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Review of Past and Contemporary Coating Technology Used In Industrial Applications

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ABSTRACT
Coating is the application of an essentially dry outer layer of coating material to the surface of a dosage form in order to provide specific benefits such as product identification and drug release modification. Many coating techniques have been developed for solvent-based or solvent-free processes to improve the efficiency of the coating process. The coating will protect the medicine from the environment while also helping to improve its stability. Improve stability because the core contains a substance that is light incompatible and sensitive to oxidation process. It cuts down on friction and speeds up the packaging process. The main advantage of tablet coating is that it allows us to control the drug's release rate while also shielding the product from the medicine's disagreeable taste and odour and giving it a smooth feel that makes it simpler to swallow. Traditional in vitro investigations of coating condition or process variable optimization (e.g., dissolving studies) are time-consuming, labor-intensive, and ineffective, hence several methods have been presented as alternatives. Multivariate imaging (MIA) and wavelet texture analysis (MWTA) can be used to describe coated tablets . Modified medication release is frequently advantageous for increasing treatment efficacy and patient compliance while also extending the duration of action. As a result, tablet film coating with various polymers has been widely researched in order to control the pace and/or sites of drug release and achieve customised drug release. To establish the quality of tablet coat, researchers must look into film and film-tablet interactions.

KEYWORDS: Coating process,Coating design,Coating techniques,Trends in coating,

I. INTRODUCTION

A tablet is a solid pharmaceutical dosage form made composed of a powdered mixture of active substances and excipients that has been crushed or compressed into a solid form. Tablets are one of the most convenient and preferred oral dosage forms due to their many advantages, including ease of administration, high patient adherence, and cost-effectiveness.Coating is the application of an essentially dry outer layer of coating material to the surface of a dosage form in order to provide specific benefits such as product identification and drug release modification. From the three types of tablet-coating methods (sugar coating, film coating, and press coating), film coating is the most extensively utilised approach to overcome numerous challenges encountered during manufacture, transportation, storage, and therapeutic use of medicinal products. In a number of typical pharmaceutical dosage forms, coatings are employed on the outside of tablets and on components supplied within gelatine capsules. The tablet coating technique can be tweaked to control how soon the active medications are absorbed in the body after ingestion. Many coating techniques have been developed for solvent-based or solvent-free processes to improve the efficiency of the coating process. However, each method has its own set of advantages and disadvantages, and future technological advancements may be critical. Tablet film coating is a technology-driven process, with advances in coating technology, equipment, analytical procedures, and protective coatings all contributing to the evolution of coated pharmaceutical formulations. (1)

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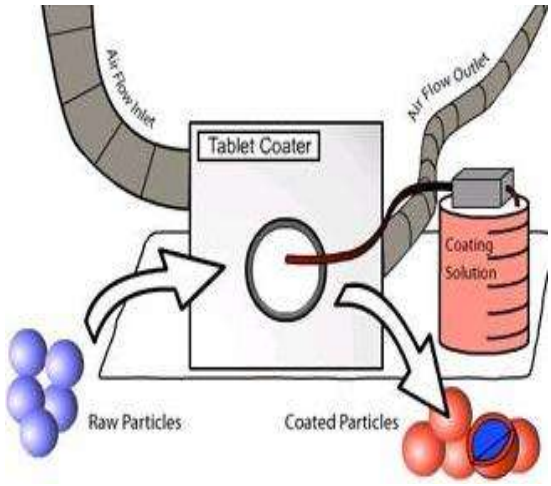

1.Kamble N. et al Innovations in Tablet Coating Technology: A Review.
International Journalof Applied Biology and Pharmaceutical
Technology, 2011, 214– 218
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BASICS PRINCIPLES

