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# TABLET: A REVIEW

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## Abstract

Oral delivery is gold standard in the pharmaceutical industry where it is regarded as the safest, most convenient and economical method of drug delivery having the highest patient compliance. The oral route is the most frequently used route for the administration of drugs. Many of the pharmaceutical dosage form are formulated as sustained release dosage form to retard the release of a therapeutic agent such that its appearance in the systemic circulation is prolonged and its plasma profile is sustained in duration. Tablets offer the lowest cost approach to sustained and controlled release dosage forms. Tablets serves as an important tool for oral extended-release dosage forms. Hence, problems like patient compliance, drug targeting, local side effects, frequent administration and fluctuations in blood concentration levels, associated with their counterparts, the conventional dosage forms were solved.

**INTRODUCTION:**

Tablets are by far the most popular dosage form for pharmaceutical products for therapeutic use. Tablets are prepared by compressing a powder mixture in a die at high compression force. The powder mixture contains next to the drug generally also filler binders, disintegrates, lubricants, glidants etc. The large scale production of high quality tablets requires a tablet mixture with excellent properties regarding homogeneity, flow ability and compatibility. When the powder mixture does not possess these properties it has to be preprocessed, else direct compression can be used. With direct compression the powder mixture is blended during a period of time and can directly be compressed into tablets. Only a lubrication step may be necessary to prevent the mixture from adhesion to the die and punches during compression. Direct compression can be used when the mixture already has good tableting properties of itself. The mixture has to flow easily and give good binding during compaction. Unfortunately, most tablet mixtures lack these properties and a wet granulation step is necessary. With wet granulation, extra process steps are necessary to produce a tablet mass with sufficient tableting properties. The powder mixture is dry blended to give a homogeneous distribution of all the components in the mixture. Then a binder solution is added to the mixture to moisten the particles. By introduction of the solution, binding between the primary particles improves and stronger tablets can be produced. Mixing is continued until the granulation end point has been reached. The end point may be defined as the mixing time or amount of granulation liquid that produces a certain amount of granules with a specific diameter. The mass is screened to remove large lumps, and dried to remove the granulation liquid. Finally, the granulations may be dry sieved to remove the agglomerates that were formed during drying. Just as with direct compression, lubrication of the granulations may be necessary. There are various techniques of producing granules such as dry and wet granulation, extrusion, or spray drying. Most commonly used is wet granulation. Here the aggregates are produced by agitation of moistened powders.[1]

**ADVANTAGES OF TABLETS:**

**PRODUCTION ASPECT**

- Large scale production at lowest cost
- Easiest and cheapest to package and ship
- High stability
- They are an economical dosage form.

**USER ASPECT (DOCTOR, PHARMACIST, PATIENT)**

- Easy to handling
- Lightest and most compact
- Greatest dose precision & least content variability
- Coating can mark unpleasant tastes & improve pt. acceptability
- The tablets are easy to be administered.
- Bitter and nauseous substances can be given easily in tablet form after giving a suitable coating to the tablets.

**DISADVANTAGES OF TABLETS:**

- Some drugs resist compression into dense compacts.
- Drugs with poor wetting, slow dissolution, intermediate to large dosages may be difficult or impossible to formulate and manufacture as a tablet that provide adequate or full drug bioavailability.
- Bitter taste drugs, drugs with an objectionable odor, or sensitive to oxygen or moisture may require encapsulation or entrapment prior to compression or the tablets may require coating[2].

**TYPES OF TABLETS**

**TABLETS INGESTED ORALLY:**

**(A)COMPRESSED TABLETS:**

Compressed tablets are prepared by single compression using tablet machines. After a quantity of powdered or granulated tableting material flow into a die, the upper and lower punches of the tablet machine compress the material under a high pressure.

**(B) MULTIPLE COMPRESSED TABLETS:**

Tablets or tablet-within-a-tablets **(with cores and shells).** In preparing layered-tablets, a portion of fill material in a die is

compressed initially, and then another portion of fill material is added to the same die. Each additional fill material is compressed to form multilayered tablets. In general, each portion of the fill material contains a different drug. This allows formulation of different drugs which are incompatible each other in Tablets may be subjected to compression more than once to prepare multiple-layered one tablet. Each layer of the multiple-layered tablets can also provide different drug release profiles. This is in a sense a controlled release device. Each portion of the fill is usually colored differently for the unique appearance. The preparation of tablets having another compressed tablet as the inner core requires special machines which can place the preformed tablet precisely within the die for the second compression.

**(C) CHEWABLE TABLETS**

Chewable tablets are prepared mainly by wet granulation and compression. Chewable tablets disintegrate rapidly when chewed or allowed to dissolve in the mouth Chewable tablets are especially useful in tablet formulations for children and are commonly employed in the preparation of multiple vitamin tablets. They are also used in the administration of antacids and antiflatulents (to remove excessive amount of gas in the stomach and intestines). Mannitol, which is a white crystalline hexahydric alcohol, is widely used as an excipient in chewable tablets. The nonhygroscopicity of mannitol makes it an ideal excipient for the preparation of chewable tablets containing moisture-sensitive drugs. Mannitol may account for 50% or more of the weight of the formulation.

