers have also employed non-contact laser profile meters to quantify the roughness of pellet surfaces [31].

Specific Surface Area

The surface area of pellets is directly linked to their size, shape, and can be determined through gas adsorption techniques.

Drug Loading

Two techniques can be employed to include the drugs into pellets:

Method 1: Porous pellets are added to drug solutions (10% and 20% w/v, 100 mL). After designated time intervals the pellets are separated using a 250 μm sieve and subsequently oven-dried.

Method 2: Aqueous coating solution containing 1% or 2% medication (w/v) is prepared. Pellets (batch size 100 g) are coated with these solutions in a fluid bed coater using specific operating parameters [31].

Coating Efficiency

Coating efficiency is determined based on the theoretical quantity of medication coated onto the pellets. Crushed pellets are immersed in water for 30 minutes, followed by centrifugation to determine loading yield (mg drug/g pellets). UV spectrofotometry measured the concentration of medication in the supernatant [32,33].

CHALLENGES ASSOCIATED WITH FORMULATING MUPS

- Ensuring consistent content and weight across the board.
- Achieving tablet compression that imparts adequate hardness while keeping friability low, without harming the film coatings.
- Ensuring the resilience of coated pellets to maintain the desired drug release pattern even after compression.
- Assessing the ability of a mixed mass of pellets and tabletting additives to compact effectively.
- Addressing the processes involved in coating and packaging [34].

OVERCOMING THE CHALLENGES

A tableting blend characterized by optimal flow and a tightly controlled particle size distribution effectively prevents the segregation of pellets and extragranular components. For larger coated particles, adjusting the external layer's dimensions might be necessary, a task that can be accomplished through granulation techniques.

To guarantee intact film coatings and consistent drug release post tablet compression, a range of influential factors must be taken into account:

Pellet shapes: Pellets should ideally possess a spherical or nearly spherical configuration to facilitate effective rhombohedral packing. A greater deviation from spherical shape leads to compacts with altered release characteristics due to imperfections and fissures during compression.

Pellet size: Coated pellet sizes should not exceed 2 mm to withstand the pressure exerted during compression. Larger pellets can lead to the cracking of their coatings because of segregating with tablet excipients, resulting in direct contact between the upper and lower punches. This situation significantly impacts the uniformity of content in the final tablet.

Pellet density: Pellets with a density approximately at 1.5 g/cm^3 tend to undergo faster gastric emptying than pellets with a higher density exceeding 2 g/cm^3.Pellets smaller than 2 mm in diameter and possessing a density below 2 g/cm^3 can traverse the pyloric sphincter in both the fasted and fed states, akin to the behaviour of liquids during gastric emptying [35].

Pellet core and its composition: It is advisable for pellets to have a low surface-to-volume ratio to prevent reduced particle contact as they consolidate. Hence, it is important for the pellet core to possess a certain degree of flexibility, allowing it to deform during compression without causing damage to the outer coating. Extensive studies have explored the use of microcrystalline cellulose (MCC) in both powdered and granulated forms. These studies have shown that MCC exhibits plastic deformation when compressed,

providing increased protection to coated particles when used as either a powder or granules. Investigations involving various concentrations of MCC and starch 155 have confirmed that higher MCC concentrations lead to the formation of strong starch compacts. Conversely, when MCC is combined with starch 1500, the strength of the compacts is reduced. It is essential that the core material is not excessively hard, such as in the case of dicalcium phosphate (DCP) pellets, which can obstruct pellet flow. In such scenarios, the compression force impacts the surface, causing surface deformation and thereby altering the release properties [36].

Porosity: Porosity plays a substantial role in the compression of pellets and the subsequent deformation they undergo. A research investigation conducted by Nicklsson examined pellets with varying degrees of porosity, categorizing them as having low, medium, or high porosity. The study also introduced extragranular materials such as microcrystalline cellulose (MCC), polyethylene glycol (PEG), and dicalcium phosphate into the mix. The findings of this research revealed that pellets with medium and high levels of porosity experienced more pronounced deformation during the compression process. Interestingly, highly porous structures exhibited increased density under the force of compression, ultimately transforming into deformed and cohesive units, thanks to the presence of non-interfering excipients.