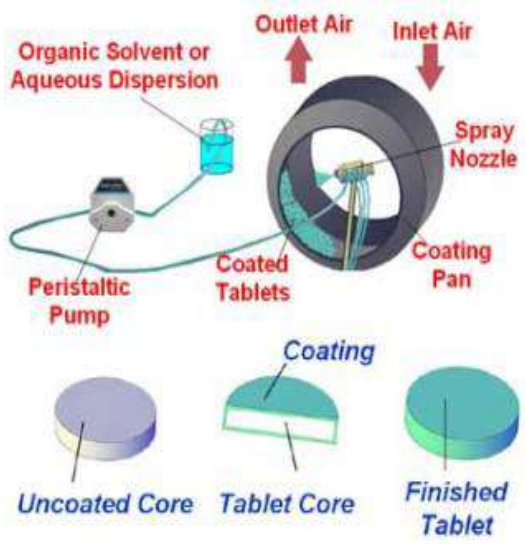
Tablet coating is the process of applying a coating composition on a moving bed of tablets while using hot air to help the solvent evaporate. Solution that has as minimal impact on the release pattern as possible while remaining inconspicuous in appearance. To avoid chemical incompatibilities, another drug or formula is incorporated into the coating and to ensure that drugs are released in a controlled manner. The use of specific colours and contrast printing to increase the pharmaceutical elegance. An acid-resistant enteric coating is being used to protect the drug from the stomach's gastric environment. (3)

There are three types of equipment used in the coating process.

- The coating pan with perforations.
- Coater with a fluidized bed.
- Coating pan (traditional).

COATING PROCESS, DESIGN AND CONTROL

The coating solutions are sprayed onto the tablets in maximal coating techniques because the tablets are stirred in a pan. As the solution is sprayed, a thin film forms that attaches to each tablet immediately.The pharmaceutical business frequently uses rotating coating pans. Even after the pills have tumbled, the liquid coating gun is introduced into the pan to coat the uncoated tablets. The liquid component of the coating gun is subsequently vaporised by blowing air over the tumbling medicines' surface. In fact, a fluid bed coater works by moving air through a bed of pills at a fast enough speed to help and separate the medications as individual items. The drugs are sprayed with the coating mixture as soon as they are separated. Subsequent steps that are involved are Batch identification and Recipe selection followed by Preheating,sprayingonto the tablets Then Drying later Cooling of tablet and Unloading is done. (4)



ADVANTAGES OF TABLET COATING

The main benefit of tablet coating is that it allows us to adjust the drug's release rate and shields from the medicine's unpleasant taste,odor and provides the product a smooth feel that makes it easier to swallow. It not only improves product acceptability but by delivering regulated, prolonged release; the coating can lower the frequency of dosage.It protects the physical or chemical integrity of the medicine against humidity, heat, and temperature this prevents the drug from being dissolved in thestomach's acidic environment until it reaches the intestine.(5)

DISADVANTAGES OF TABLET COATING

The most significant downside of tablet coating is that the procedure is tedious and time-consuming, making it costly.The formulation's pharmacodynamic properties may interact with the tablet coating.The process can cause a variety of problems in the coating, such as chipping, cracking,

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and so on because the coating process is more sophisticated than other procedures, a trained person is necessary to handle it. (6)

TRADITIONAL COATING TECHNIQUES

Sugar coating: Steps in sugar coating:

1. 2.Invensys Eurotherm. The Tablet Coating Process [Cited 2012 Aug. 18],
2. Available from http://www.eurotherm.com/industries/life-
3. sciences/applications/tablet-coating/

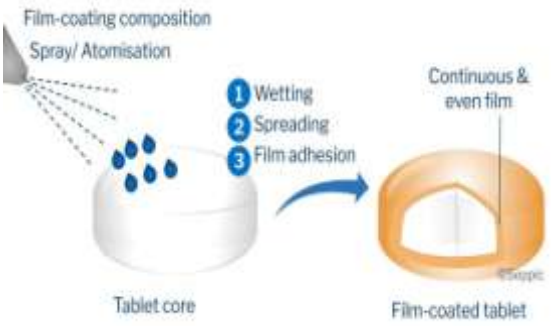
Seal coating: Sugar-coatings are aqueous formulations which allow water to penetrate directly into the tablet core, potentially affecting product stability and thus causing premature tablet dissolution.

