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A BRIEF OVERVIEW ON MODERN DEVELOPMENTS OF TABLET COATING TECHNOLOGY

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ABSTRACT

Traditional tablets are solid oral dosage forms that include excipients and an active pharmaceutical ingredient (API). Usually, dry granulation, wet granulation, or direct compression are used to make tablets. Depending on the formulation, they are made to break down and release the API either gradually or instantly. A crucial step in pharmaceutical technology, tablet coating is intended to increase the stability, patient compliance, and therapeutic efficacy of oral dosage forms. The latest developments concentrate on novel coating methods such as magnetically assisted impaction coating (MAIC), electrostatic dry coatings, aqueous film coatings, supercell coating technology, supercritical fluid spray coating, and the use of nanotechnology to increase functionality and accuracy. Furthermore, the present situation in tablet coating is analyzed in terms of industry trends and regulatory compliance. The paper illustrates the changing landscape of tablet coating technologies in contemporary pharmaceutical manufacturing and development, highlighting the possibilities.

KEYWORDS: Tablet Coating, MAIC,

INTRODUCTION

A pharmaceutical dose form is called an tablet. The active pharmaceutical ingredient and many excipients, which are often in powder form and crushed into a solid dosage form, make up the tablet.

The process of coating involves applying a layer of coating material to a dosage form's surface in order to achieve specific advantages, most notably improved medication release from the dosage form and easier product identification. One tablets that have one or more layers of a mixture of different materials, such as resins, gums, sugar, plasticiser, etc., covering them are called coated tablets. Coating materials are typically applied as suspensions or solutions in environments where the vehicle evaporates.[1]

A batch of tablets is coated with a coating composition in a tumbled coating pan, covering the tablet surfaces with a sticky polymeric film. The tablet surface undergoes a transformation during the process, going from a sticky liquid to a tacky semisolid and finally to a dry, non-sticky surface.[2]

Objectives Of Table Coating

The main goals of tablet coating are as follows

- To improve patient compliance and cover up the unpleasant taste, colour, or smell of the tablet.
- To promote stability by providing the medicine with chemical and/or physical protection and shielding it from the outside world, especially light, moisture, and air.
- To increase the drug's shelf life and make large dose forms easier to swallow.
- To delay the loss of substances that are volatile.
- To alter and/or regulate the rate of drug release in products that are sustained-release, delayed-release (enteric coated), and repeat-action.
- Combining incompatible medications into a single dose form
- Increasing the dose form's mechanical strength.[3,5]

Drawbacks of Coating

1. Compared to standard formulation, tablet coating is more costly.

2. Chipping, capping, mottling, and bridging are some of the ways that tablet coating can cause the active components to deteriorate.

3. Serious side effects can result from certain medications' increased sensitivity to the coating**.**

Coating Process

Rotating coating pans are frequently used for this. Liquid coating solutions are applied to the uncoated tablet beds inside the pan during the tablet coating process. The liquid portion of the

coating solution evaporates as air passes over the uncoated tablets, leaving a solid coated layer over the tumbling tablets. The following lists of several stages.[6,7]

i. Identifying the batch and choosing the coating type. (Sugarcoating or film)

ii. Dispensing (dosing all necessary raw ingredients precisely)

iii. Tablet loading into the pan.

iv. Tablet heating.

v. Spraying, which involves rolling the tablet and applying coating materials at the same time.

vi. Drying.

vii. Unloading and cooling.