For reservoir pellets with substantial porosity, compression resulted in increased densification and deformation without markedly altering drug release profiles. Conversely, compacting less porous pellets led to significantly elevated drug release rates because of their relatively lower compaction and deformation, porous pellets undergo changes. As pressure is applied during the compaction of these porous pellets, trapped air is released and surrounds the pellets as they become denser. Consequently, pellets experience considerable structural deformation due to bond rearrangement, observable through SEM analysis, resulting in the formation of coherent tablets.

This formation of coherent units is attributed to the polymer coating employed and the extragranular material used. The choice of excipients is crucial to ensure they do not interfere with pellets, thus avoiding any alteration of the drug release profile. Closest packing between the extragranular material and deformed pellets is pivotal for a successful outcome [37].

Polymer Coating and Flexibility of Film: Commonly used polymers for achieving specific drug release profiles encompass cellulose derivatives and polyacrylates. Cellulose and its derivatives, including HPMC and HPMCP (with elongation less than 5%), yield rigid and brittle films that fracture under compression. Conversely, polyacrylates and acrylic copolymers produce pliable films that readily deform during compression. The introduction of plasticizing agents like triethyl citrate (TEC), triacetin, and polyethylene glycol (PEG) contributes to the formation of flexible films. Among these options, TEC has demonstrated notable effectiveness. When a highly flexible film undergoes compression, it retains elasticity and guards against coating fractures. Combining polymers like Eudragit with plasticizers like triethyl citrate significantly enhances the film's flexibility to the desired level. Higher proportions of these components result in retarding properties [38,39].

Choice of Solvents: Both aqueous and non-aqueous coatings are viable options. While aqueous coatings are environmentally friendly, they possess certain drawbacks. For instance, they can lead to drug degradation due to trapped moisture. Additionally, prolonged curing to evaporate moisture can trigger degradation, alters pH of both the pellet's environment and spraying solution, and affect the solution's viscosity. The viscosity of the solution is also influenced by factors like combination polymer system, pH of spraying solution and the presence of electrolyte. On the other hand, non-aqueous coatings exhibit thixotropy in polymer solutions, transitioning from a solution to a gel-like state. This quality aids in efficiently applying the polymeric solution, and the solvent evaporates relatively early compared to aqueous solvents. However, it's worth noting that aqueous solvents can cause polymer film coagulation [40].

Mechanical Strength and Film Flexibility: Film flexibility plays a role in ensuring the mechanical stability of pellets during the compaction process. When subjected to compression, a strong mechanical resistance contributes to maintaining the integrity of the film by preventing pellet deformation. This robust mechanical stability can be achieved through a compact structure, such as, extrusion pellets, mini-tablets or roller compaction granules. Additionally, larger size of particle enhances mechanical stability and result in fewer points of contact between particles, reducing the likelihood of film damage [41].

Coating Thickness: The thickness of the coating layer plays a role in determining the mechanical resistance of pellets during compaction. Thicker coatings provide enhanced elasticity, while coatings that are too thin can lead to breakage, even if they are highly flexible. The way in which the coated pellets deform during compression influences the coating layer's thickness, which, in turn, affects the drug release profile. When the core pellet experiences deformation that elongates the coating, it becomes thinner and more porous, leading to an accelerated drug release. Conversely, if substrate pellet is compacted, the coating becomes thicker and less permeable, leading to prolonged drug release[42].

Extra-Granular Material and Cushioning Agents:

The presence of extra-granular materials during the compression process can impact the stability of the film. Abrasive and sharp-edged crystalline substances can potentially harm the coating as the compression force increases. These changes in the coating can lead to alterations in the drug release characteristics after the compaction into tablets. Therefore, it is crucial to carefully consider factors like the type and quantity of coating agents, the choice of additives like plasticizers, the use of cushioning substances, and the rate of applied pressure. Monitoring these aspects is essential to ensure the preservation of the drug release properties of the subunits and the protection of the film.

