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Semi-Solid Dosage Form Excipients A Novel Approach

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ABSTRACT:

Semi-solid dosage forms such as ointments, creams, gels, and pastes are commonly employed in pharmaceutical practices to facilitate topical or transdermal administration of pharmaceutical agents. The semi-solid dosage forms allow for the topical application of a pharmaceutical agent to a specific area of interest, which then leads to localized therapeutic effects without the need for systemic absorption or first-pass metabolism. The semi-solid dosage forms are therefore widely used in dermatological therapy or cosmetic formulations.

The effectiveness or stability of semi-solid dosage forms is a function of various excipients added to the formulation. The excipients play a crucial role in enhancing various properties of semi-solid dosage forms, including solubilizing properties, physicochemical stability, rheological properties, release characteristics, or antimicrobial protection.

The review article under consideration discusses the importance of excipients used in the formulation of semi-solid dosage forms of drugs. Various excipients like cosolvents, emulsifiers, humectants, antioxidants, surface active agents, preservatives, and emollients are discussed with respect to their functional activity. The article also discusses the physicochemical and rheological properties. Moreover, new developments like nano-based excipients, modified polymer-based excipients, lipid-based excipients, and new formulation approaches are discussed, which are used for improving drug penetration and release. The review also covers various types of semi-solid dosage forms, their advantages and disadvantages, and equipment used in the process of manufacturing. In conclusion, the study highlights the emerging role of new excipient technologies in enhancing the quality and therapeutic performance of modern topical drug delivery systems.

1. Introduction

Excipients are chemical entities added to a pharmaceutical formulation along with active pharmaceutical ingredients to ensure proper performance. Even though excipients are not therapeutically active, they play a vital role in maintaining the stability, safety, and efficacy of a pharmaceutical product. They are used to facilitate an

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increase in solubility, stability, and distribution of the active pharmaceutical ingredient.

Semi-solid dosage forms are an important group of pharmaceutical preparations. The main purpose of semi-solid dosage forms is to use them topically. Semi-solid dosage forms include ointments, creams, gels, and pastes. The main advantage of using semi-solid dosage forms is to avoid the adverse effects of the drug. Semi-solid dosage forms are used topically to obtain the desired therapeutic response.

Another significant advantage of semi-solid preparations is that they are easy to use. This is because semi-solid preparations can be used directly by patients without having to take them orally or inject them. This makes semi-solid preparations easy to use, especially for patients who find it difficult to take oral medications.

Ideally, an excipient must be chemically inactive and must be compatible with the active ingredient and be able to sustain formulation stability during processing and storage. Moreover, the excipients must not affect the therapeutic action of the drug.

In the recent past, there has been a focus on the application of natural excipients derived from plant and biological sources. This is because they are biodegradable, cost-effective, and have fewer safety concerns compared to synthetic excipients.

Advances in pharmaceutical technology have also provided various formulation approaches such as nanotechnology-based carriers, polymeric gels, and lipid-based systems, which have improved the efficacy of semi-solid drug delivery systems. semi-solid drug delivery systems also provide good therapeutic results. [1-4]

TYPES OF SEMI-SOLID DOSAGE FORM:

OINTMENTS:

Ointments are semi-solid preparations that are normally used on the outer body surface. These preparations are normally hydrophobic bases used to protect the outer body surface. The hydrophobic property of ointments allows them to increase the level of hydration on the body surface. This property also allows ointments to increase the penetration of some medications.

Petrolatum is a hydrocarbon base used to make ointment preparations. This is because petrolatum is chemically stable and is able to retain moisture on the body surface.

OINTMENT BASES:

Ointment bases vary in their physicochemical properties. Oleaginous bases are anhydrous in nature. They possess a hydrophobic nature. Due to the hydrophobic nature, the bases are difficult to spread on the skin surface. The bases cannot be washed off with water. Regarding the stability of the bases, the oil present in the base show's low stability, while the hydrocarbon shows high stability.

Oleaginous bases containing water-in-oil surfactants are anhydrous in nature. They possess a hydrophobic nature. Due to the hydrophobic nature, the bases are difficult to spread on the skin surface. The bases cannot be washed off with water. Regarding the stability of the bases, the oil present in the base show's low stability, while the hydrocarbon shows high stability.

On the contrary, oleaginous bases when mixed with water become hydrous bases. The addition of water to these bases makes them hydrophilic. This makes them easier to apply on the skin. Secondly, these bases can also be removed using water. However, these bases are unstable, especially when they are mixed with alkali soaps.

Polyethylene glycol bases can be anhydrous or hydrous. These bases are hydrophilic. The bases can easily spread on the skin. Moreover, they can be removed using water. Comparing polyethylene glycol bases to the others, it is clear that polyethylene glycol bases are more stable.[5]

CREAMS:

Semi-solid pharmaceutical preparations containing both aqueous and oily phases in the form of emulsion systems, creams can be formulated as oil-in-water emulsions or water-in-oil emulsions depending on the structure of the aqueous and oily phases. Due to their smooth texture and ease of application, creams can easily spread over the skin surface and offer higher cosmetic acceptability compared to ointments. Therefore, creams can be employed in dermatological formulations as well as in cosmetics.

