EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 8
Issue: 4
340-350
Year: 2021

MULTIPARTICULATE DRUG DELIVERY SYSTEM - A RECET NOVEL TRENS IN PELLET FORMULATION

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Article Received on 19/02/2021 **Article Revised on 11/03/2021** **Article Accepted on 01/03/2021**

ABSTRACT
The present time is considered as an era of advancements in drug delivery systems. Different novel approaches are under investigation that range from uniparticulate to multi particulate system, macro to micro and nano particulate systems. Pelletization is one of the novel drug delivery technique that provides an effective way to deliver the drug in modified pattern. The pelletization technologies are gaining much more attention as they represent as efficient pathway for manufacturing of oral drug delivery system. It is advantageous in providing site specific delivery of the drug. Drugs with unpleasant taste, poor bioavailability and short biological half-life can be delivered efficiently through pellets. Different techniques are used to fabricate the pellets such as extrusion and spheronization, hot melt extrusion, powder layering, suspension or solution layering, freeze pelletization and pelletization by direct compression method. Among various techniques, Extrusion/spheronization is the most widely utilized technique. The purpose of the current review is to discuss pellets, different techniques of pelletization and characterizations of pellets with its application to ensure its quality, safety and efficacy to give out the required therapeutic activity after administration.

KEYWORDS: Pellets, Pelletization, Extrusion, Spheronization, Multiparticulate.

INTRODUCTION
Oral drug administration has been one of the most convenient and widely accepted routes of delivery for most therapeutic agents. Traditionally, oral dosage forms are classified as single unit and multiple unit dosage forms. Multi particulate dosage forms are receiving an immense attention as alternative drug delivery system for oral drug delivery even though single unit dosage forms have been widely used for decades. The most commonly used pharmaceutical solid dosage forms today include, granules, pellets, tablets and capsules, out of which tablets being the most popular dosage form, accounting for 70% of all ethical pharmaceutical preparations produced. But soon it was sensed that some of the formulating and clinical problems (free flowing property, dose dumping, dysphasia, etc) comes along with the single dose formulations. This lead to the dividing of monolithic dosage forms into multiples.[1]

Multi particulate dosage forms are pharmaceutical formulations in which the active substance is present as a number of small independent subunits with diameter of 0.05-2.00 mm. To deliver the recommended total dose, these subunits are filled into a capsule or compressed into a tablet. They provide many advantages over single unit systems because of their small size. Multi particulates are less dependent on gastric emptying, resulting in less inter and intra–subject variability in gastrointestinal transit time. They are also better distributed and less likely to cause local irritation. Recently much emphasis is being laid on the development of multi particulate dosage forms in preference to single unit systems because of their potential benefits such as increased bioavailability, reduced risk of local irritation and predictable gastric emptying.[2]

MUDFs are formulated as granules, pellets or mini tablets. These MUDFs, can either be filled into hard capsules or compacted into bigger tablets or can be dispensed in a dose pouches or pack lets.

TYPES OF MPDDS[3]
- Drug crystals
- Irregular granules
- Spheronized granules (pellets)
- Drug – loaded non- pareils (pellets)
- Mini tablets
- Melt – spray – congeal microspheres

In order to get MPDDS, drug is distributed in small particles (0.05-0.2 mm) and then film coated to get desired drug release characteristics. Here is the account of different types of MPDDS.

Drug crystals
Drug Crystals, of appropriate size and shape can be coated with a modified release film coating.

Irregular granules
Granules used in the preparation of tablets, can be film coated. Irregular shape and variation in particle size make it difficult to achieve uniform coating thickness around each particle.

Spheronized granules (pellets)
Sphere–shaped particles simplify the coating process. The production of spheroidal particles (pellets) is achieved by extruding the powdered mass, then cutting into small cylindrical particles and finally spheronizing these particles to spherical shape.

Drug -loaded non –pareils (pellets)
Spherical particles about 1mm in diameter consisting primarily of sucrose and starch called 'non-pareils' which are available in the market. Following techniques can be used to get drug loaded non pareils.

- A powder- dosing technique involving alternate dosing of powder (containing drug substance) and binder liquid onto the surface of the non- pareils until the required dose of the drug has been loaded.
- Spray application of drug, either suspended or dissolved in a suitable solvent (usually water) containing a polymer (such as hydroxy propyl methyl cellulose or polyvinyl pyrrolidine) as a binder onto the surface of the non-pareils.

Mini tablets
Many of the other types of multi particulates described suffer from two potential batch wise drawbacks, namely:

- Variation in particle size distribution.
- Variation in particle shape and surface roughness.