To safeguard the film coating, soft materials or conventional powdered additives with plastic or elastic properties, such as microcrystalline cellulose or lactose, can be employed. When compressing extra-granular material alongside pellets, a recommended range of 30-70% w/w is typically advised. Including at least 30% (w/w) of extra-granular material is advisable as it provides support and cushioning, enabling the coated subunits to blend smoothly into the matrix without segregation, forming a cohesive tablet. While using a higher quantity of pellets, approximately 50%w/w, may reduce variability, it also carries a higher risk of coating damage.

A common recommendation is to combine fillers with different particle sizes, such as Avicel PH 200 and Avicel PH 101. Cushioning agents, which possess a waxy nature, respond to compaction pressures by adjusting their position within the tablet structure. They may also deform or fracture preferentially, offering protection to the coated pellets. These agents also contribute to the deformation of pellets when used as extra-granular material alongside diluents. Among these cushioning agents, polyethylene glycol (PEG), particularly PEG 6000, is considered the most suitable choice. Cushioning pellets typically exhibit higher porosity and softer characteristics compared to coated drug pellets. They are typically composed of commonly used excipients. The ratio of drug pellets to cushioning additives plays a critical role in preventing damage to the film coating, with a ratio of 1:3 or 1:4 being considered optimal[43].

Electrostatic Charges:

The accumulation of an electrostatic charge on the surfaces of the pellets has the potential to disrupt their movement during the tablet compression process. To address this issue, the addition of talc is commonly employed, as it serves as a glidant. When creating multiparticulate tablets, it is essential to perform comparative dissolution tests. These tests help to detect any potential disparities in the release rates between the uncompressed tabletting mixture and the resulting tablets. To ensure consistent and predictable drug release patterns, the disparity between the two dissolution profiles should not surpass 10% [44].

Table I: Some Marketed MUPS formulations [34]

Active Ingredient	Brand Name	Dosage Form	Therapeutic category	Release Mechanism	Manufacturer
Omeprazole	Losec MUPS	Orodispersible Tablets	Antiulcer	Delayed Release	AstraZeneca
Metoprolol tartrate	Troprol XL	Extended release tablet	Antihypertensive	Extended release	Astra Zeneca
Venlafaxine	Effexor XR	Extended-Release Capsule	Antidepressant	Prolonged Release	Pfizer
Methylphenidate	Concerta	Extended-Release Tablet	CNS stimulant in narcolepsy	Osmotic Release	Janssen Pharmaceuticals
Tamsulosin	Flomax CR	Controlled-Release Capsule	alpha-blocker in treatment of benign prostatic hyperplasia (BPH)	Controlled Release	Boehringer Ingelheim
Mesalazine	Salofalk Granu-Stix	Granules in Sachet	Anti-inflammatory for inflammatory bowel diseases (IBD)	Delayed Release	Dr. Falk Pharma
Quetiapine	Seroquel XR	Extended-Release Tablet	Atypical antipsychotic drugs.	Prolonged Release	AstraZeneca

CONCLUSION

Presently, a diverse range of initial pellets are available in the market. These core materials are produced as pre-prepared additives suitable for drug loading methods across different particle size segments, all falling within a defined size scope. This offers the pharmaceutical sector convenient options for

incorporating drugs using various techniques. The formulation process for various drugs into MUPS plays a crucial role, as the release of active compounds from pellets can potentially enhance their bioavailability compared to conventional drugs. In the current context, MUPS tablets offer distinct advantages due to their adaptable design in terms of achieving desired drug release properties, stability, patient adherence, and cost-effectiveness, especially when contrasted with other dosage forms. In the pharmaceutical industry, strategies for profit optimization involve innovating new products and techniques, extending product lines, securing patent extensions, achieving global product presence, and gaining a competitive edge. MUPS tablets fulfill these objectives by providing medical, healthcare, and business benefits.

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