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The formulation of creams involves the addition of several functional ingredients, which are used to enhance the stability of the formulation. The addition of thickening agents, such as agar, guar gum, xanthan gum, carrageenan, enhances the formulation of creams by improving their viscosity. The addition of emulsifying agents, such as cotton seed oil, paraffin wax, beeswax, palm oil, enhances the formulation of creams by improving the stability of the emulsion system, thereby improving the interaction between the oil and water phases. Preservatives, such as clove oil, neem oil, tea tree oil, ginger oil, are added to the formulation of creams to prevent the growth of microbes, thereby improving the stability of the formulation. In addition, antioxidants, such as peppermint, rosemary, cinnamon, saffron, are added to the formulation of creams to enhance their stability by preventing oxidative rancidity.[6]

GELS:

Gels are clear, semi-solid formulations intended for external use on the skin or mucous membranes. They are composed of semi-solid systems in which small inorganic particles or large organic molecules are dispersed within a liquid medium. The incorporation of a suitable gelling agents gives the preparation its characteristic jelly-like consistency and structure.

PASTES:

Pastes are semi-solid pharmaceutical preparations that contain one or more active ingredients and are intended for application on the skin. The name “paste” is used for ointment-type formulations that incorporate a large quantity of solid substance, such as zinc oxide, which makes them dense and rigid in nature. In comparison to ointments, pastes have a higher proportion of finely powdered solids usually between 20% and 50% resulting in a thicker, firmer, and less spreadable consistency. After application, they form a protective covering over the treated area and are mainly used as antiseptic, protective, or soothing dressings. Often, they are applied onto lint or gauze and then placed on the skin. Pastes are especially beneficial for treating moist or oozing skin conditions because they absorb excess fluid or secretions.

FIG 1: TYPES OF SEMISOLID DOSAGE FORM

ADVANTAGES OF SEMI SOLID DOSAGE FORM:

- These formulations are appropriate for drugs with an unpleasant or bitter taste, as administration does not involve oral intake.
- Semi-solid dosage forms offer greater stability when compared to liquid dosage forms, which reduces the risk of decomposition.
- Semi-solid dosage forms avoid first-pass metabolism, which means that the efficacy of the drug is maintained at the site of application.
- The drug has a localized therapeutic effect on the area of application.
- This dosage form can easily be administered to unconscious or non-cooperative patients without having to give them anything to swallow

DISADVANTAGES OF SEMI SOLID DOSAGE FORMS:

- Semi solid dosage forms can cause staining of clothes and the skin, which can affect patient acceptability.
- Dose accuracy cannot be measured accurately because these dosage forms are usually applied in non-quantified amounts.
- Manual application using the fingers can cause contamination, leading to increased risks of infection and instability of the product.
- These formulations are physiochemically less stable than solid dosage forms, making them more susceptible to degradation during storage.

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- Large-sized drug particles exhibit poor skin penetration, which can limit drug absorption and therapeutic effectiveness. [7]

IDEAL PROPERTIES OF SEMI SOLID DOSAGE FORMS:

PHYSICOCHEMICAL PROPERTIES:

CHEMICAL INERTNESS:

- Should not chemically react with the Active Pharmaceutical Ingredient (API).
- Must be stable towards oxidation, hydrolysis, and photodegradation.
- Should not interact with packaging materials.

PHYSICAL STABILITY:

- No phase separation (especially in emulsion).
- No syneresis (liquid separation in gels).
- No crystallization of drug during storage.
- Stable over a wide temperature range.

pH COMPATIBILITY:

- pH should be compatible with both drug stability and skin physiology (≈ 4.5–6.5).
- Must not cause irritation due to extreme pH.

RHEOLOGICAL (FLOW) PROPERTIES:

APPROPRIATE VISCOSITY:

- Should maintain consistency during storage.
- Easy to remove from container and apply on skin.

THIXOTROPY:

- Should decrease in viscosity when shear is applied (rubbing).
- Should regain viscosity after application.

SPREADABILITY:

- Must spread uniformly without excessive force.
- Should provide even drug distribution on the skin surface.

DRUG RELEASE & PERMEATION CHARACTERISTICS:

- Should allow uniform distribution of drug throughout the base.
- Must provide controlled and predictable drug release.
- Should not bind drug strongly unless controlled release is desired.
- Should enhance drug penetration if required (with permeation enhancers).

SAFETY & BIOCOMPATIBILITY:

- Non-toxic and non-irritant.
- sensitizing and hypoallergenic.
- Non-comedogenic (does not block pores).
- Safe for repeated and long-term application.

MICROBIAL & CHEMICAL STABILITY:

- Should resist microbial contamination.
- Compatible with preservatives.
- Should not support microbial growth.
- For ophthalmic preparations, must be sterile.

PATIENT ACCEPTABILITY:

- Pleasant appearance and texture.
- Non-greasy (if cosmetic acceptability is important).
- Easily washable (for water-removable bases).
- Odorless or mildly scented.
- Patient compliance is directly linked to texture and skin feel.

EXCIPIENTS USED IN SEMI SOLID DOSAGE FORMS:

CO-SOLVENTS:

It has been observed that the solubility of the drug can be increased by adjusting the polarity of the solvent system through the addition of a water-miscible solvent in which the drug has higher solubility. The addition of organic solvents to aqueous systems is a well-established strategy for increasing the solubility of poorly soluble drugs in water. This technique for increasing the solubility of the drug is referred to as co-solvency and involves the addition of auxiliary solvents called cosolvents that decrease the solvent-solute interaction and increase the dissolution of the drug.