Advance Techniques of Tablet Coating

Magnetically Assisted Impaction Coating

Compression coating, plasticizer dry coating, heat dry coating, and electrostatic dry coating are some of the dry coating techniques that have been developed.[8] In order to accomplish coating, these techniques typically permit the application of severe shearing stresses, high impaction pressures, or exposure to higher temperatures. The guest particles may layer or even embed themselves on the surface of the host particles as a result of the powerful mechanical forces and the heat that is produced. Because they are organic and generally soft, many food and pharmaceutical substances are extremely sensitive to heat and readily distorted by a variety of mechanical pressures. Therefore, the best options for these applications are soft coating techniques that can adhere the guest (coating material) particles to the host (material to be coated) particles with the least amount of particle size, shape, and composition deterioration brought on by heat accumulation. Soft organic host and guest particles can be coated using magnetically assisted impaction coating (MAIC) devices without significantly altering the size and form of the material. The heat produced by particle collisions during MAIC is little, despite the fact that some heat is produced on a microscale. When working with powders that are sensitive to temperature, such medications, this is an extra benefit.

Mechanism

There are several steps in the MAIC coating process

Stage I: Magnetic particle activation

Stage II: Guest particle (coating substance) dispersion

Stage III: Guest particle alignment and dispersion on the surface of the host particle (coating substance)

Stage IV: Magnetic host particle interaction

Stage V: Interaction between the chamber wall and magnetic host particles

Stage VI: Producing coated goods

Experimental Setup/ Apparatus

The MAIC apparatus consists of a processing tank encircled by an array of alternating current-connected electromagnets. The measured mass of the magnetic particles is added to the host and guest components inside the tank. Barium ferrite is used to make the magnetic particles, which are then coated with polyurethane to keep the coated particles clean. Similar to a fluidized bed system, the magnetic particles inside the vessel are stirred and move frequently when there is a magnetic field present. The host and guest particles then get energy from these agitated magnetic particles, which leads to collisions and enables coating by impacting or peening the guest particles onto the host particles. According to research on the motion of magnetic particles, the main motion caused by the magnetic field is the spinning of the particles, which encourages the guest particles to de-agglomerate and to spread and shear onto the host particles' surface.

Although the translational speed also has a big impact since it makes it possible for particles to collide with one another, which encourages coating. The following characteristics need to be taken into account during MAIC: processing time, current or voltage and frequency, magnet to powder mass ratio, current and frequency, magnetic particle speed, guest to host size ratio, and visitor to host size ratio. In order to assess how well the MAIC device alters the surface characteristics of cellulose and cornstarch (host particles) when coated with silica (guest particles), Ramlakhan M. et al. (2000) carried out an experiment.

During the MAIC process, it was found that very large silica agglomerates were de-agglomerated (broken up into smaller primary sizes), and soft organic materials like cellulose and cornstarch were coated while retaining nearly their original size and form. Even with a very discrete coating on the surface of the host particle, the material's flowability is significantly improved because the number of guest particles (coating particles) on the surface of the host particles (particles to be coated) has very little effect on the flowability once the cohesion force is decreased by one or more coating particles. Raizza R (2006)

conducted a similar work in which ibuprofen was coated with two distinct silicas, R 972 and EH-5, to improve its flowability.

When the bed height deviates from the ideal value or increases, as well as when the diameter of the host particles increases, the coating time increases significantly. According to this model, the coating duration also reduces with an increase in the starting bed height and a drop in the ratio of host to guest particle diameters.[9]