**(D) TABLET TRITURATES**

Tablet triturates are small, usually cylindrical tablets containing small amounts of potent drugs. A combination of sucrose and lactose is usually used as diluents. They are prepared mainly by compression (rather than molding). Tablet triturates must be readily and completely soluble in water. Thus, any water-insoluble material is avoided in the formulation. In the preparation of these tablets by compression, only a minimal amount of pressure is applied. Tablet triturates are used for oral administration or sublingual use (*e.g.*, nitroglycerin tablets). They may

also be used in compounding procedures by pharmacists in the preparation of other solid or liquid dosage forms. They can be inserted into capsules, and this eliminates the problems of measuring the accurate amount of potent drugs in the powder form. They can also be dissolved in a small amount of water which can be subsequently mixed with the required volume of the liquid medication.

**(E) MOLDED TABLET:**

While most commercially available tablets are primarily prepared by compression tablets can also be prepared by molding. Molded tablets are prepared by tablet machinery or manually by forcing dampened tablet material into a mold of any shape. The formed tablet is then ejected from the mold and allowed to dry. Molding is generally reserved for laboratory and small-scale production. The commercial preparation of tablets by molding has been replaced by the tablet compression process.

**(F) SUGAR COATED TABLETS:**

Compressed tablets can be coated with a sugar layer. Since the coating is water soluble, it is quickly dissolved in aqueous environment (*e.g.*, in the gastric juice after oral administration). The main purposes of having a sugar coating are:

(1) To protect the drug from the air and humidity;

(2) To provide a taste or a smell barrier to objectionable tasting or smelling drug;

(3) To enhance the appearance of compressed tablets. Sugar coating of compressed tablets requires more time and expertise, and this may increase the cost of manufacturing. Sugar coating also increases the size and weight of the compressed tab-lets. If the size of tablets is too small then the size is increased intention-ally by sugar coating.

**B. FILM COATED TABLETS:**

Compressed tablets can be coated with a thin layer of a polymer, which may be either watersoluble or water-insoluble. The polymer film has an advantage over sugar-coating in that the polymer film is more durable, less bulky, and less time-consuming to apply. Upon oral administration, the polymer film may remain intact or dissolve in the GI tract depending on the water-solubility**.** Film-coating solutions may be nonaqueous or

aqueous. The nonaqueous solutions generally contain various materials to provide the desired coating to the tablets. A film former should be able to produce smooth, thin films and be applicable to a variety of tablet shapes. An alloying substance provides water-solubility or permeability to the film to ensure penetration by body fluids and therapeutic availability. A plasticizer produces the flexibility and elasticity of the coating. This may enhance durability. Surfactants enhance spreadability of the film during application. Opaquants and colorants make the appearance of the coated tab-lets handsome and distinctive. Sweeteners, flavors, and aromas enhance the acceptability of the tablet to the patient. A glossant provides luster to the tablets without a separate polishing operation. Volatile solvents allow spreading of the other components over the tablets while allowing rapid evaporation to permit an effective yet speedy operation. Owing to the high cost of using volatile solvents and the problem of releasing these potentially toxic agents into the atmosphere, organic solvents are not widely used anymore. Pharmaceutical manufacturers favor the use of aqueous-based film-coating solutions, although they evaporate much slowly than organic-based film-coating solutions. Water-insoluble polymers can also be coated by aqueous coating techniques. In this case, instead of using polymer solution dissolved in water, latex is used. Latex is a polymer emulsion (*i.e.*, a dispersion of small (≤1 μm) spherical polymer particles in water). One commercially available water-based, colloidal coating dispersion is called Aquacoat (FMC Corp.), which contains 30% ethylcellulose pseudolatex. (Pseudolatex is different from "true" latex in that the pseudolatex is manufactured starting with polymer itself and not the monomer (Hogan, 1995). Pseudolatex dispersions have an advantage of high solid content and this allows greater coating ability with relatively low viscosity. The low viscosity allows less water to be used in the coating dispersion, and this result in a lesser requirement for water-evaporation and a reduced likelihood of water interference with the tablet formulation. Furthermore, the low viscosity permits greater coat penetration into the crevices of monogrammed or scored tablets. Another

commercial aqueous coating system based on ethyl cellulose is Surelease® from Colocon. Ethyl cellulose product is Surelease.