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Co-solvency increases the solubility of drugs by reducing the interfacial tension between the aqueous medium and the hydrophobic nature of the drugs, which is generally known as solvent blending. In co-solvency, water-soluble organic solvents are added to the solution to increase the solubility of the drugs. This increases the solubility of the poorly soluble drugs by changing the polarity of the solvent mixture. Cosolvents like polyethylene glycol 400, ethanol, sorbitol, glycerin, propylene glycol, ethanol, glycerin, polyethylene glycol, dimethyl sulfoxide, dimethyl acetamide, and others are generally used to increase the solubility of the drugs. In the case of parenteral solutions, cosolvents like propylene glycol, ethanol, glycerin, polyethylene glycol, dimethyl sulfoxide, dimethyl acetamide, and others with low toxicity are generally preferred. In addition to the above cosolvents, powerful solvent systems like dim.

Most cosolvents contain functional groups capable of hydrogen bond donation and acceptance, along with small nonpolar hydrocarbon portions. The hydrophilic groups promote miscibility with water, while the hydrophobic segments disrupt the structured hydrogen-bonding network of water. This disruption lowers the overall intermolecular attraction between water molecules, thereby improving the solubility of hydrophobic drugs.

Eg: ethanol, polyethylene glycols (PEG), glycerin and dimethyl acetamide.

ANTIOXIDANTS:

Antioxidants are added to pharmaceutical solutions and suspensions to improve the stability of drugs that are prone to oxidative degradation. These substances protect therapeutic agents by preventing or slowing down chemical reactions caused by oxygen. Antioxidants function as redox systems with a lower oxidation potential than the drug, meaning they are more readily oxidized and thus protect the active ingredient. Alternatively, they may inhibit drug degradation by interrupting free radical chain reactions.

Both water-soluble and oil-soluble antioxidants are available commercially, and the selection depends on the type and composition of the formulation. Since antioxidants possess a lower redox potential than the active pharmaceutical ingredients, they are preferentially oxidized, thereby safeguarding the drug from oxidative damage. For example, ascorbic acid acts as a sacrificial antioxidant and may be gradually consumed during the products shelf life.

In injectable formulations, chelating agents such as EDTA or citric acid may also be included to bind trace metal ions that can produce oxidation reactions. Antioxidants primarily work by terminating free radical chains through direct reaction with free radicals. A common example of a true antioxidant used in formulations is butylated hydroxytoluene (BHT).

Several natural antioxidants are used as excipients in semi-solid pharmaceutical formulations. Catechin is a naturally occurring flavonoid compound widely present in many plants and fruits. It belongs to the flavanol group and is primarily utilized for its antioxidant activity. Due to these properties, catechin is commonly incorporated into cream formulations.

Wheat bran is obtained from the outer layers of the wheat kernel and belongs to the family *Gramineae*. It is also known as cereal fiber or dietary fiber. Wheat bran possesses antioxidant properties and is frequently used in pharmaceutical preparations such as nano-emulsion systems.

Saffron is derived from the dried stigmas of the flowers of the *Crocus* plant. It is commonly referred to as kesar or jafran. Because of its antioxidant potential, saffron is incorporated into topical formulations including creams and lotions [8].

Eg: Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA).

LUBRICANTS:

Non-ionic surfactants are widely used in the formulation of stable emulsions due to their comparatively low toxicity and reduced sensitivity to variations in pH and electrolyte concentration when compared with ionic surfactants. Examples of such compounds include sorbitan esters and polysorbates. Besides the main function of stabilizing the dispersed liquid droplets, the surfactants may also improve the viscosity of the continuous phase, thus increasing the physical stability of the emulsion [10,11].

Eg: grease (e.g., lithium or calcium soap-based), and wax.

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EMULSIFYING AGENTS:

To prevent the coalescence of dispersed droplets, an emulsifying agent has to be added to cover each droplet with a protective layer. Surfactants tend to accumulate on the interface of the oil droplet and the water, thus forming a monomolecular layer on the surface of the dispersed droplet, which reduces the interfacial tension. For the emulsification of the system to occur properly, a hydrophilic emulsifier is generally required to stabilize the aqueous phase, whereas a lipophilic or hydrophobic emulsifier is required to stabilize the oil phase.

Non-ionic surfactants are generally used to prepare stable emulsions because they are comparatively less toxic to the system compared to ionic surfactants, which tend to have minimal sensitivity to pH and electrolyte concentration changes. These include sorbitan esters and polysorbates. In addition to the emulsifying action, the emulsifying agent may increase the viscosity of the dispersion medium, which would contribute to the stability of the emulsion.

Eg:polysorbate 80, wool fat, cetomacrogol and glyceryl monostearate.

HUMECTANTS:

Humectants are water-soluble and hygroscopic chemical substances that have the ability to attract and hold water. Humectants are moisture-binding agents that assist in maintaining a layer of water on the skin's surface and thereby moisturize the skin. Glycerin is the most commonly used humectant in personal care and pharmaceutical products. However, its use may result in a greasy skin feel, which can be overcome by using a mixture of glycerin and other humectants such as sorbitol.

Propylene glycol, which is cheaper than glycerin, is the second most commonly used humectant in cosmetic and toiletry products. Apart from its moisturizing properties, it also reduces the system's viscosity and can prevent foam formation.

Humectants that are cationic in nature have the ability to bind to the skin's surface because of its negative charge. In such humectants, the hydrophilic component is responsible for retaining moisture, and the hydrophobic chain present on the cationic end of the humectant molecule is responsible for skin substantivity and skin conditioning [12,13].

Eg:glycerin (glycerol), sorbitol and propylene glycol.