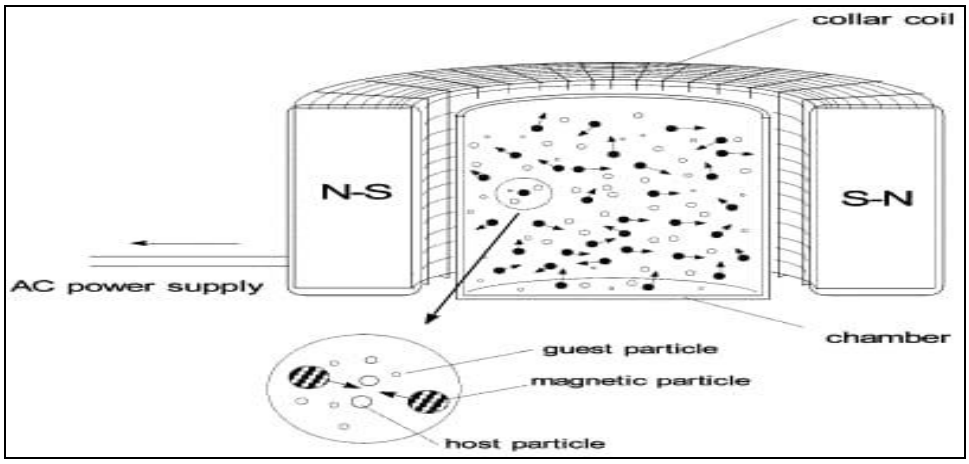

Figure 1: Apparatus of MAIC.

Electrostatic Dry Coating

In a pan coater device system for solid dosage forms, an electrostatic dry powder coating method was created for the first time. The tablet benefits from this method by having a flat surface bed, outstanding coating homogeneity, and release at a specific solvent grade. In a number of production sectors, including paint technology, food technology, metal coating, and pharmaceuticals, the electrical coating method was crucial for coating solid dosage forms. Without the use of a solvent or heating, the electrostatic dry coating technique works on the idea of immediately distributing particles and a polymer mixture on the tablet bed surface until a film forms on the tablet surface.[10,11]

Based on the charging mechanism, there are primarily two types of charging units:
a) Corona charging mechanism, and b) Tribo charging mechanism.

1. Corona charging mechanism

This has been Completed. Characterized by an electrical breakdown followed by air ionization when a high voltage is applied to an electrode that resembles a sharp needle (also known as the charging pin) at the gun's output. As the powder particles travel from the

cannon to the substrate, they absorb the negative ions. The combination of mechanical and electrical forces primarily controls the particle mobility between the charging gun and the substrate. The powder is blown from the spray cannon towards the substrate by the mechanical forces created by the air. The electrical field between the spray gun's charging tip and the earthy material, as well as the repulsive forces between the charged particles, are the sources of the electrical forces for corona charging. As the powder is released from the gun, the electrical field can be changed to control pattern size, form, and density as well as to direct the powder's flow.[12]

2. Tribo Charging Mechanism

Tribo charging, as opposed to corona charging guns, uses the friction charging concept linked to solid materials' dielectric qualities; as a result, there won't be any free ions or an electrical field between the spray gun and the grounded material. Only the repulsive forces between the charge particles are taken into consideration by the electrical forces in tribo charging guns. The attraction forces between the charged particles and the grounded substrate cause the particles to deposit on the substrate when they enter the area next to the substrate after spraying. Because of electrostatic attraction and mechanical forces, charged particles are uniformly sprayed onto the clay substrate. Particles build up on the substrate before the electrostatic attraction is outweighed by the deposited particles' increased repulsion force against the approaching particles.

Particles can no longer stick to the substrate once the aforementioned repulsion and attraction are equal, and the coating thickness stops increasing.[13]