Sealing (Waterproofing): This includes the application of one or more coats of water-proofing substance or material in the form of alcoholic spray, such as pharmaceutical Acrylic or synthetic polymers like CAP.

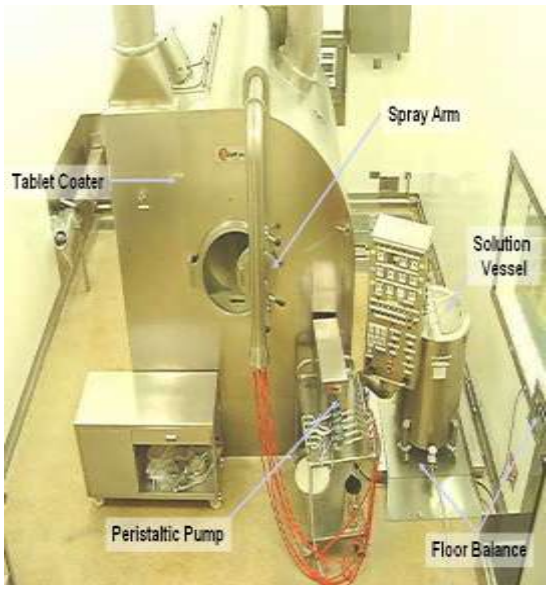
Sub coating: Sugar coatings are usually applied in large quantities to the tablet core, leading in a 50-100 percent growth in tablet weight.

Smoothing coating: To hide defects in the tablet surface produced by sub coating and to achieve the desired colour. "Grossing syrups" are the first syrup coatings that contain some suspended powders. After that, dilute colours can be added to create a coloured base that will assist in uniform coating in subsequent steps. Finally, syrup standard solutions the dye would be applied until the appropriate size and colour are achieved.

Finishing: Syrup coating towards the end.Just a few clear applications of syrup are required.



Film coating: Film coating and sugar coating both use the same equipment and follow the same process parameters.



Film coating process in Tablet manufacturing pharmaceutical industry

Method of Pan-Pouring: The sugar coating on a pan is the same as the sugar coating on a pan.The method is time-consuming and technique-dependent. And the operator's ability Over wetting is more likely with aqueous-based film coating.

Pan-Spraying Method: Use of an automated spraying system for pan-spraying.

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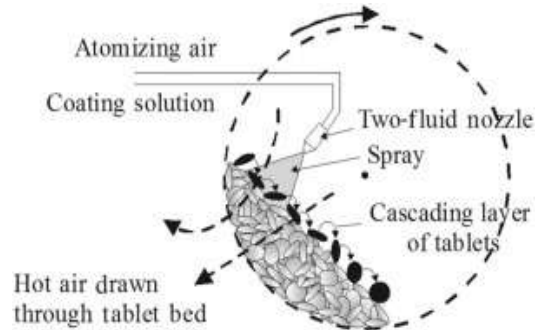
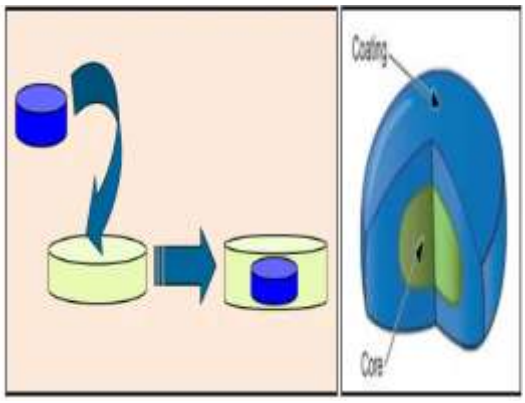