DISINTEGRANTS:

Disintegrating agents are usually added to a tablet formula to enable easy disintegration of a compressed tablet when it comes into contact with a liquid. They enable the penetration of a liquid into a compressed tablet. Their main purpose is to counteract the binding effect of a tablet binder and compressional forces that act on a tablet.

The mechanism of action of disintegrants is not entirely clear, although several theories have been proposed to explain how they act. The theories proposed are capillary action, swelling, recovery of deformation, repulsion of particles, and heat of wetting. However, it is clear that no single theory accounts for the action of disintegrants.

Disintegrants achieve this by breaking down the cohesive forces holding the tablet together. The swelling action of disintegrant particles leads to a state of internal mechanical stress, which causes the tablet to disintegrate into smaller particles. For example, research on crosspovidone has demonstrated that larger particle size disintegrants, ranging between 50-300 μm, achieve faster disintegration times. This is attributed to larger pore size, which increases capillary water absorption. The increased length of fibre's also plays a role in enhancing capillary penetration.

Disintegrants also act by inhibiting the binding agent's cohesive action, which is achieved by enzymes, or by enhancing capillary action, which allows for rapid absorption of water to facilitate tablet disintegration.

Eg: sodium starch glycolate (e.g., explotab, primogel) and crosspovidone (e.g., kollidon CL)

EMOLLIENTS:

Emollients are sometimes termed as refatting agents or refatteners, especially when they are incorporated into bath products or cleansing agents. Emollients work by staying on the skin's surface or in the stratum corneum, where they help to reduce dryness or flaking. The term "refatting agent" refers to emollients that help to prevent

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the excessive removal of the skin's natural oils, thus protecting the skin from dryness.

Emollients have been identified as having considerable lipophilic activity, which has led to their classification as an occlusive agent. Emollients are fatty or oily in nature, thus helping to form a protective layer on the skin's surface, which assists in the reduction of trans epidermal water loss. As defined by the CTFA, occlusives are cosmetic agents that help to slow the evaporation of water from the skin's surface. As a result, the level of hydration in the skin increases.

Eg: petroleum jelly, lanolin and hydrophilic petrolatum.

WETTING AGENT:

A wetting agent is a chemical substance used to lower the surface tension of a liquid. Surface tension is a result of the cohesive forces between molecules of a given substance, causing them to stick to one another. The addition of a wetting agent to a liquid breaks the intermolecular forces between the molecules and enables the liquid to spread more readily and evenly on the surface of a solid material.

Wetting agents provide a formulation with surface activity through the reduction of the free energy on the surface during immersion. This reduces the spreading and effective wetting of the solid surfaces. Wetting agents also minimize the contact angle between the liquid and the solid phase, allowing the liquid to penetrate more effectively and distribute evenly on the surfaces of powders and solid materials.

These agents are adsorbed at the interface of solid and liquid, and in this process, the affinity between the particles and the liquid medium is increased while the mutual affinity between the particles is decreased. When the system is dispersed in water, the air that is normally present in the system is displaced by the liquid in the presence of the wetting agents.

If the wetting agents are used in excess quantities, then the system may exhibit adverse effects such as excessive foam formation and the development of unpleasant taste and smell.

Eg:polysorbates (tween 20, 40, 60, 80) and polyoxyl 8 stearate.

SURFACTANTS:

Some compounds have specific solubility properties due to the presence of hydrophobic groups, i.e., water-repelling groups, which cause the hydrocarbon chains of the surfactants to cluster together, resulting in the formation of micelles.

Soaps and detergents function effectively because they contain surfactants, which are substances capable of reducing the surface tension of water and attaching to dirt or oily substances. After the surfactant molecules bind with the dirt particles, the rinsing water removes the surfactant–dirt complex, thereby carrying away the impurities from the surface.

Synthetic surfactants can attach to particles because they possess an electrical charge. Depending on the type of surfactant, it may develop either a positive or negative charge when dissolved in water. Many surfactants used in soaps and detergents become positively charged in aqueous solutions. By lowering the surface tension of water, surfactants make water more capable of spreading and interacting with substances such as oil and grease, rather than sticking only to itself.

An emulsifying agent is used to ensure the stability of an emulsion through adsorption on the interface between two non-miscible liquids to produce an oriented interface film. This film reduces the interfacial tension between the two liquids and retards the coalescence of dispersed droplets. This is done by creating a mechanical, steric, and/or electrical layer on the droplets. A good mechanical barrier prevents droplets from coalescing when they come into contact with one another. To produce a good mechanical barrier, the interface film from the adsorption of a good surfactant must be dense and have good lateral interactions.

Inside a micelle, a drug is able to be isolated from reactive molecules such as hydronium and hydroxide ions. This is able to increase the stability of the drug to prevent its degradation in the medium**.**

Eg:polysorbate 20/80 (tween), sodium lauryl sulfate (SLS), span, Ceto stearyl alcohol

BITTER MASKING AGENTS:

The complexing agents can also minimize bitterness associated with a particular drug by reducing

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the solubility of the drug in the oral cavity following administration or by controlling the interaction between the taste buds and the particles of the particular drug. This action is essentially equivalent to minimizing bitterness associated with a particular drug.

The process of granulation is also beneficial for taste masking, as it reduces the surface area of a bitter taste associated with a particular drug. This leads to a minimized interaction between taste buds on the tongue and the particles of a particular drug, minimizing unpleasant taste.

Several liquid vehicles, including low-melting waxes such as glycerol palmitostearate, glyceryl behenate, and hydrogenated castor oil, are used for taste masking.