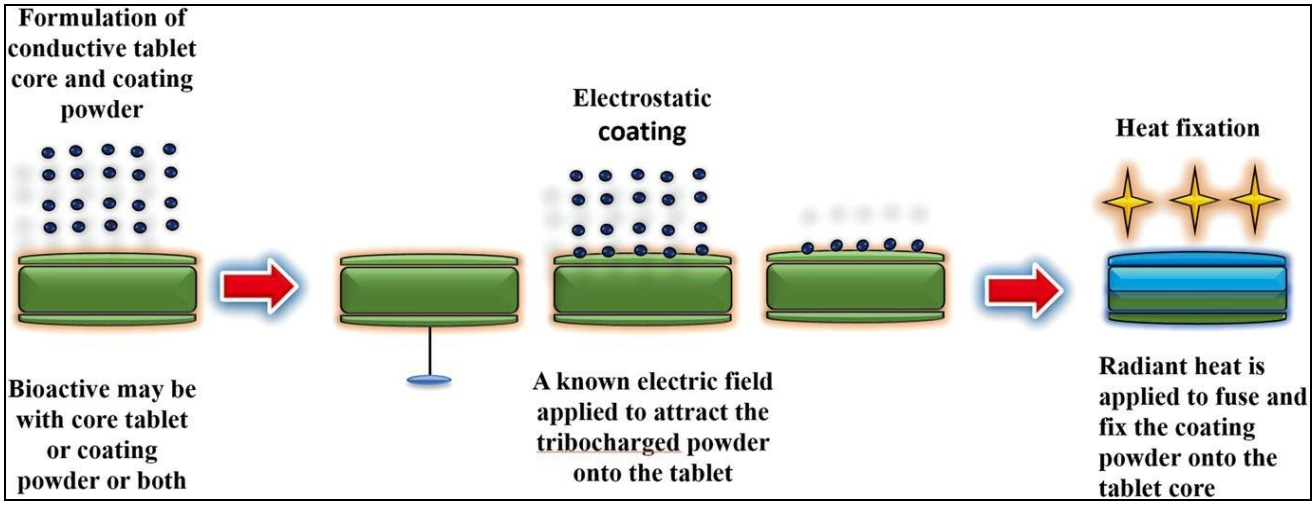

Figure 2: Diagramatic representation of electrostatic dry coating.

Aqueous Film Coating

A tablet's surface is coated with a thin layer of polymeric material called aqueous film coating. Film coating can shield the tablet from light, heat, and moisture; cover up bad tastes or odours; enhance appearance; give the tablet a unique identity; make swallowing easier; and regulate or alter the drug's release. For safety, environmental, and financial reasons, aqueous coating of oral solid dosage forms has quickly supplanted solvent-based coating. The pharmaceutical quality of the finished product is impacted by a number of variables in the film-coating of tablets, including coating equipment, process circumstances, core tablet composition, tablet form, coating liquid, etc. A high-quality aqueous film coating must guarantee a drug's chemical stability and be smooth, consistent, and adhere to the tablet surface suitably.[14]

According to myths, the coating procedure is based on engineering success. The pharmaceutical quality of the finished product is influenced by a variety of parameters in the multivalent process of film coating tablets, including coating equipment, process conditions, and the makeup of the core tablet and coating liquid. The most popular tablet coating tool is the side-ventilated, perforated pan coater. Its perforated pan airflow system guarantees quick and constant drying conditions. Due to water's poor evaporation capacity, aqueous film coating equipment must have a high drying efficiency.

Historically, coating equipment has had minimal levels of automation and instrumentation, making it challenging to regulate the coating process. The pharmaceutical industry is seeing a rise in demand for coating equipment automation and instrumentation to enhance the quality and safety of the finished coated product as well as the reproducibility and predictability of the coating process. Cutting product costs has emerged as a crucial component and need for effective manufacturing. A vital process parameter monitoring system and an automated film coating process would be a helpful tool for process control and for comprehending the phenomena that occur during the process. A high-quality aqueous film coating must guarantee a drug's chemical stability and be smooth, consistent, and adhere to the tablet surface suitably.

The following polymers are frequently found in aqueous film coatings**:**

Polyvinyl Pyrrolidone (PVP): renowned for its superior solubility and film-forming qualities, PVP is frequently utilised in taste-masking applications.

Cellulose derivatives: These include HPMC and hydroxypropyl cellulose (HPC), which offer good flexibility and film strength.

Natural gums: Due to their biodegradability and biocompatibility, xanthan gum and guar gum are utilised.[15]

Reduced solvent exposure, simpler processing, and the possibility of improved drug release patterns are the advantages of aqueous film coatings. Additionally, they support sensitive API stability. However, depending on the composition and processing conditions, the film could not be as durable as organic coatings.

