An Overview - Semi Solid Dosage Form of Gel

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Abstract- *The purpose of writing this review was to compile the recent literature with a special focus on a rational approach to topical formulation and basic components of topical drug delivery systems. Topical applications of drugs have advantages of delivering the drug directly to the site of action and acting for a longer period of time. Skin is one of the most widespread and readily accessible organs on the human body for topical administration and is the main route of topical drug delivery system. Many widely used topical agents like ointments, creams and lotions have numerous disadvantages as they are usually very sticky causing uneasiness to the patient when applied. Moreover, they also have less spreading coefficient and need to apply with rubbing and also exhibit the problem of stability, due to all these factors, within the major group of semisolid preparations; the use of gas has increased both in cosmetics and in pharmaceutical preparations. A gel is colloid that is typically 99% by weight liquid, which is immobilized by surface tension between it and a macromolecular network of fibers built from a small amount of a gelatinous substance present.*

Keywords- Pharmaceutical gels; Terminologies; Characteristics; Classification; Preparation; Evaluation of Gels; Patents

I. INTRODUCTION

Topical gels are semi-solid, homogenous formulations used for both skin condition treatment and prevention. Gels' hydrophilic properties allowed the medication or active ingredient to be released fast.

Three-dimensional material with a large enough liquid content to form a stiff enough network to immobilize the liquid continuous phase.

To form the structural network of gel, both inorganic particles and organic macromolecules are used.

Chemical gels have a permanent covalent bonding that binds the particles together, whereas physical topical gels have secondary intermolecular forces includes hydrogen bonds, electrostatic interactions, hydrophobic contacts, and Vander Waal forces that are weaker and reversible.

The application of a material to the skin for the purpose of treating or curing skin conditions is known as topical medication delivery.

When other methods of administration prove to be inadequate.

Its deeper penetration of the skin enhances absorption. There is no discernible advantage between topical application and traditional dose forms. They are usually considered safer and more effective than conventional formulations due to the bilayer composition and structure.
It increases the medication's bioavailability by reducing GI irritation and preventing the liver from metabolizing the drug.

Topical medications, such as ocular, vaginal, and rectal ones, are delivered locally through the skin.

ROUTES OF DRUG PERMEATION THROUGH SKIN:-

Primary Transcellular:-

The chemical moieties are transferred into and out of the cell membrane throughout the keratin-packed coenocytes.

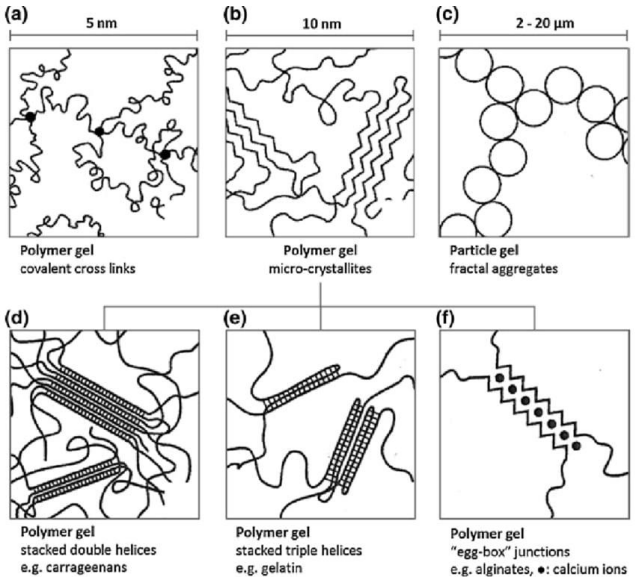
Secondary Intercellular:-

In the lipid-rich extracellular space surrounding coenocytes, the molecules are transported.

Thirdly Transappendageal:-

Hair follicles, sebaceous glands, and sweat glands all support these transports.

STRUCTURE OF GELS:-



A natural or synthetic polymer forms a three-dimensional matrix in a hydrophilic liquid or dispersion medium to form a gel.

The medicine is contained in a thin layer of the gel-forming matrix that physically covers the skin as soon as the liquid is applied because it evaporates quickly.

The network formed by the interlocking of gelling agent particles is what gives a gel its flexibility.

IDEAL PROPERTIES OF TOPICAL GEL:-

- The gel ought to be uniformly clear.
- The gel ought to have an inert nature.
- It should not be sticky to the gel.
- The gel and any other ingredients in the formulation shouldn't interact.
- There should be stability in the gel.
- The skin or any other area where the gel is applied should not become irritated.
- The ideal viscosity should be achieved.
- It ought to possess antimicrobial properties.