Such variability can result in variable coating thickness and thus product performance. This problem can be overcome by using mini compressed tablets (size range of 1-2 mm) produced using modification of traditional tabletting processes.

Melt-spray-congeal microspheres
Spherical, smooth, 50-µ m to 300-µm particles, typically with embedded API, can be produced by a continuous spinning disk process.

The current review focuses on the pelletized form of multiple units, they are prepared by process called Pelletization which is referred to as a size enlargement process and the final product obtained is called pellets.

Pellets
Traditionally, the word "Pellet" has been used to describe a variety of systematically produced, geometrically defined agglomerates obtained from diverse starting materials utilizing different processing conditions.

Pelletization is an agglomeration process that converts fine powders or granules of bulk drugs and excipients into small, free flowing, spherical or semi spherical units, referred to as pellets.[4] Pellets range in size, typically, between 0.5 – 1.5 mm, though other sizes could be prepared.

Pellets are for pharmaceutical purposes and are produced primarily for the purpose of oral controlled-release dosage forms having gastro resistant or sustained-release properties or the capability of site-specific drug delivery. For such purposes, coated pellets are administered in the form of hard gelatin capsules or disintegrating tablets that quickly liberate their contents of pellets in the stomach.

As drug-delivery systems become more sophisticated, the role of pellets in the design and development of dosage forms is increasing. Formulation of drugs in multiple-unit dosage forms, such as coated pellets filled in capsules or compressed into tablets, offers flexibility as to target-release properties. The safety and efficacy of the formulation is higher than that of other dosage forms.

Pellets provide the development scientist with a high degree of flexibility during the design and development of oral dosage forms. They can be divided into desired dose strengths without formulation or process changes, and can also be blended to deliver in- compatible bioactive agents simultaneously or particles with different release profiles at the same site or at different sites within the gastrointestinal tract.

In addition, pellets have numerous therapeutic advantages over traditional single units, such as tablets and powder-filled capsules taken orally, pellets generally disperse freely in the gastrointestinal tract, and consequently maximize the drug absorption, minimize local irritation of the mucosa by certain irritant drugs because of the small quantity of drug available in a single pellet, and reduce inter- and intrapatient variability.[5]

As the advantages of pellets over single units became clear, the pharmaceutical industry as a whole started to devote resources to conduct research in pellet technology and, whenever possible, acquire advanced equipment suitable for the manufacture of pellets.

Pellets may be manufactured by using different methods according to the application and the choice of producer. The methods used for pelletization are

essentially the same as the granulation methods. The most widely used processes are extrusion and spheronization and solution or suspension layering, and powder layering. Other processes with limited application in the development of pharmaceutical palletized products include globulation, balling, and compression.

Advantages of pellets

- They can be divided in to desired dosage strength without process or formulation changes.
- When pellets containing the active ingredient are in the form of suspension, capsules, or disintegrating tablets, they offer significant therapeutic advantages over single unit dosage forms.[6-8]
- They can also be blended to deliver incompatible bioactive agents.
- They can also be used to provide different release profile at the same or different sites in the gastrointestinal tract.
- Pellets offer high degree of flexibility in the design and development of oral dosage form like suspension, sachet, tablet and capsule.[9-11]
- Pellets disperse freely in GI tract, maximize drug absorption, and minimize local irritation of the mucosa by certain irritant drugs.

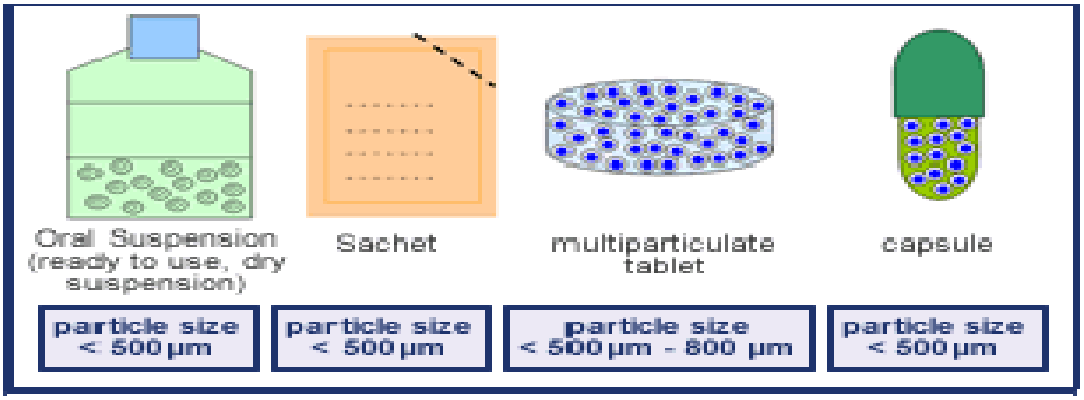


Figure 1: Flexibility of pellets in development of dosage form.