Development of film coating formulation

Optimising the film coating formulation, decreasing intagliation bridging, increasing coating hardness, or improving any other attribute that the formulator deems inadequate is necessary to improve the coating adhesion properties to the core materials. Elasticity, tensile strength, and film–tablet surface interaction are the three main variables that the development scientist needs to consider since they can impact film quality.[16]

Supercell Coating Technology

Hard coating components can be applied to a disruptive tablet that uses Supercell coating technology to withstand very hygroscopic materials. Due to flaws and unpredictable outcomes, this approach occasionally yields nonhomogeneous findings. The tablets' ends are trimmed using the Supercell coating technique to produce a uniform finish because the coating thickness on the edges is irregular when compared to the surfaces.

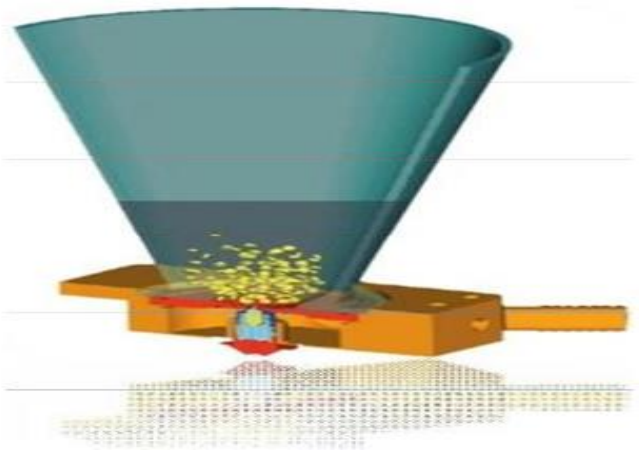

Figure 3: Processing of coating technology.

effect This stops pills from piling up in the revolving pan and stops air from passing through it. The modified release of coating is decreased as a result of the coating components being deposited. The Supercell coating process was created by Niro Pharma Systems and employs a small, modular architecture to help with a number of problems.[17]

Furthermore, tablets with fat forms or unusual configurations, as well as hygroscopic tablets, cannot be coated with the current technology. This process needs to be done carefully to avoid "twinning," which occurs when two or more tablets adhere to one another. This study aims to investigate Supercell coating, a virtual tablet coater system that employs a unique airflow configuration. The of different moisture conditions on the quality of the coats produced is investigated using tablets coated at different spray velocities (4, 6, 8, 10, and 12 mL/min). When compared to other spray rates, the degree of roughness is found to be lower at 6 mL/min, and the coat seems smoothest, with the droplets seemingly connected together. The droplets have branching arms and scale-like patterns when sprayed more quickly.

SCT uses a dependable and effective continuous small-batch coating method. The quantity of coated tablets in SCT varies from 30 to 120 g, and they scale up consistently to meet manufacturing requirements. The coating spray is applied to the tablets in the same manner as the drying gas to accomplish a more efficient procedure. SCT's unique air circulation plate design allows the tablets to travel quickly and evenly across the spray zone. Because the tablets only get a very small amount of coating per run, this enables improved coating accuracy. It is simpler for the tablets because this process takes less time-minutes or seconds as opposed to hours.

In addition to fat or very oval tablet shapes, fragile tablets can also be covered with Supercell coating technology. This technique works well for coating hygroscopic tablets since it dries quickly. According to The Niro Company, conventional methods of tablet coating provide inconsistent and less-than-ideal results, which may have an effect on the tablet's functionality.

A certain amount of variability may be introduced by this result, which is especially significant when a small batch of tablets is produced for clinical testing. In conventional coating machines, tablets are positioned inside large rotating pans and allowed to dry in hot air..

The tablet edges may be worn down by this process, any engraved markings may be filled in with the coating material, and the edges and corners may have uneven coating thickness in comparison to the tablet faces. These types of mistakes, in Niro's opinion, limit the use of specific release coatings.[9]

Unique features of supercell coating technology

1) The surface bed of solid dosage forms is coated in several layers.
2) It is simple to modify modular designs.
3) Coating is simply adjustable and continuous.
4) The production capacity is greater and can reach 120 mg with 6 cell coats.
5) Despite the minimum batch size range of 30 mg, it can be utilised in the R&D sector.
6) Far more precise than alternative technologies.
7) Using a low humidity procedure that works well for materials that are sensitive to low moisture levels.
8) Technology that facilitates.
9) Friable tablets.