ADVANTAGES OF GEL FORMULATIONS :-

- Gels are much easier to prepare than other formulations.
- Gel has a sophisticated, non-greasy formula.
- Gels adhere exceptionally well to the application site.
- Eco-friendly and biocompatible are gels.
- Possess exceptional resilience to stressful situations.

DISADVANTAGES OF GEL FORMULATION:-

- Gels have a slower, more sustained effect.
- Additives or gelators could irritate skin.
- The likelihood of a fungal or microbial attack in gel is increased by water content.
- Gel dries out due to solvent loss in the formulation.
- In certain gels, flocculation results in an unstable gel.

IDEAL CHARACTERISTICS OF GELS:-

Swelling:

Gels can swell, taking in liquid and growing larger as a result. This could be seen as the start of the breakdown process.

Solvent seeping into the gel matrix causes gel-solvent interactions to take the place of gel-gel interactions.

Limited swelling results from normal cross-linking in the gel matrix, which prevents total disintegration.

This gel swells considerably when the solvent combination has a solubility characteristic that is comparable to the gellant's.

Syneresis:

Many gel systems shrink when left to stand. The interstitial liquid is released and gathers on the surface of the gel.

In addition to organic hydrogels, this technique—known as syneresis—has also been observed in organogel and inorganic hydrogels. A decrease in polymer concentration frequently causes syneresis to intensify.

Ageing:

In colloidal systems, slow spontaneous aggregation is quite common. This process is referred to as aging. Gels gradually accumulate a thick network of the gelling ingredient as they age.

The timer assumes that this process is the same as the first gelling process and that it continues after the initial gelation because the fluid medium is removed from the newly formed gel.

Structure:

A gel's flexibility comes from the network formed by the particles of the gelling agent interacting with one another.

The type of particles used and the force applied to form the links determine the properties of the gel and the structure of the network.

Rheology:

Pseudoclasticity, or pseudo-plastic solutions, are solutions containing gelling agents and flocculated solid dispersion that exhibit nonNewtonian flow characteristics, which are characterized by a decrease in viscosity with an increase in shear rate.

The delicate structure of inorganic particles dispersed in water is disrupted by breaking down interparticle attachment, and when shear force is applied, the particles show a stronger tendency to flow. In a similar manner, macromolecules align in the direction of tension when shear stress is applied to them.

CLASSIFICATION OF GELS:-

Gels can be categorized according to their physical characteristics, rheological properties, solvent type, and colloidal phases.

Based on colloidal phases:

They are classified into:

1. Inorganic (Two phase system)
2. Organic (Single phase system)

Inorganic (Two-Phase System):-

Rather than being composed of larger molecules, the system is made up of floccules of smaller particles, and if the dispersed phase partition size is particularly large and creates a three-dimensional structure throughout the gel, the gel structure will become unstable.

They have to be thixotropic, which means that they should change from a semisolid to a liquid when disturbed. Two examples are bentonite magma and aluminum hydroxide gel.

Organic (Single Phase System):-

Large organic molecules are continuously dissolved on the twisted threads. Most organic gels are single-phase mixtures of organic liquids (like plastic base) and gelling agents (like tragacanthin and carbomer)**.**

Based on Nature of the Solvent Hydrogels:-

Organogel:

An organogel is a kind of gel that contains a liquid organic phase inside a three-dimensional, cross-linked network. The lecithin solution in organic solvents gels or organogels when a polar solvent is added.

Xerogels:

Xerogels are gels that are solidified by letting materials slowly dry at room temperature and shrink without any constraints.

When a xerogel is heated above a specific temperature, a process known as viscous sintering occurs, which transforms the porous gel into a thick glass. Polystyrene, dry cellulose, and tragacanth ribbons are a few examples.

When a gel exhibits non-Newtonian flow, it can also be classified as a thixotropic gel, pseudo-plastic gel, or plastic gel.

Based on Physical Nature Elastic gels:

Rigid gels:

Macromolecules with primary valence bonds joining the framework can be used to make this. For instance, the Si-O-Si-O link in a silica gel holds silic acid molecules together, creating a polymer structure with a network of pores.

PREPARATION METHODS OF GELS:-

Dispersion Method:

The dispersion method involves immersing the polymer in water for two hours or letting it soak completely before adding the remaining ingredients and stirring until a homogenous mass is formed.

Cold Method:

When using the cold method, all of the ingredients should combine to form a homogenous mass at a low temperature of roughly 50°C. Solution A was created by combining the penetration enhancer and polymer, and Solution B was created by combining the drug with the solvent. Subsequently, solution B was added to solution A while stirring continuously.