- **Improved flow characteristics;** spheres have excellent flow properties which can be used in automated processes or in processes where exact dosing is required, e.g. tableting, moulding operations, capsule filling, and packaging.

- **Coating;** coating of granules is often applied for stabilizing active ingredients in the granule or to control the release of these active ingredients. Typical applications in the pharmaceutical industry are the controlled release medicines. The easiest shape to coat is the sphere due to the absence of edges. It is also the most economical one to coat as no extra coating material is required to fill irregularities in the surface of the granules.[4,12, 13]

- **Packing of beds and columns;**[14] in certain processes, porous beds or columns are used as chemical reactors. Spherical particles allow the reproduction of beds with always the same void volume, surface area and permeability. Calculations and predictions of the process characteristics also become easier when round particles are used as many equations are based on flows around symmetrical bodies.

- **Density increase;** both the true and the bulk density of granules are increased by spheronising. This can improve the process and the packaging.

- **Marketing;** for consumer products, spheronising is sometimes only applied for improved product appearance and marketing reasons.

- **Hardness and friability;** hardness and friability depend on the internal cohesive forces and surface characteristics. Spheronization increases the hardness and reduces the friability of granules. This will reduce the amount of fines generated during handling or transportation.

Disadvantages of pellets[15]

- Dosing by volume rather than number and splitting into single dose units as required.
- Involves capsule filling which can increase the costs or tableting which destroy film coatings on the pellets.
- The size of pellets varies from formulation to formulation but usually lies between 1 to 2mm.

Desirable properties of pellets[16.17]

- **Uncoated pellets**
  - Uniform spherical shape, Uniform size, Good flow properties,Reproducible packing,High strength,Low friability, Low dust,Smooth surface,Ease of coating.

- **Once coated**
- Maintain all of the above properties, Have desired drug release characteristics.

Figure 2 (a) Pellets, (b) Perfect pellet, (c) Coated pellet.

Pelletization techniques[18-20]

The preparation of spherical agglomerates can be approached by several techniques which can be subdivided into the basic types of systems shown in Figure 3.

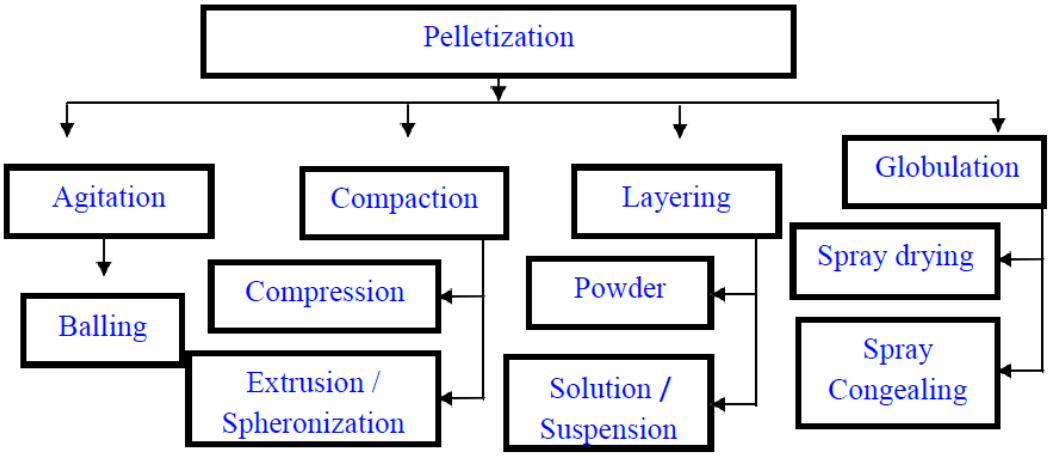


Figure 3 Different pelletization techniques.

Balling; describes a pelletization process in which finely divided particles are converted, upon the addition of appropriate quantities of liquid, to spherical particles by a continuous rolling or tumbling motion. The liquid may be added prior to or during the agitation stage. Pans, discs, drums, or mixers may be used to produce pellets by the balling process.

Compression[21]**;** is a pelletization process in which mixtures or blends of active ingredients and excipients are compacted under pressure to generate pellets of defined shape and size. The pellets are small enough to be filled into capsules. The formulation and processing variables that govern the production of pellets during compression are similar to those that are routinely employed in tablet manufacturing. In fact, pellets produced by compression are nothing but small tablets that are approximately spheroidal in shape.

Globulation[22]**;** globulation or droplet formations describe the two related processes of spray drying and spray congealing.