Supercritical Fluid Spray Coating

In order for the coating material to precipitate onto drug particles scattered throughout the medium, the supercritical fluid spray coating technique entails dissolving the coating material or medication in supercritical carbon dioxide and then progressively lowering the solvent power of carbon dioxide. Despite being a solvent-based coating process in theory, this method circumvents some of the drawbacks of conventional solvent-based methods by using carbon dioxide as the supercritical fluid. Lipids (fats and waxes) are the primary coating ingredients utilised in supercritical fluid coating when co-solvents are not present.[18]

Supercritical fluid technique for microencapsulation combines gas-like transport characteristics (such as viscosity and diffusivity) with liquid-like density and solvating power. Because of its comparatively low critical temperature (31°C) and pressure (74 bar), carbon dioxide is the most commonly used supercritical fluid. Supercritical fluid technology, particularly CO2, is used for encapsulation mostly because of its benign processing conditions, which enable the microencapsulation of delicate substances for medications and cosmetics.[19]

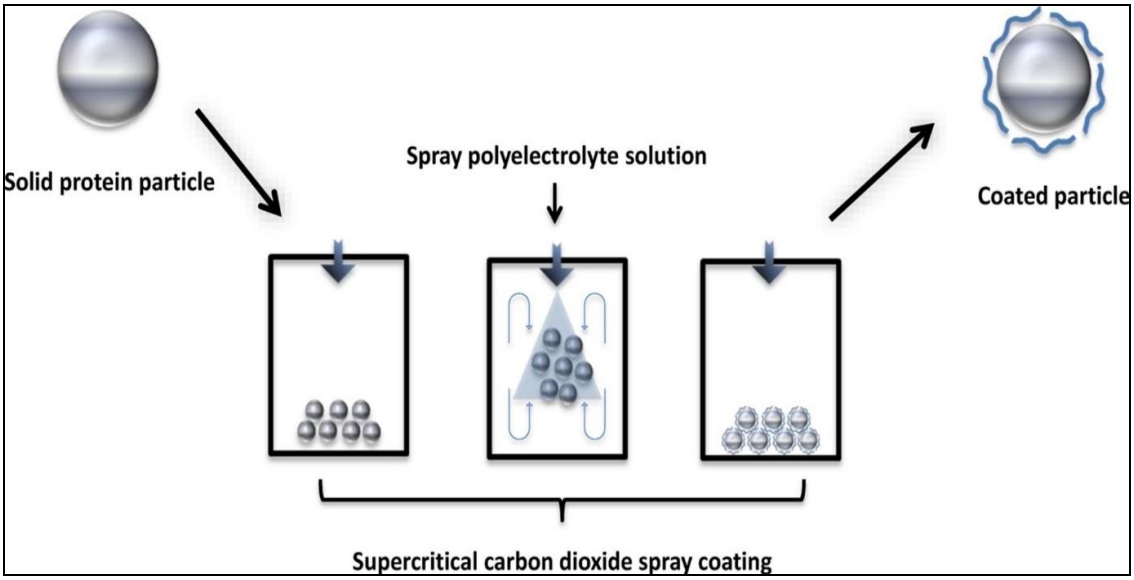

Figure 4: Supercritical fluid spray coating.