Chemical Reaction:

Gel is created in this chemical reaction method through the chemical reaction of the solute and solvent. Creating silica gel and aluminum hydroxide gel, for instance.

Flocculation:

Gelatin is created in this flocculation method by adding enough salt to create an age state but not adequate to cause the entire precipitation temperature effect lowering the temperature causes lipophilic colloid agar to become less soluble.

Evaluation Parameters of the Formulated Gels:-

Measurement of pH:-

Digital pH meters were used to measure the pH 1g of gel should be dissolved in 100 ml of distilled water and kept for two hours measured the pH three times and determined the average results.

Drug content:-

1g of the gel was combined with 100 ml of an appropriate solvent. Screen the solution that is already prepared. Next, using appropriate dilutions, prepare aliquots of varying concentrations and measure the absorbance. The equation, obtained through linear regression analysis of the calibration curve, was used to calculate the drug content.

Viscosity study:-

A Brookfield viscometer is used to perform the procedure. The gels were rotated at 0.3, 0.6, and 1.5 RPM. At each speed, record the corresponding dial reading.

The viscosity was obtained by dial reading × factor given in the Brookfield viscometer catalogues.

Spreadability:-

A wooden block and a glass slide apparatus were used to determine it. Twenty grams of weight were added to the pan, and the amount of time it took for the movable upper slide to fully separate from the fixed slides was recorded.

spreadability is calculate by using the formula:

$$S = M \cdot L / T$$

Where,
S – spreadability
M – weight tide to upper slide
L – length of glass slide
T – time taken to separate the slide completely from each other

MECHANISM OF GEL FORMATION:-

Gels are formed via three types of cross-linking,

a) Chemical cross-linking
b) Physical cross-linking
c) Ionic cross-linking

a) Chemical cross-linking:

Polymers with bonded units in their structure demonstrate chemical cross-linking as well. These polymers create an irreversible interaction between the free group and the added chemical, which is then strengthened by cross-linking agents.

When viscosity in this type of reaction reaches a certain concentration, gel formation occurs. Think about polyacrylic acid, which has several carboxylic acids.

b) Physical cross-linking:

Solution to gel transitions can also be accomplished by creating hydrogen bonds in response to temperature changes, concentration fluctuations, and the solubilization of crystalline components. Examples of physical cross-linking include cellulose and dextran gels.

c) Ionic cross-linking:

In this instance, a charge is applied to the polymer (S) or different particles (Solvent), causing them to attract one another and form gel. Charges on molecules produce ionic charges.

APPLICATION OF GELS:-

• Found in both hard and soft gel pills.
• Continuous drug release formulations are made with gels.
• Used to administer drugs via a variety of routes, including tropical, intranasal, intraocular, vaginal, rectal, intramuscular, and, in certain situations, parenteral.
• The food and cosmetics industries make extensive use of them.

• Dental care products that contain sodium fluoride and phosphoric acid gel.

Factors Affecting Skin Penetration:-

1. **Skin Condition**: More drugs permeate the surface of injured or abraded skin than normal skin. Chemicals cause skin damage, which increases the drug's penetration.
2. **Content of Fat:** The fat-containing epidermis has no effect on drug absorption.
3. **Age:** Since their skin is so delicate, children's and newborns' skin absorbs more than that of adults.
4. **Hyperemia:** Despite being caused by localized or widespread stimulation, drug penetration through the skin increases as a result of blood vessel vasodilatation.
5. **Hydration of Skin:** Drug penetration is greater on hydrated skin than on dry skin. When skin is hydrated, water acts as a penetration enhancer, increasing permeability through the stratum corneum.
6. **Types of Vehicles:** Vehicles are crucial to the penetration and absorption of drugs through the skin's surface. It is dependent upon the kind of skin and whether it is hydrated or dry.
7. Lipophilic substances allow for greater skin penetration.
8. Physiological aspects like skin pH, hair follicle density, blood flow to the application site, skin inflammation, sweat gland density, and lipid content.

II. CONCLUSION

These days, more people are using pharmaceutical gels because they are more stable and offer controlled release compared to other semisolid dosage forms. The topical gel increases the bioavailability of medication by enhancing the skin's ability to absorb it. The primary benefit of a topical administration system is that first-pass metabolism is avoided. It also provides a high level of patient acceptance. Topical distribution is usually the preferred method of medication administration when another method has a lower bioavailability. The clinical data suggests that topical gel is a safe and useful therapeutic option for the management of illnesses related to the skin.

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