During Spray drying, drug entities in solution or in suspension form are sprayed, with or without excipients, in to a hot air stream to generate dry and highly spherical particles. Though the technique is suitable for the development of controlled release pellets, it is generally employed to improve the dissolution rates and hence, bioavailability of poorly soluble drugs. Spray drying has been used for a variety of reasons. Consequently, the literature is replete with description of both process and equipment.

Spray congealing is a process in which a drug is allowed to melt, disperse, or dissolve in hot melts of guns, waxes, fatty acids, etc. , and is sprayed in to an air chamber where the temperature is below the melting points of the formulation components, to provide, under appropriate processing conditions, spherical congealed pellets. Depending on the physicochemical properties of the ingredients and other formulation variables, pellets with immediate or controlled release behavior can be produced.

Extrusion / Spheronization; extrusion-spheronization is a multiple step process capable of making uniformly sized spherical particles. Although the process is more efficient than other techniques for producing spheres, it is more labor and time-intensive than the more

common granulation techniques. Therefore, it should be considered as a granulating technique when the desired particle properties are essential and cannot be produced using more conventional techniques.

Spheronization is a process invented by Nakahara, in 1964. The patent describes a Method and Apparatus for Making Spherical Granules from wet powder mixtures.[24] And described the steps involved in the process, including.[15,22]

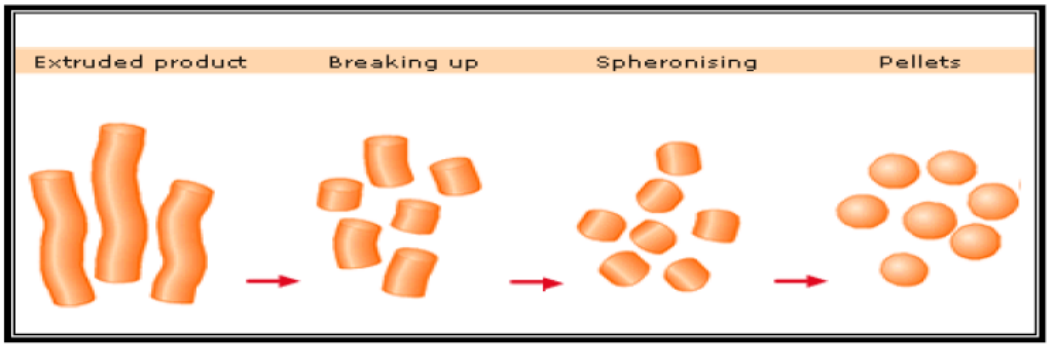


Figure 4: Principle of the extruded product spheronising process.

(A) Dry mixing; during the first step, powders are dry mixed to achieve a uniform dispersion before wet granulation. It is generally carried out in the same mixer used for the granulation; however, if a continuous granulator is used, a separate mixer is required for the dry mix. This step is typically taken for granted because wet massing follows. The uniformity of the dry mix, however, can have a significant effect on the quality of the granulation and, in turn, on the spherical particles produced.

(B) Granulation; the second step is granulation, during which a wet mass, having the requisite plasticity or deformation characteristics, is prepared. With a few exceptions, this step is similar to conventional granulation techniques used to produce products for compression. It is typically carried out in a batch-type mixer-granulator; however, any equipment capable of producing a wet mass, including the continuous type, can be used.

(C)Extrusion; extrusion is the third step of the process and consists of shaping the wet mass into long rods, which are more commonly termed 'extrudate'. The extrusion process is used not only in the pharmaceutical industry but also in the food, ceramic and polymer industries. The extrusion process is currently used as an alternative method for the manufacture of completely water-soluble tablets.[27]

The wet mass is forced through dies and shaped into small cylindrical particles having a uniform diameter. The extrudate particles break at similar lengths under their own weight. The extrudate must have enough plasticity to deform, but not so much that it adheres to other particles when collected or rolled in the spheronizer.

Classification of extruders; extruders come in many varieties, but can generally be divided into three classes, based on their feed mechanism as given in Table 1.

Table 1: Type of pharmaceutical extruders.

Sr. No.	Extruder	Examples
1	Screw fed extruders	Axial or end plate, dome, radial
2	Gravity feed extruders	Cylinder roll, gear roll, radial
3	Piston feed extruders	Ram

(D)Spheronization[24]; the fourth step in the extrusion-spheronization process is the spheronization step. It is carried out in a relatively simple piece of equipment. The working parts consist of a bowl having fixed sidewalls, with a rapidly rotating bottom plate or disk. The rounding of the extrudate into spheres is dependent on frictional forces. The forces are generated by particle-to-particle and particle-to-equipment interaction.