Although supercritical fluids exhibit a significant shift in density close to the critical point, allowing for precise control of their solvating power with slight variations in temperature or pressure, they are particularly well-suited for particle production. When the conditions within the autoclave are changed to insolubilise the coating material, the coating material must be sufficiently soluble in liquid or produce a coating thick enough to offer the required level of protection. Deposition should ideally result in a coating or film free of flaws.[20]

Current Challenges and Future Prospective

The productivity, quality, and regulatory compliance of pharmaceutical goods are all impacted by the complex challenges facing tablet coating technology today. Achieving uniform coating thickness, which is essential for reliable drug release profiles, is one major problem; differences may result from uneven spraying methods or equipment performance. Furthermore, scalability and reproducibility issues frequently arise during the development of novel coating materials, making the shift from lab formulations to mass production more difficult.[15] Tablet coating methods are expected to undergo significant change in the future, reflecting continuous advancements in engineering, materials science, and pharmaceutical applications (Figure 5). In the field of tablet coatings, compositions, and applications, a number of significant trends and opportunities can be expected as research progresses:

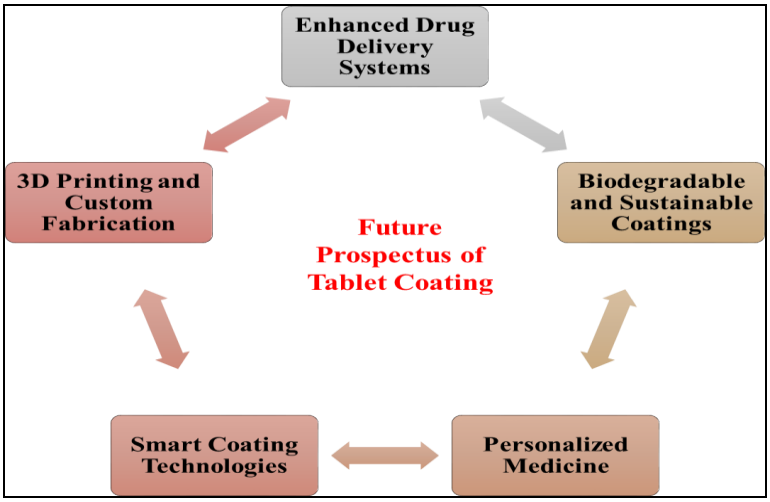

Figure 5: Representations of future prospectus of tablet coating.

Enhanced Drug Delivery Systems: As new coating materials and methods are developed, more advanced drug delivery systems will be possible, including multi-layer coatings that offer targeted distribution and controlled release. This will facilitate more accurate dosing, better patient compliance, and better treatment of chronic illnesses.[15]

Biodegradable and Sustainable Coatings: Biodegradable and environmentally friendly coating materials are expected to become more popular in the future as the pharmaceutical business is under growing pressure to implement sustainable practices. Green chemistry and natural polymer innovations will lessen coatings' negative environmental effects while preserving or improving their functionality.

Personalised Medicine: The development of tablet coatings will be greatly impacted by the shift to personalised medicine. Tailored medication release mechanisms will be made possible by customised coatings that adjust to the unique characteristics of each patient, improving treatment results and reducing side effects.

Smart Coating Technologies: The usefulness of coated tablets will be improved by the incorporation of smart technologies, such as stimuli-responsive coatings that respond to particular physiological parameters (such as pH or temperature changes). By guaranteeing exact release at specific locations inside the gastrointestinal tract, these developments may increase the effectiveness of pharmaceuticals.

3D Printing and Custom Fabrication: By enabling the accurate fabrication of intricate geometries and customised formulae, the use of 3D printing technology in tablet coating will

completely transform the pharmaceutical manufacturing industry. This could make it possible to produce customised coated tablets on demand, cutting waste and increasing productivity.[15]

There are numerous opportunities for tablet coating in the future that could improve patient adherence, increase drug delivery, and lessen environmental effects. Better health outcomes for patients around the world will eventually result from the pharmaceutical industry's ability to adapt to the changing demands of healthcare as research and technology advance.

CONCLUSION

The improvement of the solid dosage form's quality in recent decades has been greatly aided by the coating of pharmaceutical dosage forms. To improve the tablet's appearance, lower mistake rates, stability, and ease of control and operation, a number of development strategies have entered the market. Every method has advantages and disadvantages of its own. The energy consumption, film processing, and drying quality of this technique have all significantly improved. There are still plenty of chances for coating technology advancement in the future. It is necessary to conduct more research on improved drying, spaying, and coating solvents.