**(G) ENTERIC-COATED TABLETS**:

The many water-soluble polymers, some polymers show the property of pH dependent water-solubility. Some polymers do not dissolve at low pH (e.g., pH in the stomach) but readily dissolve at neutral pH (e.g., pH in the intestine). If such a polymer film is coated on compressed tablets, the tab-lets will resist dissolution or disruption in the stomach but not in the intestine. Such tablets are known as enteric-coated tablets. Since enteric-coated tablets do not dissolve in the stomach, they are useful for the drugs which are not stable in gastric juice (*i.e.*, at low pH) or are irritating to the gastric mucosa. By-passing the stomach and release of acid-labile drugs in the intestine will enhance the drug absorption significantly.[3]

**MANUFACTURING OF COMPRESSED TABLETS:**

**1. PREPARATION OF GRANULES FOR COMPRESSION:**

Granulation is the process of collecting particles together by creating bonds between them. Bonds are formed by compression or by using a binding agent. If one were to make tablets from granulated sugar versus powdered sugar, for example, powdered sugar would be difficult to compress into a tablet and granulated sugar would be easy to compress. Powdered sugar's small particles have poor flow and compression characteristics. These small particles would have to be compressed very slowly for a long period of time to make a worthwhile tablet. Unless the powdered sugar is granulated, it could not efficiently be made into a tablet that has good tablet characteristics such as uniform content or consistent hardness.[4] The granulation process combines one or more powders and forms a granule that will allow the tableting process to be predictable and will produce quality tablets within the required tablet-press speed range. A tablet formulation contains several ingredients, and the active ingredient is the most important among them. The remaining ingredients are necessary because a suitable tablet cannot be composed of active ingredients alone. The tablet may

require variations such as additional bulk, improved flow, better compressibility, flavoring, improved disintegration characteristics, or enhanced appearance. If the active ingredient in a formulation represents a very small portion of the overall tablet, then the challenge is to ensure that each tablet has the same amount of active ingredient. Sometimes, blending the ingredients is not enough. The active ingredient may segregate from the other ingredients in the blending process. The ingredients may be incompatible because of particle size, particle density, flow characteristics, compressibility, and moisture content. These incompatibilities can cause problems such as segregation during blending or during transfer of the product to the press as well as separation of the active on the tablet press. Granulating the active by itself and then blending it with the rest of the ingredients is one solution to the segregation problem. Or, all or most of the ingredients could be granulated together. The best course of action to ensure that each tablet contains the correct amount of active ingredient, especially if the active is only a small percentage of the tablet ingredients, is to mix the active thoroughly with some or most of the other ingredients and then granulate the blend (i.e., form the blend into granules). Each granule would contain a little of each of the ingredients, and the active ingredient would be distributed evenly throughout the blend. The link between particles in each granule must hold the particles together and keep them from breaking apart before they are compressed. If the active ingredient represents a high overall percentage of the total tablet, then the active must flow, compress, and eject from the tablet press and disintegrate properly. Even in this case, most actives do not cooperate. To solve this problem, the active must be granulated by itself, blended with the other ingredients in the formulation, and compressed on the tablet press.

The nature of the active must be understood and its characteristics may have to be improved to make this process work. Some actives are very fine, small particles that are lighter than other particles. Even if the active is the correct size it may not flow smoothly and flow ability is very important to making a good tablet. Furthermore, the active could be the right particle size and it may flow well, but it may not blend well

with the other ingredients. The active may be too dry or too moist, which prevents proper compression. Once the challenges to making an active perform well are determined, the objective can be identified and granulation can begin. This article explains in simple terms the fundamentals of the granulation process. Three basic techniques are used to prepare powders for compression into a tablet: direct compression, wet granulation, and dry granulation. Ten different formulations would probably require that the powders for each of the formulations be prepared in various combinations. This article investigates the three techniques and discusses how to determine which method is best for individual formulations.

The following steps are involved during the preparation of granules:

**(A)WEIGHING OF THE INGREDIENTS**:

The ingredients should be weighed accurately using a balance of good quality. There should be a double check on the weighing in order to rule out any human error.

**(B)MIXING THE POWDERED INGREDIENTS AND EXCIPENT**:

The main objective of mixing the medicaments and excipents is to prepare a homogeneous mass, that uniform tablets be manufactured .mixing o ingredients should be done in an ascending order of their weight.

**(C)CONVERTING THE MIXED INGREDIENTS INTO GRANULES:**

The crystalline medicaments can be compressed to get good quality compressed tablets. In case the medicaments along with excipents are powder form it can be compressed as such into tablets because: The granules can be prepared by the following methods[4].

**1. WET GRANULATION:**

This is the most widely used method of preparing granules. The powdered medication along with other excipients, such as, diluents, binding agent and a part of the disintegrating agent are moistened with a sufficient quantity of granulating agent in order to make a coherent mass. The coherent mass is then passed through sieve No.8 or 10.if the mass sticks to the wire of the sieve it indicates over moistening. The wet granules are spread in trays and dried at $60^0$C in a hot air oven.