The property of sodium alginate is that it has an ability to form a water-insoluble gel when it comes into contact with a divalent metal ion. This property has been used to mask taste. For example, the bitterness of amiprolose hydrochloride tablets has been successfully masked by applying an initial coating of sodium alginate, followed by an outer coating of calcium gluconate [33].

The molecular structure of a compound is an important factor when it comes to its interaction with taste receptors, which determines taste. Changes to the molecular structure can decrease the rate at which a drug binds to taste receptors, leading to a decrease in bitterness [14].

Eg: polyethylene glycol (PEG), Carbomer (934, 971, 974), cyclodextrins and sorbitol.

PRESERVATIVES:

Preservatives are often incorporated into various food items and pharmaceutical products to increase their shelf life. Preservatives are very significant in controlling spoilage or contamination of a product by microorganisms during storage, especially when a product has a large amount of water content, which is a prerequisite for microorganism growth.

The mode of action of preservatives on microorganisms involves several aspects. The first is that they alter the permeability of the membrane, which leads to leakage of vital components. This action can cause damage to microorganisms, leading to lysis or leakage of cytoplasmic contents, which ultimately leads to cell death.

preservatives can also act by inhibiting metabolism, which involves interference with enzymes, synthesis of the cell wall, or oxidation and hydrolysis of vital components.

Several plant-based excipients are used in pharmaceutical and cosmetic formulations due to their preservative potential. Lemon oil is a natural product that is extracted from the skin of a lemon fruit, which is scientifically known as “Citrus limon” and belongs to the Rutaceae family. The product is mainly used as a natural preservative in shampoos and pastes.

Neem oil is a natural product that is extracted from the fruits of “Azadirachtaindica”, which belongs to the Meliaceae family. The product is also referred to as margosa oil. The product is well known for its preservative potential. Therefore, it is used to make various products such as shampoos and creams.

Cumin seeds, which are derived from the plant known as “Cuminumcyminum”, belong to the Apiaceae family and are also known as Nigella. The cumin seeds have preservative properties and can be used in pharmaceuticals in the form of suppositories.

Cayenne pepper is derived from the fruits of “Piper nigrum” and its family is known as Piperaceae. It is also known as chilli pepper and is used because of its preservative properties. In pharmaceuticals, it can be used in ointment and cream forms [9].

Eg: parabens (para-hydroxy benzoates), phenol, chlorocresol and benzyl alcohol.

EQUIPMENT USED IN PRODUCTION OF SEMISOILIDS:

TRIPLE ROLLED MILL:

A Triple Roller Mill is an essential pharmaceutical machine used for the processing of semisolid pharmaceutical products such as ointments, creams, and pastes. The machine has three rollers aligned horizontally. The rollers turn at different speeds to achieve shear action, which is necessary for mixing and size reduction. The semisolid product is supplied to the machine via a hopper. The product then moves between rollers successively, during which the lumps are crushed, and the active ingredients are mixed uniformly with the base. The gap between rollers is adjustable to vary the smoothness of the final product.

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The final product is collected using a scraper blade fixed to the last roller. The machine is also equipped with a cooling system to avoid heat buildup during operation. This machine is used to achieve uniformity, texture, and stability of semisolid pharmaceutical products.

FIG 2: TRIPLE ROLLED MILL

COLLOID MILL:

Colloid mills are pharmaceutical equipment that is used to make semisolid pharmaceutical products such as creams, gels, ointments, emulsions, etc. The device works on a principle whereby a rotor is fixed with a stator, which rotates rapidly. This helps to achieve a shear rate that is necessary for efficient size reduction of particles. The material is introduced into a hopper, which then passes between a narrow gap between the rotor and stator. This gap is adjustable to achieve a smooth finish on the final product.

The rotor is run by a motor running at a fast speed. The device is also provided with a cooling system to prevent heat formation during operation. The device is used to make semisolid pharmaceutical products with a good texture, stability, and distribution of active pharmaceutical ingredients.

PRINCIPLE:

A colloid mill is based on the rotor-stator principle. The reduction of the particle size is accomplished by the high shearing action between the rotor and the stator. The rotor is rotated at high speeds to produce a high shear rate, resulting in hydraulic shearing. An increase in the shear rate results in the formation of smaller particles. The particle size is controlled by the clearance between the rotor and the stator. The product is then discharged through the drain outlet.

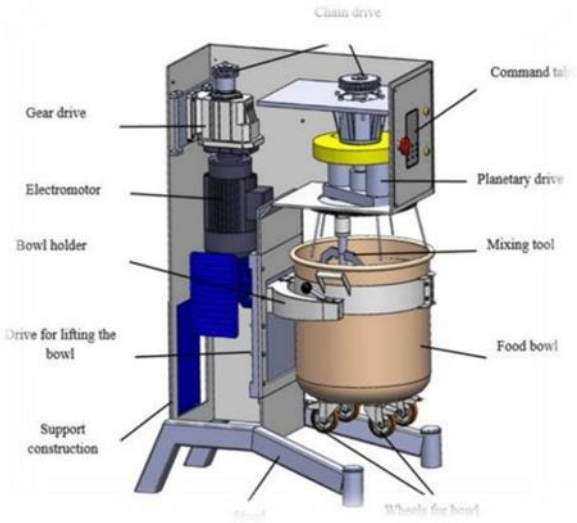

FIG3: COLLOID MILLMIXER

PLANETARY MIXER:

A Planetary Mixer is most commonly used in the pharmaceutical industry to develop semisolid pharmaceutical formulations like creams, ointments, gels, and pastes. The mixer contains a stainless-steel mixing container and one or more agitators with blades that move on their own axis and simultaneously move around the inner circumference of the container. This motion enables the effective mixing of semi-solid pharmaceutical formulations, which are often very viscous in nature. The pharmaceutical formulations are uniformly mixed with active pharmaceutical ingredients. The equipment usually contains a variable speed drive system to facilitate effective mixing, scraper blades to prevent the mixture from adhering to the sides of the container, and a vacuum system to remove air bubbles from the mixture. The pharmaceutical formulations are uniformly mixed with active pharmaceutical ingredients and are of smooth texture.