Working Principle; the differential in particle velocity as they move outward to the walls, begin to climb the walls, and fall back onto the rotating bed, along with the angularmotion of the disk, results in a rope-like formation.[15] A graphic representation of this rope-like formation is shown in Figure 5.

(a) (b)

Figure 5 (a): A Radial pattern with the groves running from the center, (b): A Graphical representation of the characteristic rope like formation in a spheronizer bowl during operation.

(E) Drying; drying is the final step in the process. This can be accomplished in any dryer that can be used for conventional type granulations, including tray dryers, column-type fluid beds, and deck-type vibratory fluid beds. Fluidized bed dryers result in a much more rapid drying rate because of the higher air volumes and the potential use of higher inlet temperatures.

Layering[25,26] **;** layering processes are probably the most well-controlled and straightforward pelletization techniques that have been used over the years. They are classified into three categories: direct pelletizing, solution layering or suspension layering, and powder layering.

Direct pelletizing[27] **;** means manufacturing of pellets directly from powder.

- **Effective process;** pellets are manufactured directly from powder with a binder or solvent, fast process. Low usage of auxiliary materials.
- **Product advantages;** compact, round pellets - ideal for automatic dosing and even coating and pellet diameter also obtained between 0.2 m m and 1.2 m m.
- **Comparison;** pellets have a higher density than spray granulates and agglomerates.
- **Process principles;** powder is mixed and moistened. A solvent or binder can also be added. The powder bed is set into a centrifugal motion. (fluid bed pelletizing in the rotor). The impact and acceleration forces that occur in this process result in the formation of agglomerates, which become rounded out into uniform and dense pellets. The speed of rotation has a direct influence on the density and size of the pellets. The moist pellets are subsequently dried in the fluid bed. If required, the systems can be made inert for applications with organic solvents. Another alternative for direct pelletizing is spray granulation.
- With suitable additives, pellets can be made into tablets or used to fill capsules. The round shape is ideal for uniform coating. Pellets are good for automatic dosing.

Powder layering[27]**;** powder layering involves the deposition of successive layers of dry powder of drug or excipients or both on performed nuclei or cores with the help of a binding liquid. Because powder layering involves the simultaneous application of the liquid and dry powder, it generally requires specialized equipment. Pieces of equipments revolutionized powder layering processing as a pelletizing techniques are- tangential spray or centrifugal fluid bed granulators. In case of tangential spray the rotating disk and fluidization air provides proper mixing.

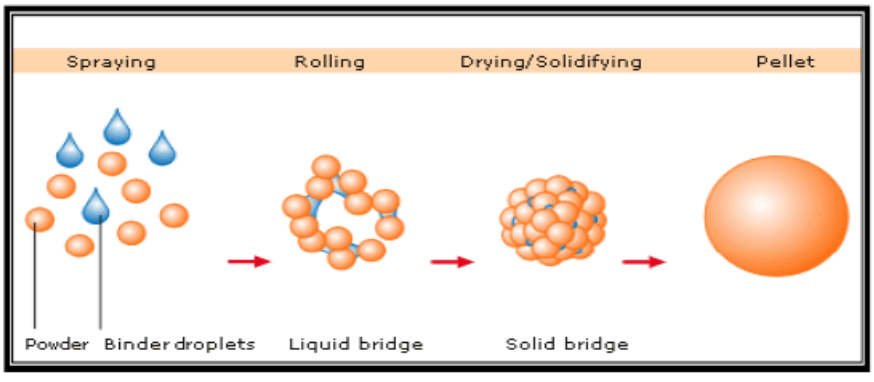


Figure 6 Process principles of direct pelletizing.

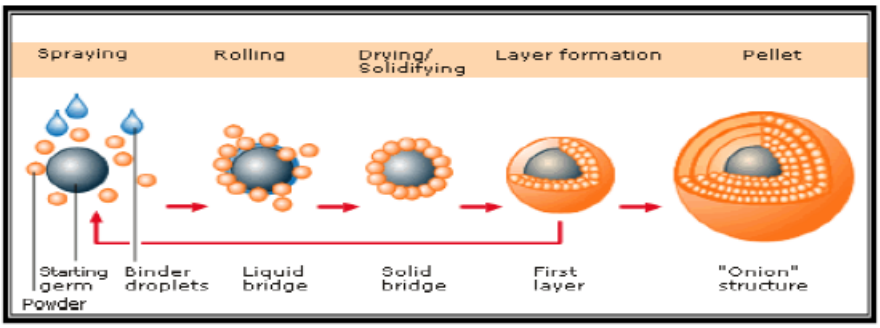


Figure 7: Principle of powder layering process.