RECENT TECHNOLOGY

Traditional in vitro investigations of coating condition or process variable optimization (e.g., dissolving studies) are time-consuming, labor-intensive, and ineffective, hence several methods have been presented as alternatives. To describe coated tablets (e.g., colour uniformity, surface roughness, and erosion), multivariate imaging (MIA) and wavelet texture analysis (MWTA) can be used. These procedures are simple, cost-effective, and ideal for industrial applications. While traditional human taste panel techniques have issues with personal evaluation of tastes and difficulties interpreting results, the electronic tongue is a useful diagnostic technique for evaluating the taste-masking effect of film coated tablets, especially in paediatric formulations. The electronic tongue is a gadget that duplicates the human sense of taste by using chemical sensors and pattern recognition systems. This sensing device's advantages include inexpensive manufacturing and analysis costs, the capacity to analyse small sample volumes, the ability to automate analytical processes, and application in on-line monitoring. (7)

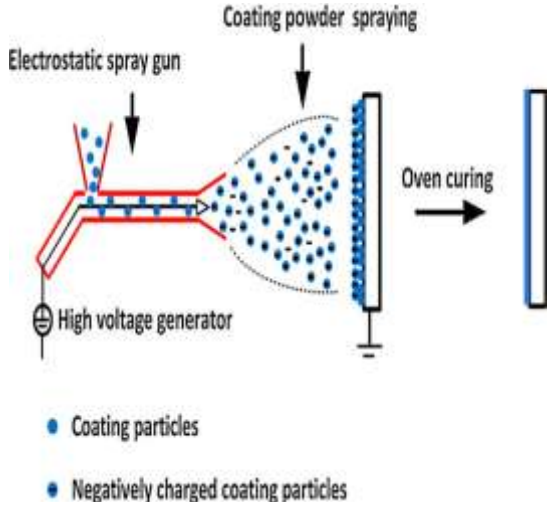
Compression coating:

Inner core material and surrounding coat are included in this type of tablet. One turret houses the core, which is a little porous tablet. A larger die hollow area is employed in every other turret for the preparation of the last tablet, where the coat cloth is packed to half of the space, the centre tablet is robotically moved, the remaining space is filled with coat fabric, and finally compression force is applied. Because the coat is water soluble, it should dissolve easily after ingesting.



Electro static coating:

Powder is sprayed across a powerful electric region with a high unfastened-ion concentration in this coating. The particles are charged as they pass through this area. Pauthenier's equation is used to control this process. Field power, powder particle size and shape, and the time a particle spends within the charged region are the factors that most substantially influence charging.



Magnetically assisted impaction coating (MAIC):

In a magnetically assisted impaction coating tool, this approach is utilised to estimate the coating time. The mixture of host, guest, and magnetic particles is meant to maintain a fluidized state with a Maxwell-Boltzmann-like velocity distribution. Collisions between particles are thought to be important for the guest debris to adhere to the host debris, and as a result, they produce a semi-permanent coating on the host debris's surface. (9)

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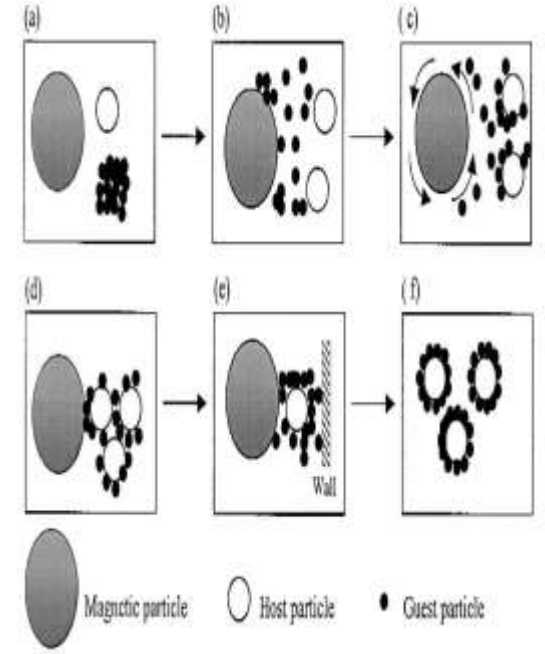
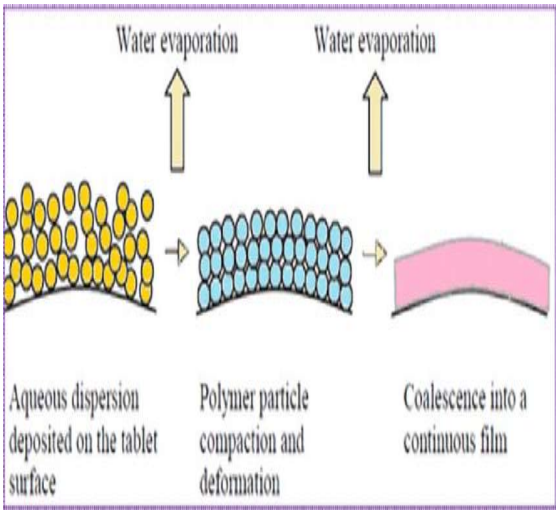