The dried granules are passed through sieve number 20 to collect the granules of uniform size. The lubricating agent, any volatile substance and the remaining part of the disintegrating agent are mixed. These granules are then ready to be compressed. When powders are very fine, fluffy, will not stay blended, or will not compress, then they must be granulated. Fluffy is not a technical term, but it fits the problem well; it means that the required Quantity of powder physically will not fit into the die cavity on the tablet press. The volume of fill (bulk density) is greater than that which is mechanically allowed. Wet granulation, the process of adding a liquid solution to powders, is one of the most common ways to granulate. The process can be very simple or very complex depending on the characteristics of the powders, the final objective of tablet making, and the equipment that is available. Some powders require the addition of only small amounts of a liquid solution to form granules. The liquid solution can be either aqueous based or solvent based. Aqueous solutions have the advantage of being safer to deal with than solvents. Although some granulation processes require only water, many actives are not compatible with water. Water mixed into the powders can form bonds between powder particles that are strong enough to lock them together. However, once the water dries, the powders may fall apart. Therefore, water may not be strong enough to create and hold a bond. In such instances, a Liquid solution that includes a binder (pharmaceutical glue) is required. Povdone, which is a polyvinyl pyrrolidone (PVP), is one of the most commonly used pharmaceutical binders. PVP is not soluble in water, so a solvent must be used to carry the PVP particles in a liquid solution. When PVP and a solvent are mixed with powders, PVP forms a bond with the powders during the process, and the solvent evaporates (dries). Once the solvent has been dried and the powders have formed a more densely held mass, then the granulation is milled. This process results in the formation of granules .Many different types of binders exist. Some binders, called wet binders, only work when added as a solution. Dry binders are preprocessed powders that when mixed with other powders help bind the ingredients together. Binders that can be used wet or dry are also available.

**2. DRY GRANULATION:**

There are certain medicaments which are available in crystalline form or in the form of granules. Such are passed through sieve No.20 or any other specified sieve and then mixed with any additional excipient. This method is used for making tablets of aspirin, sodium bromide, potassium chlorate and dried yeast etc. The dry granulation process is used to form granules without using a liquid solution because the product to be granulated may be sensitive to moisture and heat. Forming granules without moisture requires compacting and densifying the powders. Dry granulation can be conducted on a tablet press using slugging tooling or on a roller compactor commonly referred to as a chilsonator when a tablet press is used for dry granulation, the powders may not possess enough natural flow to feed the product uniformly into the die cavity, resulting in varying degrees of densification. The roller compactor uses an auger-feed system that will consistently deliver powder uniformly between two pressure rollers. The powders are compacted into a ribbon or small pellets between these rollers and milled through a low-shear mill. When the product is compacted properly, and then it can be passed through a mill and final blend before tablet compression. Roller-compaction or dry-granulation equipment offers a wide range of pressures and roll types to attain proper densification. This equipment is loud and dusty compared with other process machinery. Material feed rates are critical for attaining the final objective. The process may require repeated compaction steps to attain the proper granular end point. Typically, a percentage of products does not get compacted and may require screening to remove excessive fines. Again, successful compaction depends on the compatibility of the products being compressed. If fines are not removed or reprocessed, then the batch may contain too many of them, a situation that can contribute to capping, laminating, weight, and hardness problems on the tablet press. The need for screening large amounts of fines is common to roller compaction, and the degree to which it can be managed depends on the nature of the ingredients. Any product that is removed from the rest of the batch because of particle size must be analyzed to determine what is being removed. Roller compacting

the complete formula is not usually necessary. The object is to densify powders and form granules of the products in the formula that must be compacted , mill the granules, and then blend them back in with the rest of the formula's ingredients. Most dry-granulated products do not have problems with picking and sticking because moisture is not present.

**3. Granules by preliminary compression:**

This method is also known as the "slugging method" .the method is used in those cases where the medicament is unstable in presence of moisture. In this process the dry powder is compressed into large tablets of "slugs". These slugs are broken into small pieces which are passed through a specified sieve to collect the granules of suitable size. A lubricating agent and a disintegrating agent are mixed with these granules before compression into the tablets machine.[5]

**II. EXCIPIENTS FOR COMPRESSED TABLETS:**

Compressed tablets usually contain a number of pharmaceutical adjuncts, known as excipients, in addition to the medicinal substance. The use of appropriate excipients is important in the development of the optimum tablets. Excipients determine the bulk of the final product in dosage forms such as tablet, capsule, etc., the speed of disintegration, rate of dissolution/release of drug, protection against moisture, and stability during storage, and compatibility. Excipients should have no bioactivity, no reaction with the drug substance, no effect on the functions of other excipients, and no support of microbiological growth in the product (Banakar & Makoid, 1996). Sections II.A–G describes many of the common adjuncts and excipients used in the pharmaceutical industry.

**A. DILUENTS:**

Diluents increase the volume to a formulation to prepare tablets of the desired size. Widely used fillers are lactose, dextrin, microcrystalline cellulose, starch, pregelatinized starch, powdered sucrose, and calcium phosphate. The filler is selected based on various factors, such as the experience of the manufacturer in the preparation of other tablets, its cost, and compatibility with other formulation ingredients. For example, in the preparation of tablets or capsules of tetracycline antibiotics, a calcium salt should not be

used as filler since calcium interferes with absorption of the antibiotics from the GI tract.