REFERENCES

1. Hemchand P, Avinash DR, Tukaram MS, Mahavir B. Recent advances in different aspects of tablet coating. 2017; 16.
2. Kamble ND, Chaudhari PS, Oswal RJ, Kshirsagar SS, Antre R V. Innovations in tablet coating technology: A review Department of Pharmaceutics ISSN 097. Int J Appl Biol Pharm Technol. 2011; 2(1): 214–8.
3. Basu A, De A, Dey S. Techniques of Tablet Coating, Concepts and Advancements: A Comprehensive review. Res Rev J Pharm Pharm Sci., 2013; 2(4): 1–6.
4. Pawar AS, Bageshwar D V, Khanvilkar V V, Kadam VJ. Advances in pharmaceutical coatings. Int J ChemTech Res., 2010; 2(1): 733–7.
5. Reddy BV, Navaneetha K, Reddy BR. Tablet Coating Industry Point View - A Comprehensive Review. Int J Pharm Biol Sci. 2013; 3(1): 248–61.
6. Lachman Leon et al. The Theory and Practice of Industrial Pharmacy. Second edition. Fourth Indian Reprint, Bombay: Published by Varghese Publishing house (1991).
7. Lippincott Williams and Wilkins. Remington’s The Science and Practice of Pharmacy. Volume-I. 21sted. Indian Edition (2005).

8. Cerea M, Zheng W, Christopher R, McGinity J. A novel powder coating process for attaining taste masking and moisture protective films applied to tablets. Int J Pharm, 2004; 279(1-2): 127–139.
9. Ahmed SAN, Patil SR, Khan MKS, Khan MS (2021) Tablet coating techniques: concept and recent trends. Int J Pharm Sci Rev Res., 66(1): 43–53.
10. Vyas S, Khar R. Controlled Drug Delivery Concepts and Advances; First Edition: 219-256.
11. Ansel H, Allen L, Popovich N. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems; Eighth Edition, 227-259.
12. Mazumder M, Sims R, Biris A. Twenty-first century research needs in electrostatic processes applied to industry and medicine. Chem Eng Sci, 2006; 61: 2192- 2211.
13. Luo Y, Zhu J, Ma Y, Zhang H. Dry coating, a novel coating technology for solid pharmaceutical dosage forms. Int J Pharm, 2008; 358(1-2): 16-22.
14. Release oral dosage forms. In Aqueous Polymeric Coatings for Pharmaceutical Dosage Forms. Marcel Dekker Inc., New York, 1997; 2: 81-100.
15. Raj Kumar Mandal, Paarth Saini, Rahul Pal, Prachi Pandey, Anshita Dubey. Coating Tablets, Compositions, Recent Advancement and Current Status: A Comprehensive Review. Journal of Drug Delivery & Therapeutics. 2024; 14(10): 182-195. DOI: http://dx.doi.org/10.22270/jddt.v14i10.6809
16. Aulton M. Pharmaceutics: The Science of Dosage Form Design. International Student 3rdEdition: 304-321: 347-668.
17. Kumar KV, Sivakumar T, Mani TT (2011) Colon targeting drug delivery system: a review on recent approaches. Int J Pharm Biomed Sci., 2: 11–19.
18. Marentis R, James K. Processing pharmaceuticals with supercritical fluids, 4th Brazilian Meeting on Supercritical Fluids EBFS 2001.
19. Ribeiro Dos Santos I. et al. Microencapsulation of protein particles within lipids using a novel supercritical fluid process. Int J Pharm, 2002; 242: 69-78.
20. Thies C, Ribeiro I, et al. A supercritical fluid-based coating technology 1: Process considerations. J Microencapsul, 2003; 20(1): 87–96.