Aqueous film coating technology:

Because the sugar-coating technique is time-consuming and dependent on the talents of the coating operator, it has been supplanted by advances in film coating technology. Organic solvents, such as methylene, were first used in this method.



Super cell coating technology:

Super cell coating is a new sort of tablet coating that correctly accumulates a certain amount of coating materials on medications, even if they're exceedingly hygroscopic or friable. Edges of tablets can be ground off, it can be filled in with coating material, and edges and corners may not be covered with the same thickness as the tablet faces in due to the tablets being stacked in large rotating pans and vented for adequate air drying.

Dip coating:

Dip coating is a well-known method of producing thin films for research purposes. On flat or cylindrical surfaces, uniform films can be applied. Spin coating is more commonly employed in commercial initiatives.There are five phases to the dip coating process: (10)

a) **Immersion:** At a steady pace, the substrate is immersed in the coating material solution.

b) **Start-up:** The substrate was hauled up after remaining inside the solution for some time.

c) **Deposition:** The thin layer deposits itself on the substrate as it is drawn up.

d) **Drainage:** The surface will drain any excess liquid.

e) **Evaporation:** The solvent then evaporates from the liquid, leaving a thin film behind.

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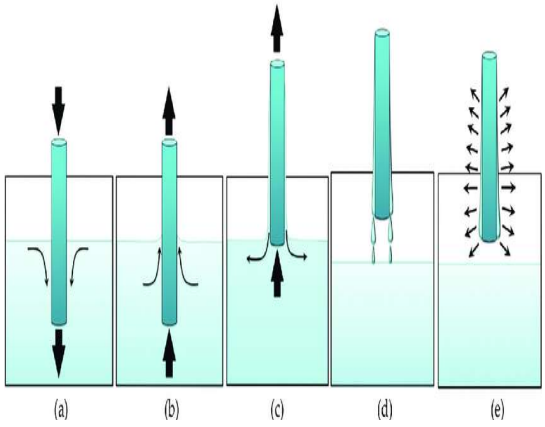

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TRADITIONAL COATING TECHNIQUES:-
Generally three methods are used for tablet coating
1.SUGAR COATING
2.FILM COATING
3.ENTERIC COATING
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Pharmaceutical Application of Film Coating:

Modified Drug Release:

Modified medication release is frequently advantageous for increasing treatment efficacy and patient compliance while also extending the duration of action. As a result, tablet film coating with various polymers has been widely researched in order to control the pace and/or sites of drug release and achieve customised drug release. Here are some examples of drug release modification techniques using film coating. (11)

Delayed Drug Release:

Enteric coating has the primary benefit of improving drug stability in the harsh gastrointestinal environment and/or reducing drug-induced gastric discomfort. Enteric film coating uses polymers with pH-dependent solubility or water-insoluble polymers to avoid premature medication release in the stomach and ensure drug release primarily in the small intestine. These polymers can be employed alone, in combination, or one after the other to ensure delayed medication release. (12)

Sustained Drug Release:

To modulate the rate of drug release, the amount of polymers employed for surface treatment and the physicochemical properties of the drug can be used. It can also be altered by altering the thickness, tortuosity, and permeability of the coating layer. Water-insoluble and pH-independent coating materials for prolonged drug release include ethyl cellulose, polyvinyl acetate, and polymethacrylate copolymers. These polymers have exceptional film forming properties and mechanical resilience, making them ideal for long-term drug release coatings. Combining hydrophobic and hydrophilic polymers has also been tried to improve medication release. With a longer Tmax and lower Cmax than the rapid release tablet, the controlled release tablet extended drug release. (13)

Improved Drug Stability:

The stability of APIs or pharmacological products may be affected by external environmental conditions such as temperature, humidity, and light, as well as compatibility between excipients and APIs. Moisture has the potential to damage pharmaceuticals by hydrolysis and to cause storage instability. Moisture-absorbent drug products can expand, split, and disintegrate inside the container, causing significant changes in product appearance and shortening the shelf life of the medicine. When exposed to light, APIs can oxidise and hydrolyze. To avoid these external variables from causing API or drug product instability, a film coating can be applied to the surface of core tablets. To protect the main tablet from external conditions, hydrophobic materials such as lipids, wax, and triglycerides are widely used as sub-coatings and outer-coatings. (14)

Taste Masking:

Unpleasant taste, especially in children and the elderly, is a key deterrent to patient compliance. Bitterness is the taste that most people dislike. As a result, concealing bitter taste in oral dosage forms is a good strategy to improve treatment adherence and therapeutic efficiency. To conceal taste, scientists have used chemical modification (prodrug method), salt creation, interaction with ionogenic polymers (methacrylate), complexation, integration of

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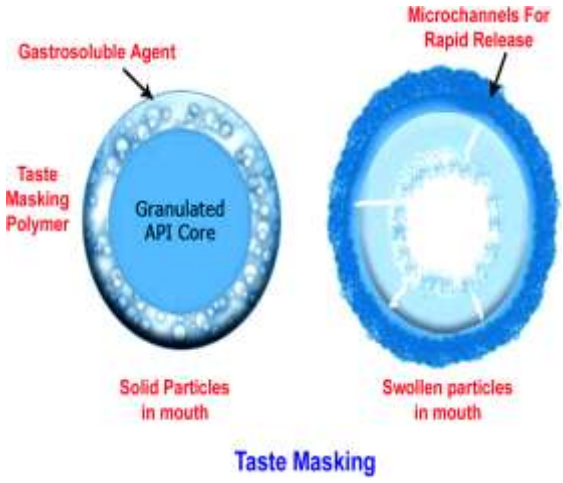
flavour enhancers (e.g., sweeteners) in the formulation, and surface coating. The most effective and widely acknowledged approach for flavour masking is film coating, which is especially well adapted to microencapsulating microscopic particles to create flavour-masked multi-unit dosage forms. (15)



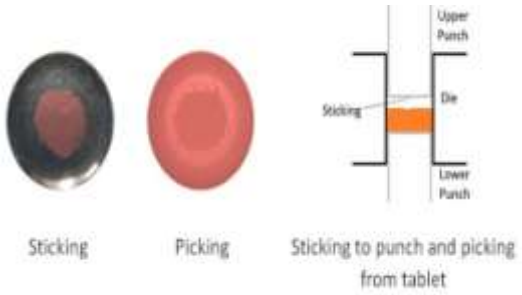
Active Film Coating:

Active film coating is the process of coating a solid dosage unit (tablet or pellet) with a solution or suspension containing APIs. This coating approach is very useful for creating fixed-dose combination (FDC) products to control drug release rate or physically prevent interaction between APIs, and it meets formulation needs such as rapid drug release and improved product stability. Water-soluble drugs can be sprayed onto core tablets after being dissolved in an aqueous coating solution or suspension. As a result, establishing an active coating approach for water-soluble pharmaceuticals is less difficult than for water-insoluble drugs. (16)

DEFECTS AND SOLUTIONS OF COATED TABLETS

The defects in tablets and solutions of coated tablets are given below. (17)

Picking and sticking: When the coating separates a section of the tablet from the core, this occurs. Over-wetting the pills, under-drying the tablets, or weak or soft granules are all causes.