With a double wall centrifugal granulator, the process is carried out in the open and closed position. With powder layering, the inner wall is closed so that simultaneous application of liquid and powder could proceed until the pellets have reached the desired size. The inner wall is then raised, and the spheres enter the drying zone. The pellets are lifted by the fluidization air up and over the inner wall back in to forming zone. The cycle is repeated until the desired residual moisture level in the pellets is achieved.

The other requirements which formulation are suppose to meet are[27]

- Binder solution must have a high binder capacity.
- Micronizing or finely milling the drug before layering improves the efficiency of the layering process.
- The rheological properties of binding liquid, the liquid application rate, and drying air temperature should be optimized.
- In addition, the powder should be delivered at a rate that maintains a balance between the surface wetness of the cores and powder adhesion.

Solution or suspension layering[27]**;** involves the deposition of successive layers of solution and/or suspension of drug substances and binder on starter seeds, which may be inert materials or crystal/granules of the same drug. The primary features that distinguish wurster equipment from other fluid bed equipment are the cylindrical partition located in the product chamber and the configuration of the air distribution plate, also known as the orifice plate. The latter is configured to allow most of the fluidization or drying air to pass at high velocity around nozzle and through the partition, carrying with it the particles that are being layered on.

Once the particles are exits the partition, they enter the expansion chamber, where the velocity of the air is reduced below the entrainment velocity, and the particles fall back to the area surrounding the partition. The down bed is kept aerated by the small fraction of air that passes through the small holes on the periphery of the orifice plate. The spray direction is concurrent with the particle movement. The disadvantages of the wurster process are the inaccessibility of the nozzles. If the nozzles are clogged at any time during the layering process, the operation has to be interrupted, and the spray guns must be removed for cleaning. The problem can be alleviated by screening the formulation or by using a spray gun with a bigger nozzle. Suspension layering is usually used when the desired drug loading of the pellets is low because production of pellets from low solids content formulation is not economically feasible.

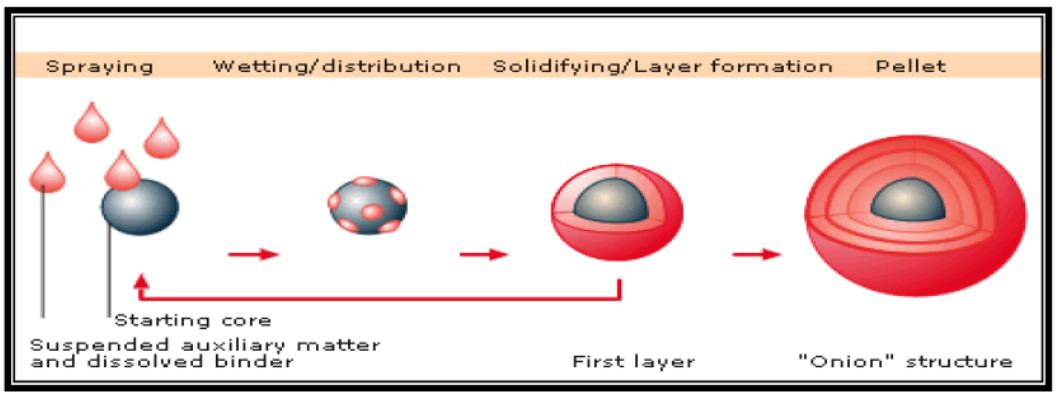


Figure 8: Principle of solution and suspension layering process.

An important factor that needs to be considered when suspensions are used as opposed to solutions is the particle size of the drug. If the size of the drug in suspension is large, the amount of binder required to immobilize the particles on to cores will be high, and consequently pellets of low potency are produced.

Fluid bed coating for layering of pellets[]