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FIG4: PLANETARY MIXER

SIGMA BLADE MIXER:

A Sigma Blade Mixer is commonly used in the pharmaceutical industry to prepare semisolid dosage forms such as ointments, creams, pastes, and other highly viscous products. The mixer is designed to have a horizontal trough in a U-shape and is fitted with two sigma-bladed rotors rotating in opposite directions at different speeds. The formulation ingredients are placed inside the trough to be mixed and blended properly by the counter-rotating sigma blades to ensure uniform blending and distribution of the active ingredients in the base material. The mixer is usually powered by a motor and is also fitted with a jacket to allow temperature control through heating and/or cooling. A tilting mechanism is also usually incorporated to facilitate easy removal of the product mixture from the trough. A sigma blade mixer is commonly used to process heavy and sticky semisolid products and is particularly effective in processing semisolids of high viscosity and maintaining uniformity and consistency in the product mixture.

FIG5: SIGMA BLADE MIXER

DOUBLE CONE MIXER:

A Double Cone Mixer is usually used in the production of semisolids for the uniform blending of powders and granules before their addition to a formulation such as ointment, creams, and gels. The equipment is characterized by a double cone-shaped container that is mounted on a rotating shaft that rotates to tumble the materials and facilitate uniform blending. The mechanism of operation is gentle tumbling that enables uniform blending of materials while minimizing the production of heat and stress on the materials to be blended. The equipment is usually powered by a motor and may be fitted with internal baffles to improve efficiency in blending materials. In the production of semisolids, the use of a double cone mixer is important in blending the dry materials before further processing to improve uniformity and consistency of the final product [32]

NOVAL METHODS AND APPROACHES IN SEMI SOLID DOSAGE FORM:

NANOTECHNOLOGY BASED EXCIPIENTS:

Nano-excipients are excipients in pharmaceutical formulations that fall in the range of the nanometre scale. These excipients can either be synthesized intentionally or can occur unintentionally in the formulation of nano-based advanced drug delivery systems. In the formulation of NADDS, excipients can transform to the nano-scale. The role of nano-excipients in pharmaceutical formulations was acknowledged by Moreton, who emphasized the role of nano-excipients in pharmaceutical formulations. Due to their very low size, excipients in the nano-scale are likely to display altered physicochemical characteristics, which are likely to improve their permeability in biological systems. Due to the altered characteristics, nano-excipients are likely to undergo further safety testing compared to their non-nano counterparts.[15]

The regulatory point of view of the USFDA on the evaluation of nano-excipients is described in a document titled “Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies, on the Safety and Regulatory Status of Food Ingredients and Food Contact Substances, Including Food Ingredients that are Colour Additives.” This document describes the point of view of the

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USFDA on how to evaluate the effects of various changes to the manufacturing process, especially when emerging technologies are used. The document is a guidance document that discusses how nanotechnology is used in food-related substances. The document emphasizes the deliberate use of nanotechnology to achieve specific purposes, as opposed to naturally occurring nano-sized particles that are part of various products. The document also emphasizes that a more detailed evaluation of products that are made using nanotechnology is necessary. The final decision on the safety of a product is based on the final product. However, it should also be recognized that when a product is made using nanotechnology, it is not possible to use the standards used to evaluate conventionally made food substances because of differences in size. [16]

MODIFIED POLYMER EXCIPIENTS:

Modification of polyethylene glycol (PEG) polymers can be done for better performance in various medical and pharmaceutical applications. Even though PEG polymers are highly renowned for their biocompatibility and versatility in the design of scaffold structures, these materials can have some disadvantages such as low antimicrobial properties and volume expansion. These disadvantages can be eliminated by using PEG in combination or as a modified form of other polymers. [17-19]

Polyvinyl alcohol (PVA), another hydrophilic polymer, has been highly recognized for its excellent biocompatibility. The properties of PVA can be enhanced in combination with other natural polymers. Additionally, Carbopol, a synthetic polymer of high molecular weight and derived from acrylic acid monomers, is often employed in the preparation of hydrogels. Due to its ability to absorb and retain water in large amounts, Carbopol forms nanohydrogel structures [31].

In summary, synthetic polymers such as PEG, PVA, and Carbopol are very important in designing nanohydrogels to develop topical and targeted drug delivery systems. By selecting and modifying synthetic polymers, researchers are able to develop nanohydrogels with specific characteristics to meet the requirements of new drug delivery systems.[19]

LIPID-BASED EXCIPIENTS:

Lipids are a group of organic compounds which include fatty acids, their derivatives, and other compounds which are related to the fatty acids either by their structures or their biological functions. These compounds have an amphiphilic nature because their structures are composed of two parts: a non-polar hydrophobic fatty acid chain and a polar hydrophilic group. The fatty acids are usually connected to the polar group through an ester bond. The melting points of the lipids are determined by their structures. An increase in the molecular weight of the lipid generally increases the melting point, while the presence of double bonds in the fatty acid chains lowers the melting points.