**B. BINDERS (OR ADHESIVE):**

Binders promote the adhesion of particles of the formulation. Such adhesion enables preparation of granules and maintains the integrity of the final tablet. Commonly used binding agents, these are used as an aqueous solution in wet granulation.

**C. LUBRICANTS AND GLIDANTS:**

Lubricant is a substance capable of reducing or preventing friction, heat, and wear when introduced as a film between solid surfaces. It works by coating on the surface of particles, and thus preventing adhesion of the tablet material to the dies and punches. Glyceryl monostearate (USP/NF $CH_2(OH)CH(OH)CH_2O_2CC_{17}H_{35}$) is one example of a lubricant. Lubricants play more than one role in the preparation of tablets as described below.

1. Lubricants improve the flow of granules in the hopper to the die cavity.

2. Lubricants prevent sticking of tablet formulation to the punches and dies during formulation.

3. Lubricants reduce the friction between the tablet and the die wall during the tablet's ejection from the tablet machine.

4. Lubricants give sheen to the finished tablets.

A glidant is a substance that allows particles moving smoothly, continuously, and effortlessly. Both lubricants and glidants have the same effect, but the ways they work are different. Unlike lubricant, glidant works by removing moisture and as a result enhancing flow.

In tableting, a dry lubricant is generally added to the granules to cover each granule with lubricant. The most widely used lubricant is magnesium stearate. (Magnesium stearate is also the most widely used excipient.) Talc and glyceryl monostearate are also commonly used as lubricants. Fumed silicon dioxide is used as a glidant. Talc has both lubricant and glidant effects.

**D. DISINTEGRATOR:**

The breakup of the tablets to smaller particles is important for dissolution of the drug and subsequent bioavailability. Disintegrators promote such breakup. To

rupture or breakup of tablets, disintegrating agents must swell or expand on exposure to aqueous solution. Thus, the most effective disintegrating agents in most tablet systems are those with the highest water uptake property. In general, the more hydrophilic, the better disintegrating agents are therefore highly hydrophilic. Croscarmellose is made by crosslinking CMC. Sodium CMC is made to undergo an internal crosslinking reaction by lowering the pH of the solution, followed by heating. No chemical additives are used. The crosslinking reaction makes the soluble NaCMC insoluble but crosslinked CMC possesses swellable character owing to its highly hy-drophilic nature. This is why crosslinked CMC, such as Ac-Di-Sol®, can be used as a super disintegrant for tablet dissolution. Croscarmellose is a super disintegrant for tablet dissolution which employs various mecha-nisms to cause rapid tablet breakdown. Water wicking and dis-integrant swelling represent two means commonly used in determining disintegrant performance. The fibrous nature of Ac-Di-Sol® gives it out-standing water wicking capabilities and it crosslinked chemical structure creates an insoluble hydrophilic, highly absorbant material with good swelling properties. Please note that microcrystalline cellulose has various functions in direct compression. It can be used as a binder, disintegrant, lubricant, and filler. Microcrystalline cellulose was introduced as a tablet binder in the 1960s and since then provided a major advancement for the production of many solid dosage formulations. Microcrystalline cellulose allows direct compression of tablets and wet granulation processes. In wet granulation, it can be used as a binder and for rapid wicking action. It can be com-pressed to form various shapes and sizes that disintegrate rapidly in water. Furthermore, the binding capacity and absorptive power together with its anti-caking properties makes it very effective in formulating dry, free flowing mixtures for tablets and capsules. The limitations of MCC are low bulk density, poor flow characteristics, loss of compactability after wet granulation, and sensitivity to lubricants (Sherwood & Becker, 1998). To alleviate some of the known deficiencies of conventional MCC and to offer enhanced performance, silicified MCC (SMCC) was developed recently (Sherwood & Becker,

1998). SMCC is produced by combining MCC with colloidal silicon dioxide. Avicel® RC/CL is a commercial product from FMC Corp. Microcrystals of Avicel® microcrystalline cellulose (< 0.2 µm) are leashed together with chains of soluble CMC to form a mesh-like powder particle by spray drying. Avicel® RC/CL is a water-dispersible organic hydrocolloid used in the preparation of pharmaceutical suspensions and emulsions. The colloidal MCC provides a structured dispersion vehicle while the CMC facilitates dispersion and serves as a protective colloid. Applications have been:

1. Oil/water emulsifier: pharmaceutical and cosmetic lotions and creams

2. Emulsion stabilizer: pharmaceutical and cosmetic creams

3. Foam stabilizer: aerosol foams

4. Suspending agent: pharmaceutical and cosmetic suspensions, reconstitutable pharmaceutical suspensions such as antibiotics

5. Bodying agent, thickener, opacifier: pharmaceutical and cosmetic creams, vaginal gels, cosmetic gels.

**E. WETTING AGENT:**

Water molecules attract each other equally in all directions. Water molecules on the surface, however, can only be pulled into the bulk water by water molecules underneath, since there are no water molecules to pull in the opposite direction. The surface tension of water is strong enough to support the weight of tiny insects such as water striders. The surface tension in action can be visualized by placing a small drop of alcohol on a thin layer of water. Alcohol with lower surface tension mixes with water causing reduction in the surface tension in the local region. Owing to the higher surface tension of water in the neighbor, water is pulled from the alcohol dropped region into the neighbor, and this leads to the formation of a dry spot in the middle of the water layer.