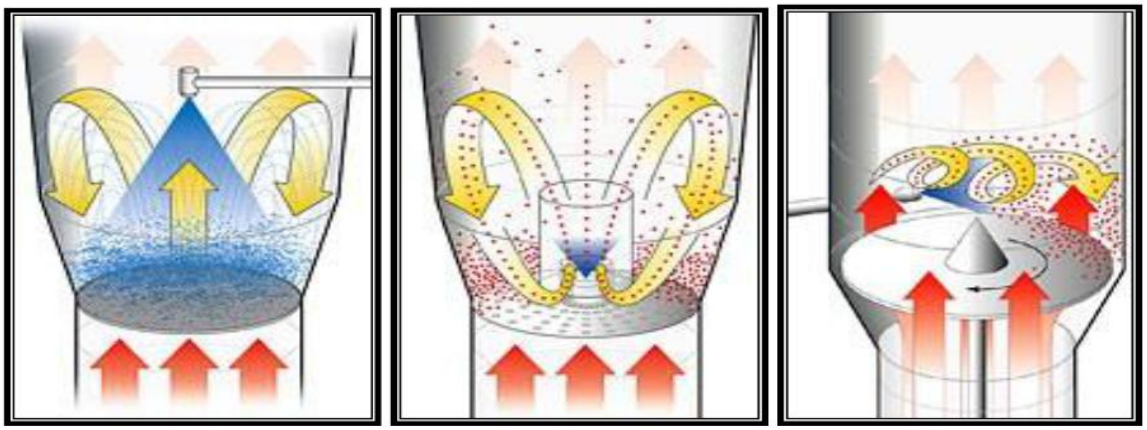
- Innovative processes for coating our products.
- Film coating; lipid hot melt coating, coating of granules, pellets, tablets.
- Specific manipulation of the particle surface characteristics. Protection of the product against moisture, light, air, etc.
- Specific manipulation of the way in which the particle dissolves the decomposition or the release of active ingredients.
- **Process advantages;** uniform, continuous product coating. Aqueous or organic coatings can be applied. Coating and drying take place in one machine. In terms of total containment, the coating process and the filling and emptying of the machine can be carried out in complete isolation and without product spreading into the environment.

Principle of operation of fluid bed coating[28]**;** with fluid bed coating, particles are fluidized and the coating fluid sprayed on and dried. Small droplets and a low viscosity of the spray medium ensure an even product coating. Glatt offers fluid bed systems in different batch sizes with.

A) Top spray coating

This process is used for general coatings right up to enteric coating. With top spray coating in the fluid bed (batch and continuous), particles are fluidized in the flow of heated air, which is introduced into the product container via a base plate.

The coating liquid is sprayed into the fluid bed from above against the air flow (countercurrent) by means of a nozzle. Drying takes place as the particles continue to move upwards in the air flow. Small droplets and a low viscosity of the spray medium ensure that the distribution is uniform. Coating in the continuous fluid bed is particularly suitable for protective coatings/color coatings where the product throughput rates are high. The product is continuously fed into one side of the machine and is transported onwards via the sieve bottom by means of the air flow. Depending on the application, the system is sub-divided into pre-heating zones, spray zones and drying zones. The dry, coated particles are continuously extracted.



(a) (b) (c)

Figure 9 (a) Principle of top spray fluid coating, (b) Principle of bottom spray fluid coating, (c) Principle of tangential spray fluid coating.

B) Bottom spray coating (wurster coating)

This process is particularly suitable for a controlled release of active ingredients. In the wurster process, a complete sealing of the surface can be achieved with a low usage of coating substance. The spray nozzle is fitted in the base plate resulting in a spray pattern that is concurrent with the air feed. By using a wurster cylinder and a base plate with different perforations, the particles to be coated are accelerated inside the wurster tube and fed through the spray cone concurrently. As the particles continue traveling upwards, they dry and fall outside the Wurster tube back towards the base plate. They are guided from the outside back to the inside of the tube where they are once again accelerated by the spray. This produces an extremely even film. Particles of different sizes are evenly coated.

Bottom spray coating (continuous fluid bed); particularly suitable for protective coatings/color coatings where the product throughput rates are high. The product is continuously fed into one side of the machine and is transported onwards via the sieve bottom by means of the air flow. Depending on the application, the system is sub-divided into pre-heating zones, spray zones and drying zones whereby spraying can take place from below in the form of a bottom spray. The dry, coated particles are continuously extracted.

C) Tangential spray coating (rotor pellet coating)

Ideal for coatings with high solid content. The product is set into a spiral motion by means of a rotating base plate, which has air fed into the powder bed at its edge. The spray nozzle is arranged tangentially to the rotor disc and also sprays concurrently into the powder bed. Very thick

film layers can be applied by means of the rotor method.

Dosage form design of pellets[29,12]

With regard to the final dosage form, the multiparticulates can be filled into hard gelatin capsules or be compressed into tablets. The compression of multiparticulates into tablets is becoming more popular, especially in the USA, where hard gelatin capsules have been tampered (Tylenol").