In most instances, they have very little solubility in water but are soluble in nonpolar organic solvents. Lipids are also grouped on the basis of various properties, including fatty acid content, melting point, hydrophilic/lipophilic balance, and solubility index. Lipids are classified into several types, including fats, oils, waxes, as well as more complex biological molecules such as sterols, phospholipids, glycolipids, lipoproteins, and sphingolipids. Of all these types of lipids, vegetable oils and their derivatives are used as vital raw materials for developing various types of lipid-based excipients for enhancing the oral bioavailability of various types of pharmaceutical drugs. [20-21]

EXCIPIENTS FOR 3D-PRINTED SEMI-SOLID DOSAGE FORM:

Excipients form the structural basis of dosage forms and must be in compliance with specific regulatory guidelines. In addition, excipients must be selected from a source that is approved, such as the Inactive Ingredient Database (IID), or must fall under the Generally Recognized as Safe (GRAS) category. However, not all excipients are suitable for all 3D printing processes. Every 3D printing technique requires specific physicochemical properties of excipients to ensure compatibility.

In Fused Deposition Modelling, it is necessary that the material be melted to a temperature that is sufficient to bind with another layer. At the same time, it must also be able to solidify immediately to retain its geometry and avoid deformation [22,23]. In FDM, excipients must

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be thermoplastic in nature to be able to melt and be extruded at a high temperature. Moreover, excipients and drugs must be thermally stable to be able to withstand such temperatures. It is also necessary that all the formulation materials be in a filament form before 3D printing.

The most frequently used polymers in FDM are acrylonitrile-butadiene-styrene copolymer (ABS), poly (lactic acid) (PLA), polyvinyl alcohol (PVA), polycarbonate (PC), and polyamides (PA), which are commercially available as filaments with diameters of 1.75 mm or 3 mm. Among the mentioned FDM processes, only PLA and PVA are included in the Inactive Ingredient Database (IID) or are Generally Recognized as Safe (GRAS), thus making them more suitable for pharmaceutical applications. [24,25]

In binder jetting–based pharmaceutical printing, the powder bed must exhibit both physical and chemical compatibility with the selected binder solution, along with adequate wettability. Insufficient wetting can lead to improper rearrangement of powder particles, resulting in weak interparticle bonding and challenges in achieving the required mechanical strength and printing resolution. Conversely, excessive wetting or delayed interaction between powder and binder may cause structural deformation and decreased porosity of the powder bed. [26,27]

The mechanical integrity of the printed dosage form is influenced by several formulation and process parameters, including the type and concentration of the binder, the ratio between binder volume and powder bed, and the conditions applied during post-processing. For optimal performance, formulation components should ideally remain insoluble in the binder to avoid structural collapse or sagging of the powder layer during printing.[28]

Several excipients have been evaluated for binder jetting. Synthetic polymers like polycaprolactone, polylactic acid, and poly(lactic-co-glycolic acid) are used with organic solvents. On the contrary, natural polymers like starch, dextran, and collagen peptides are used with aqueous solutions. The choice of these excipients is vital to guarantee stability, mechanical properties, and accuracy of printed pharmaceutical formulations. [29,30]

CONCLUSION:

Semi-solid dosage forms constitute an important and frequently employed form of pharmaceutical preparations for topical and transdermal administration of medications. The therapeutic efficacy of semi-solid dosage forms is not just dependent upon the API content of the dosage form; rather, the selection and optimization of the excipients also play a crucial role in this regard. Excipients in semi-solid dosage forms have been found to play several key roles in the formulation, such as increasing the solubility of the API content, ensuring the physical and chemical stability of the formulation, increasing the spreadability of the formulation, controlling the release of the API content, and ensuring the microbiological safety of the formulation.

CONFLICT OF INTEREST:

The authors declare that there are no conflicts of interest associated with this manuscript.

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REFERENCE:

1. Bora A, Deshmukh S, Swain K, “Recent advances in semisolid dosage form”, *International journal of pharmaceutical science and research*, 2014:1;5(3594):3594-08.
2. Chaudhari SP, “Pharmaceutical excipients: a review”, *International journal of Advances in Pharmacy, Biology and Chemistry*, 2012;1(1):21-34.
3. Giorgio Pifferi, “The safety of pharmaceutical excipients”,*Il Farmaco*,2003 ;58(8):541-50.
4. Dorland WA. Dorland's medical dictionary. (No Title). 1974.
5. Poonam V, Sagar G, Abhishek K, Yuvraj S, “Remarkable contribution of natural excipients in finished pharmaceutical products (FPPs)”,