The first step toward dissolution of a tablet is wetting of the surface. If the surface of a tablet is not hydrophilic enough to allow water spread and absorb into the tablet, dissolution will not take place or will take a long time and the bioavailability will be decreased. To increase the wetting, various wetting agents can be used. A wetting

agent is a surfactant (*i.e.*, surface active agent) which allows easy spreading of water on the surface. It also makes water easy to displace air and spread over the surface inside the tablet.

The effect of a wetting agent can be realized by measuring the contact angle between the surface and the wetting liquid (*i.e.*, aqueous solution such as gastric juice in our case). As the wetting agent becomes more effective, the contact angle becomes smaller. If the surface is very hydrophilic, such as clean glass, the contact angle is almost zero. This means that water spread without forming any water droplets.

Surfactants have both polar and nonpolar groups. For this reason, they are also called amphiphiles. The amphiphilic property makes surfactants to possess a certain affinity to both polar and nonpolar solvents. The extent of the affinity to either polar or nonpolar solvent depends on the nature and the number of the polar and nonpolar groups present. Thus, a surfactant may be predominantly hydrophilic (water-loving), predominantly lipophilic (oil-loving), or well balanced between these two extremes. Since the balance between hydrophilic and lipophilic properties of a surfactant is important, an arbitrary scale of values is used for a quantitative comparison of the hydrophilic-lipophilic balance (HLB) of different surfactants. The scale ranges from 0 to 20 and surfactants with the HLB value larger than 10 are more hydrophilic, while those with less than 10 are more lipophilic. For the surfactants to be adsorbed to the tablet surface (or any solid sur-face), their HLB values must be in a certain range. Wetting agents are surfactants' with the HLB values between 7 and 9. Examples are sorbitan monolaurate (Span® 20; HLB = 8.6), polyethylene lauryl ether (Brij® 30; HLB = 9.5), and gelatin (Pharmagel® B; HLB = 9.8).

Surfactants spread on water quite easily and this can be visualized us-ing the powder of lycopodium (club moss spores), which are small and light enough to spread and do not aggregate at the air/water interface. If olive oil or oleic acid is dropped on water covered with lycopodium (*e.g.*, by using a clean toothpick), olive oil or oleic acid spreads quickly on the water surface, and this can be visualized by quick movement of lyco-podium. The same result can be obtained by spraying other surfactants, such as WD-40 (polydimethyl siloxane).

Another demonstration could be extinguishing hexane fire on water by touching the water surface with a tiny piece of soap mounted on a spatula. When agents which are not sur-face active such as mineral oil are applied to the water, they form a lens instead of spreading.[6]

**2. COMPRESSION OF GRANULES INTO TABLETS:**

The dried granules are compressed into tablets in a machine known as a tablets making machine. The various types of machines used for this purpose are:

- Single punch tablets machine which may be hand-operated or electrically operating,
- Multipunch tablet machine,
- Rotary tablet machine and
- Dry coat tablet machine

In all these tablets machines the compression is achieved by filling the required quantity of granules into the dies and then compressing them in between the lower punch and the upper punch. The single punch machine is used for small scale manufacturing. Rotary machine, having about 70 sets of dies produce about 1200 tablets in one minute.

**SINGLE PUNCH TABLET MACHINE:**

1. After ejection of tablet it is displaced by the shoe of the hopper. as it moves back to the die for next tablet.
2. OUTPUT:200 TABS per minute
3. Used in production of small batches.
4. It poses a die and a pair of punches.
5. The amount of powder fill in to the die is controlled by the position of the lower punch.

**MULTI-PUNCH TABLET MACHINE**

In a multi punch tablet machine, 2 to 12 dies on a big platform. The no of punches depends upon the no of dies fixed to the platform. The working of the machine is similar to that of asingle punch machine but in this machine in one stroke as many tablets are compressed as a number of dies instead of just one tablet as in a single punch machine.

**ROTARY TABLET MACHINE**

1. Developed to increase the output.

2. It operates with a number of dies & sets of punches which can vary considerably.
3. Both the dies & punches rotate during the operation.