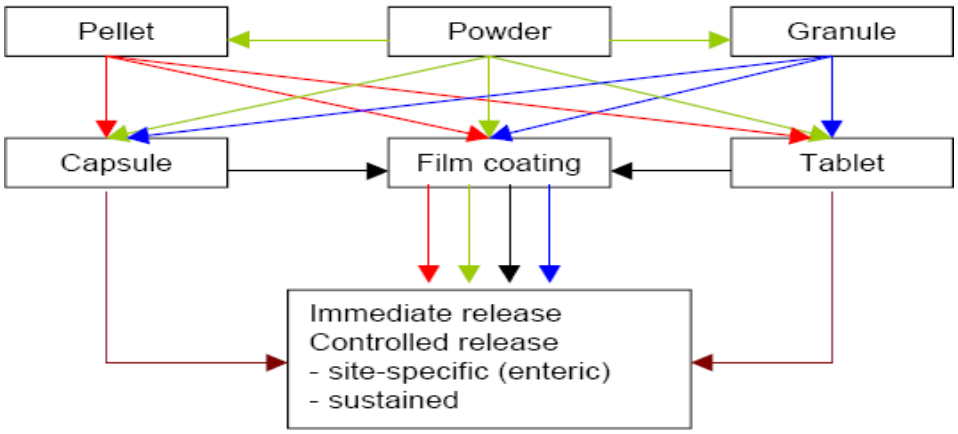


Figure 10: Dosage form design of pellets.

The advantages of tableting multiparticulates include a reduced risk of tampering and less difficulty in oesophageal transport when compared with capsules. Large volume tablets generally have a higher patient compliance than capsules; higher dose strength could be administered with tablets, Tablets from pellets can be prepared at lower cost when compared to pellet-filled capsules because of the higher production rate of tablet presses. The expensive control of capsule integrity after filling is also eliminated. In addition, tablets containing multiparticulates could be scored without losing the controlled release properties. Scored tablets allow a more flexible dosing regimen. Compaction of coated multiparticulatesinto tablets could either result in disintegrating tablets providing a multiparticulate system during GI- transit or in intact tablets due to the fusion of the multiparticulates in a larger compact. Ideally, the compacted pellets should disintegrate rapidly in the individual pellets in gastrointestinal fluids.[30,31]

Characterization of pellets

Pellets are evaluated for certain quality measures, which reflect the suitability and endurance of material during various operations like filling, transportation and handling.

Particle size distribution: Particle size can be determined by sieve analysis by using sieve shaker which is simple and economical technique. Optical microscopy and scanning electron microscopy can be used for measuring the diameter of pellets. This characteristic feature of pellet helps in coating and drug release rate. Patappee.W. 2004 reported the use of vernier callipers to determine the size of pellets.[32-34]

Surface area: Surface area has an effect on drug release and results in batch to batch variability. To ensure the production of consistent shape pellets, surface area is analysed by particle size distribution, gas absorption (BET method-Brunauer, Emmett & Teller) and air permeability method.[33-35]

Porosity: The porosity of pellets influence the rate of release of drugs from the pellets by affecting the capillary action of the dissolved drug. Porosity can be measured qualitatively by scanning electron microscopy (SEM) and quantitatively by mercury porosimetry. The porosity of pellets can be determined quantitatively also by using optical microscopy and scanning electron microscopy together with image.[33-35]

Density: The density of the pellets is affect by change in the formulation or process factors. Change in the density of pellets affects the other factors or process like capsule filling, coating and mixing. Bulk density can be measured by using an automated tapper or pycnometer. True density shows the extent of densification or compactness of substance.[32,33]

Friability and hardness: The friability and hardness determination is important as pellets need to withstand during handling, coating, packaging, shipping and storage. Roche friabilator, Erweka friabilator, Pharma test friabilator are different equipment used. The % friability of pellets should be less than 0.08%. Karl pellet hardness tester provides relative hardness values.[32,33]

Tensile strength: The tensile strength of the pellets is determined by using tensile apparatus with a 5 kg load cell. The pellets were strained continuously until failure occurs. Further load is recorded and the tensile strength is calculated applying the value for the failure load and the radius of the pellets.[32,34]

Pharmaceutical applications[37,38]

The process of FBP is used to produce a wide variety of

engineered, controlled release drugs. These solid dosage forms are mostly in the form of tablets or capsules containing high levels of an active pharmaceutical ingredient (API). Product characteristics include.

- Dense pellets
- Smooth coatable pellets
- Narrow particle size distributions, and
- High yield and flow ability.

Important pharmaceutical applications include

- Controlled release pellets for encapsulations
- Sustained release pellets / delayed release enteric coated pellets
- Multi-particulate systems
- Multi-unit erosion matrix pellets
- Pellets for special tableting applications
- Immediate release pellets for sachets

CONCLUSION

In present day pelletization represents an efficient pathway for novel drug delivery in the scope for different oral immediate or controlled delivery systems. Due to its simple design, efficiency of producing spherical pellets and fast processing; it has found a special place in the pharmaceutical industry and moreover its use in production of multiparticulate oral drug deliverdrug deliver system. Among the possible various techniques extrusion spheronization represents an efficient pathway for novel drug delivery system. Using these pelletization techniques we can formulate suitable dosage forms of drugs that will have more patient compliance, safety and efficacy.

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