International Journal of Pharmaceutical Sciences and Research. 2018;52(1):7-14.
6. De Villiers M. "Surfactants and emulsifying agents. A Practical Guide to Contemporary Pharmacy Practice",*Thompson, JE, Ed.; Lippincott Williams and Wilkins: Philadelphia, PE, USA*. 2009:251
7. Changmei sun, "A review of the properties and applications ofbioadhesive hydrogels", *Poly. Chem*., 2021, 12, 3721-3739. DOI: 10.1039/d1py00282a
8. Lieberman H, Rieger M, Banker GS, editors.Pharmaceutical dosage forms: Disperse systems. ISBN:9781003067368.
9. Lachman L, Lieberman HA, Kanig JL. The theory and practice of industrial pharmacy. ISBN: 0812109775, 9780812109771.
10. Maheshwari R. "Novel spectrophotometric estimation of some poorly water soluble drugs using hydrotropic solubilizing agents". *Indian journal of pharmaceutical sciences*. 2006 Mar 1;68(2).
11. Sharma S. "Taste masking technologies: a review". *International journal of pharmacy and pharmaceutical sciences*. 2010;2(2):6-13.
12. AyenewZ.Trends in pharmaceutical taste masking technologies: a patent review. Recent patents on drug delivery & formulation. 2009 Jan 1;3(1):26-39. DOI: https://doi.org/10.2174/1872211308666140206150840
13. Sharma DK, Nandgude TD.A review on taste masking methods for bitter drug. net. 2007;5(4):112-5.
14. Brahamnkar DM. Prodrugsin Biopharmaceutics and Pharmacokinetics A Treatise. VallabhPrakashan, ISBN: 8185731934
15. Moreton C. "Trends in pharmaceutical excipients: an update*". American pharmaceutical review*.2010;13:22-7.
16. FDA U. Final Guidance for Industry: Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies, on the Safety and Regulatory Status of Food Ingredients and Food Contact Substances, Including Food Ingredients That Are Colour Additives. Docket No. FDA-2011-D-0490. Washington, DC: US Food & Drug Administration; 2014.
17. Ahmad MZ. Co-delivery of imiquimod and curcumin by nanoemugel for improved topical delivery and reduced psoriasis-like skin lesions. Biomolecules. 2020 Jun 27;10(7):968.
18. Qureshi M,S. Berberine loaded dermal quality by design adapted chemically engineered lipid nano-constructs-gel formulation for the treatment of skin acne. *Journal of Drug Delivery Science and Technology*. 2021 Dec 1:66:102805.
19. Filippone A. "Topical delivery of curcumin by choline-calix [4] arene-based nanohydrogel improves its therapeutic effect on a psoriasis mouse model",*International Journal of Molecular Sciences*. 2020
20. World Health Organization. The international pharmacopoeia. World Health Organization; 2006.
21. Carl O. Formulating with microspheres, InTechnical seminar, April 2008 (Vol. 14)
22. Norman J, Madurawe RD, Moore CM, Khan MA, Khairuzzaman A., "A new chapter in pharmaceutical manufacturing: 3D-printed drug",*Advanced drug delivery reviews.* 2017 Jan 1; 108:39-50.
23. VentolaCL,"Medical applications for 3D printing: current and projected uses",*Pharmacy and Therapeutics.* 2014 Oct;39(10):704.
24. Mancuso E, Alharbi N, Bretcanu OA, Marshall M, Birch MA, McCaskie AW, Dalgarno KW. Three-dimensional printing of porous load-bearing bioceramic scaffolds. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine. 2017 Jun;231(6):575-85.
25. Sheydaeian E, Vlasea M, Woo A, Pilliar R, Hu E, Toyserkani E. Effect of glycerol concentrations on the mechanical properties of additive manufactured porous calcium polyphosphate structures for bone substitute applications. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 2017 May;105(4):828-35.
26. Wu BM, Borland SW, Giordano RA, Cima LG, Sachs EM, Cima MJ. Solid free-form fabrication of drug delivery devices. Journal of Controlled Release. 1996 Jun 1;40(1-2):77-87.
27. Kim SS, Utsunomiya H, Koski JA, Wu BM, Cima MJ, Sohn J, Mukai K, Griffith LG, Vacanti JP. Survival and function of hepatocytes on a novel three-dimensional synthetic biodegradable polymer scaffold with an intrinsic network of channels. Annals of surgery. 1998 Jul 1;228(1):8-13.

28. Zeltinger J, Sherwood JK, Graham DA, Mueller R, Griffith LG. Effect of pore size and void fraction on cellular adhesion, proliferation, and matrix deposition. Tissue engineering. 2001 Oct 1;7(5):557-72.
29. Lam CX, Mo XM, Teoh SH, Hutmacher DW. Scaffold development using 3D printing with a starch-based polymer. Materials Science and Engineering: C. 2002 May 31;20(1-2):49-56.
30. Seitz H, Rieder W, Irsen S, Leukers B, Tille C. Three-dimensional printing of porous ceramic scaffolds for bone tissue engineering. Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2005 Aug;74(2):782-8.
31. S Gokulakrishnan , K. B. Ilango , Kalyan R, R Samyuktha , A Subash , K Subhashini , An Innovative Formulation Development Approach of Sustained Release Matrix Tablet: A Review , Journal of Drug Delivery and Therapeutics: Vol. 15 No. 12 (2025): Volume 15, Issue 12, Dec 2025. Doi: https://doi.org/10.22270/jddt.v15i12.7432.
32. Gokulakrishnan S, Anitha K, Bharathi S, Jothika J, Keerthana T, Bilal NM, Shree DSS, Vignesh K and Ilango KB: A comprehensive review of formulation methods of chewable tablet- a novel approach. Int J Pharm Sci& Res 2025; 16(10): 2692-99. doi: 10.13040/IJPSR.0975-8232.16(10).2692-99.
33. S Gokulakrishnan , K. B. Ilango, E Ajay , M Gayathri, M jeeva, M Kavisri , M Sakthi , Review of Orodispersible Tablet: The Current Trends , Journal of Drug Delivery and Therapeutics: Vol. 15 No. 12 (2025): Volume 15, Issue 12, Dec 2025. Doi:https://doi.org/10.22270/jddt.v15i12.7433.