- The vertical movement of the punches is controlled by tracks that pass over cams and rolls used to control the volume of powder fed in to the die and the pressure applied during compression

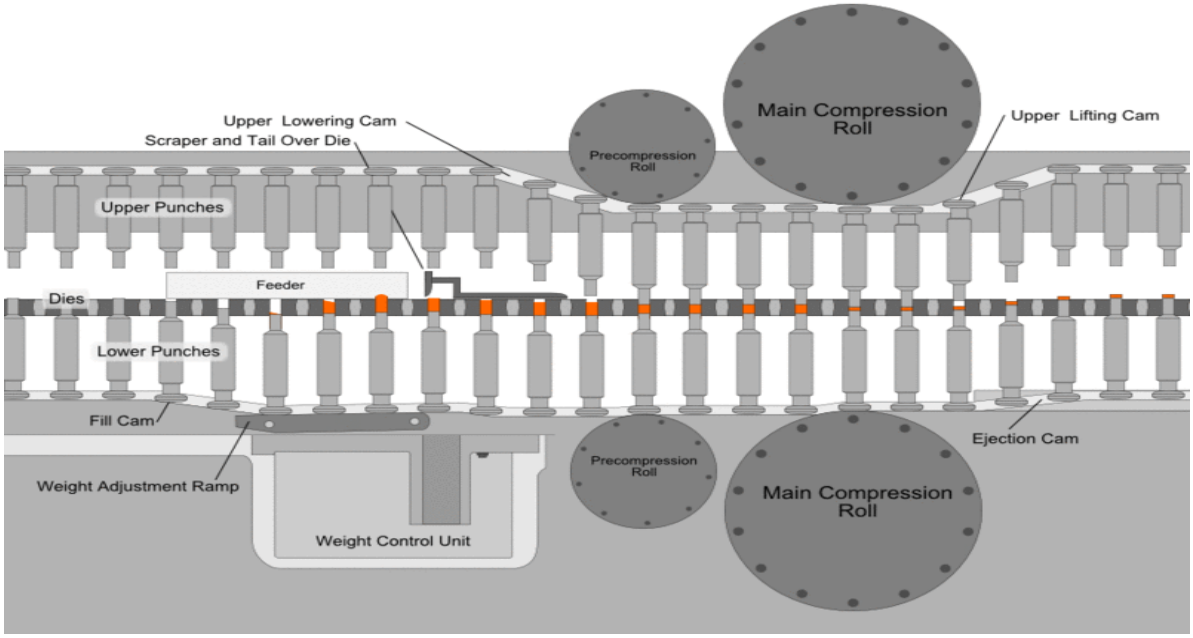


**FIGURE NO. 1**

**DRY COTA TABLETS MACHINE**

The machine is used for manufacturing of multi-compressed, multi-coloured and press-coated tablets. In this machine two rotary machine works simultaneously by a single driven shaft. The core tablet is prepared in one machine which is transferred to the second machine for compress coating.

**(C) COATING OF TABLETS:**

Tablet are coated for the following purposes

1. To mask the unpleasant
2. To improve the appearance of tablets
3. To prevent the medicament from atmospheric effect

4. To control the site of drugs (enteric coating).
5. To produce the sustained released product.

The tablet coating is generally done by using any of the following processes:

**1. PAN COATING:**

In this technique the coating is done in a pan made up of copper of stainless steel. The pan is rotated with the help of electric motor. The tablet to be coated is placed in the pan. Hot air is blown in. The speed of the pan is adjusted in such a way that the tablet remains separated from each other in the pan. After coating, polishing is done in a polishing pan. Pan coating technique is used for sugar coating.

**2. PRESS COATING:**

In this technique the granules of coating material are prepared and a layer of coating material is placed on the preformed tablets in a drycota rotary tablet machine. The operation is carried out automatically a number of steps.[7]

**3. SUGAR COATING:**

Compressed tablets can be coated with a sugar layer. Since the coating is water-soluble, it is quickly dissolved in aqueous environment (*e.g.*, in the gastric juice after oral administration). The main purposes of having a sugar coating are:

(1) To protect the drug from the air and humidity;

(2) To provide a taste or a smell barrier to objectionable tasting or smelling drug;

(3) To enhance the appearance of compressed tablets.

Sugar coating of compressed tablets requires more time and expertise, and this may increase the cost of manufacturing.

Sugar coating also increases the size and weight of the compressed tablets. If the size of tablets is too small then the size is increased intention-ally by sugar coating.

**1. PROCESS OF SUGAR COATING:**

**(A) WATERPROOFING AND SEALING:**

If tablets contain components that may absorb moisture or be adversely affected on contact with moisture, a waterproofing layer of coating of a material such as shellac is placed on the compressed tablets first.

The shellac or other waterproofing agent is applied in solution.

**(B) SUBCOATING:**

Tablets with the waterproofing or sealing coat are given about 3 to 5 subcoats of sugar-based syrup. This is for rounding the tablet and bonding the sugar coating to the tablet. A subcoating is applied by adding heavy syrup containing gelatin or PVP to the tablets as they roll in the coating pan.