Bridging: This happens when the coating fills in the text or logo on the tablet, and it's usually caused by too much solution, a bad tablet embossing design, a high coating viscosity, a large number of particles in the solution, or an incorrect atomization pressure.

Erosion: Soft tablets, an over-wetted tablet surface, or a lack of tablet surface firmness can all cause this.

Twinning: This is the name for two tablets sticking together during the coating process, which is a typical problem with capsule-shaped tablets. Change the pan speed and spray rate to address the problem.

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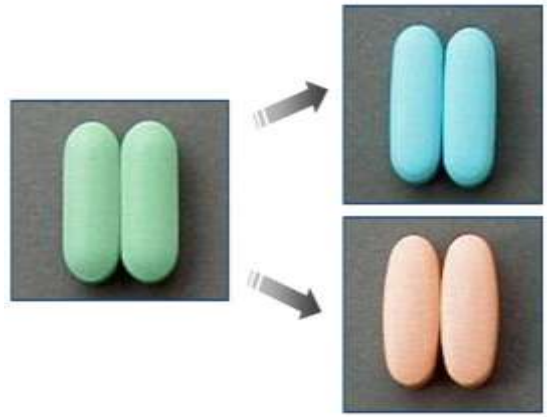
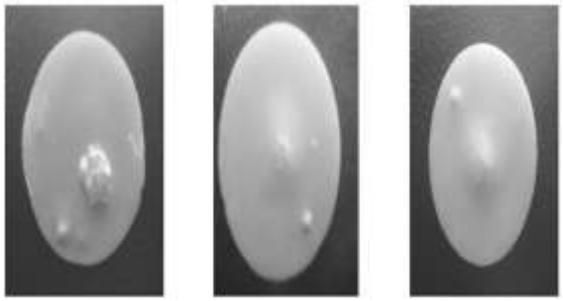
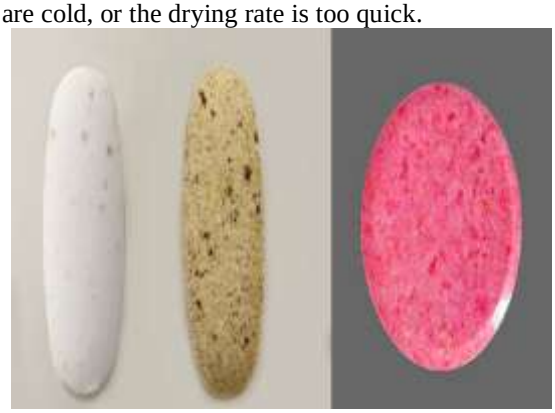


Blistering: Blistering can be caused by the quick evaporation of the solvent from the coated tablets, as well as the influence of high temperatures on the film's strength and flexibility. In this instance, milder conditions are necessary.



Mottled color: This can happen if the coating solution isn't made properly, the actual spray rate isn't the same as the desired rate, the tablet cores are cold, or the drying rate is too quick.



TABLET EVALUATION

The investigation of film and film-tablet interactions is required to determine the quality of tablet coat. The methods listed below can be used to conduct tests. (18)

1. The force required to remove the film off the tablet surface is measured using adhesion tests using tensile strength testers.
2. A tablet hardness tester should be used to measure the dimetric crushing strength of coated tablets.
3. Coated tablet disintegration and dissolving rates should also be investigated.
4. On coated tablets, stability tests can be performed to see if temperature and humidity fluctuations cause film flaws.
5. Measurement of tablet weight growth and exposure to high humidity offer relative information on the film's protection.

II. CONCLUSION:

For more than a century, pharmaceutical solid-dosage forms, particularly tablets, have been coated. Although such a technique is frequently applied to a dosage form that is functionally complete, which may make usquestion the necessity for the additional expenditure, it is clear that coating methods are still widely used in pharmaceutical manufacture.

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