**(C) SMOOTHING AND FINAL ROUNDING:**

After subcoating, 5 to 10 additional coating of very thick syrup are applied to complete the rounding of the tablet and smoothing the coating. The syrup used in this step may be sucrose-based simple syrup, or may have additional components like starch and calcium carbonate.

**(D) FINISHING AND COLORING:**

Several coats of thin syrup containing the desired colorant (if any) are applied to attain the final smoothness and the appropriate color to the tablets.

**(E) POLISHING:**

Coated tablets may be polished in special drum-shaped pans made by stretching a cloth fabric over a metal frame or in ordinary coating pans lined with canvas. The fabric or canvas may be impregnated with a wax (such as carnauba wax) with or without the addition of beeswax. The tablets are polished as they roll about in the pan. Alternatively, the wax may be dissolved in anonaqueous solvent such as acetone or petroleum benzin and sprayed on the rolling tablets in small amounts.

**FILM COATING:**

Compressed tablets can be coated with a thin layer of a polymer, which may be either water-soluble or water-insoluble. The polymer film has an advantage over sugar-coating in that the polymer film is more durable, less bulky, and less time-consuming to apply. Upon oral administration, the polymer film may remain intact or dissolve in the GI tract depending on the water-solubility.

Film-coating solutions may be nonaqueous or aqueous. The nonaqueous solutions generally contain various materials to provide the desired coating to the tablets. A film former should be able to produce smooth, thin films and be applicable to a variety of tablet shapes. An alloying

substance provides water-solubility or permeability to the film to ensure penetration by body fluids and therapeutic availability. A plasticizer produces the flexibility and elasticity of the coating. This may enhance durability. Surfactants enhance spreadability of the film during application. Opaquants and colorants make the appearance of the coated tab-lets handsome and distinctive. Sweeteners, flavors, and aromas enhance the acceptability of the tablet to the patient. A glossant provides luster to the tablets without a separate polishing operation.

**ENTERIC COATING:**

The many water-soluble polymers, some polymers show the property of pH-dependent water-solubility. Some polymers do not dissolve at low pH (*e.g.*, pH in the stomach) but readily dissolve at neutral pH (*e.g.*, pH in the intestine). If such a polymer film is coated on compressed tablets, the tablets will resist dissolution or disruption in the stomach but not in the intestine. Such tablets are known as enteric-coated tablets.

Since enteric-coated tablets do not dissolve in the stomach, they are useful for the drugs which are not stable in gastric juice (*i.e.*, at low pH) or are irritating to the gastric mucosa. By-passing the stomach and release of acid-labile drugs in the intestine will enhance the drug absorption significantly.[8]

**EVALUATATION OF TABLETS:**

**A. PHYSICAL SPECFICATION OF COMPRESSED TABLETS:**

When compressed tablets are prepared, various physical specifications are examined (for quality control). They should be controlled to assure not only the outward appearance of the product but also its therapeutic efficacy. The shapes of the compressed tablets differ widely. It can be round, oblong, or triangular. Tablets may be flat or have varying degree of convexity depend upon the counter of the punches, such as flat face, shallow cup, standard cup, deep cup or modified ball. Some tablets are scored or grooved in halves, thirds, or quadrants. This allows fairly accurate breaking of the tablet for the administration of a partial amount. In general scored tablets are grooved on a single side. Tablet shapes and size are determined by the die and punches used for the compression of the tablet.

**(B) DISINTEGRATION AND DISSOLUTION TEST:**

Tablet disintegration is the first step for a drug to become bioavailable. The tablet must first disintegrate and discharge the drug to the body fluids. The drug in the disintegrated tablets (*i.e.*, drug in particulates) must be dissolved in the fluid to be absorbed into the blood stream. Some drugs, such as antacids or antidiarrheals, are intended to be used locally in the GI tract. In these instances, tablet disintegration provides drug particles with a greater surface area for increased localized activity. Since the disintegration and dissolution of tablets are so important that each batch of tablets must meet the specified disintegration and dissolution standards[9].

**3. FRIABILITY TEST**

Normally during the course of compression of tablets a sufficient pressure is applied on the granules, so that the tablets can withstand the wear and tear during transportation and handling. But in spite of observing all the precautions, the tablets show considerable powdering after normal handling, giving an undesirable appearance. Friability test is performed to evaluate the ability of the tablets to withstand wear and tear in packing, handling and transporting. The apparatus used to perform this test is known as "friabilator". The apparatus consists of a plastic chamber, which is divided into two parts and it revolves at a speed of 25r.p.m. twenty tablets are weighed and placed in the plastic chamber. The chamber is rotated for 4 minutes or 100 revolutions. During each revolution the tablets falls from a distance of 6 inch. The tablets are removed for the chamber after 100 revolution and weighed. Loss in weight indicates the friability. The tablets are considerable to be of good quality if the loss in weight is less than 0.8%[10]

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