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A Comprehensive Review on Pharmaceutical Gels and Their Impact on Drug Delivery Technologies

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ABSTRACT
The purpose of this review was to compile recent literature, with a focus on a rational approach to topical formulation and the fundamental components of topical drug delivery systems. Topical drug delivery systems include a variety of pharmaceutical dosage forms, including semisolids, liquid preparations, sprays, and solid powders. A gel is a cross-linked polymer network that has swollen in a liquid environment. Its properties are heavily influenced by the interaction between the solid-state polymer and the liquid component. The I.P. defines gels as homogeneous, semisolid preparations made up of solutions or dispersions of one or more medicaments in suitable hydrophilic or hydrophobic bases.According to the U.S.P. definition, gels are a semisolid system composed of a dispersion of either small inorganic particles or large organic molecules that are encased and interpenetrated by liquid. The inorganic particles create a three-dimensional "house of cards" structure. In terms of structure, gels are a two-phase system in which inorganic particles are dispersed throughout the continuous phase rather than dissolved, and large organic particles are dissolved in the continuous phase, randomly coiling into flexible chains. Gels are typically made from a liquid phase that has been thickened with additional ingredients.They are typically prepared using appropriate gelling agents such as HPMC, Carbopol, and Sodium CMC, among others. Gel formulations include additives such as antioxidants, stabilizers, and antimicrobial preservatives.

I. INTRODUCTION

Compared to other drug delivery methods, the topical/transdermal (TT) route has numerous advantages, including increased patient compliance, continuous drug delivery, fewer side effects, and avoidance of the hepatic first pass effect [1]. Drugs for topical use are intended to be applied outside. Sunscreen, keratolytic agents, local anaesthetics, antiseptics, and anti-inflammatory medications are examples of products with a localized effect on one or more layers of the skin. Although some of the drug in these topical preparations may enter the bloodstream unintentionally, it is typically at subtherapeutic doses and has no significant side effects, with the possible exception of pregnant or nursing patients. Gels are semi-solid preparations that disperse small and large molecules in aqueous liquid carriers. Gels are semi-solid systems in which colloidal particles interact (physically or covalently) within a liquid medium. The gel formula includes synthetic polymers like Carbomer 934 and celluloses like hydroxypropyl cellulose and hydroxypropyl methylcellulose, as well as tragacanth gum, pectin, and natural agar gum.

Skin

Topical drug delivery systems are used to administer medications to specific areas of the body's skin. Drugs are delivered locally rather than systemically to treat localized skin conditions [2, 3, 4]. They are used when the drug's local effect is desired. Corticosteroids, antifungals, antivirals, antiseptics, local anaesthetics, and antineoplastics are examples of drugs that are readily available locally. Topical agents with physical action include 4044 protective ingredients, adsorbents, emollients, and cleansers [2]. External dosage forms are typically classified as liquid, semisolid, or solid. Liquid topical dosages consist of low viscosity emulsions (also known as emulsions), suspensions, and solutions. Semi-solid topical dosage forms include gels, foams, ointments, pastes, creams, and gel. Solid topical dosage forms include powder, patch, gauze, tape, and stick. These dosage forms vary greatly depending on their physical properties [2, 3]. Topical administration has several advantages over other methods of administration. The main advantage of topical administration is that it has few systemic side effects when the product is applied to the affected area [5]. Second, the topical delivery system avoids first-pass metabolism by delivering actives through the skin. It prevents the active ingredient from being broken

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down before reaching the intended target site of action. Topical products are simple to use and can be self-administered, increasing patient compliance.Topical administration does not necessitate complex administration procedures, thereby avoiding the risks and inconveniences of intravenous administration. Furthermore, the skin covers the majority of the human body's surface. It has a relatively broad application range and can selectively deliver more drug to specific locations. It can maintain a high local drug concentration in the surrounding tissues for an extended period of time, reducing the need for frequent dosing. Topical application reduces the risk of systemic side effects because the drug does not enter the bloodstream [6].

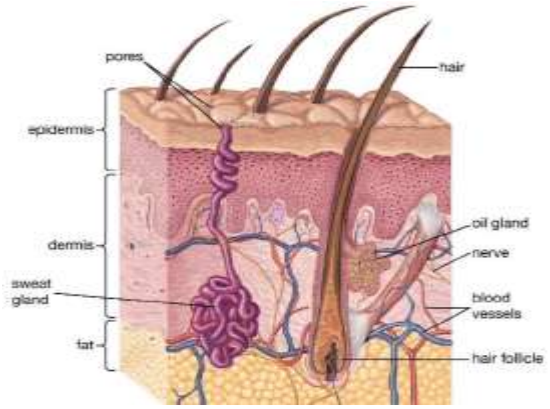

Figure 1. Structure of skin

However, there are some disadvantages. These include: skin irritation caused by drugs or excipients; poor skin penetration of certain drugs; this route is not appropriate for large particle size agents; the possibility of allergic reactions; and sex change [6].

Several semi-solid topical dosage forms were developed during this study, including one cream and two gels with antiviral and antibacterial properties.

Pathways of Drug Penetration through the Skin:
The Three Most Important Pathways of Skin Absorption. [7, 8]

1) First, Transcellular: The drug portions enter and exit the cell membrane through the keratin-coated nucleus.
2) Secondary, intercellular: Molecules are transported around nucleated cells in the lipid-rich extracellular space.
3) Third, Trans appendageal: These transports are been supported by sweat glands, hair follicles and sebaceous glands.

Topical Drug Delivery System: [9]

Any drug delivery system must deliver a therapeutic dose of medication to the correct location in the body in order to quickly achieve and then maintain the desired drug concentrations. The route of administration of a medicine has a significant impact on its therapeutic outcome. Topical medication is primarily delivered through the skin, which is one of the most easily accessible organs on the human body.

Topical delivery is defined as the application of a drug-containing formulation to the skin to treat cutaneous disorders (such as acne) or the cutaneous manifestations of a general disease (such as psoriasis); Topical delivery refers to the application of a drug-containing formulation to the skin to treat cutaneous disorders (such as acne) or the cutaneous manifestations of a general disease. Semi-solid formulations of all types are most commonly used for topical distribution, but foams, sprays, medicated powders, solutions, and medicated adhesive systems are also used.

- External topicals applied to cutaneous tissues via spreading, spraying, or other means to cover the affected area.
- Internal topicals for local activity are administered orally, vaginally, or to anorectal tissues.
- External topicals are spread, sprayed, or otherwise applied to cutaneous tissues to cover the affected area.
- An internal topical that is applied to the mucous membrane orally, vaginally, or to anorectal tissues for local activity.

Advantages of Topical Drug Delivery System:

- Eliminates first-pass metabolism.
- Allows for easy termination of medications as needed.
- Arelativelylargeareaofapplicationincomparison withbuccalornasalcavity
- Ability to deliver drugs more selectively to a specific location.
- Providing utilization of drugs with a short biological half-life.
- Improving the physiological and pharmacological responses.
- Increase patient compliance.
- Ensure suitability for self-medication.

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Disadvantages of Topical Drug Delivery System:

- The drug and/or excipients may cause skin irritation associated with contact dermatitis.
- Some drugs have poor permeability through the skin.
- The possibility of allergic reactions.
- Can only be used for drugs with low plasma concentrations.
- Drugs may be denatured by enzymes in the epidermis.
- Larger particle size drugs may not be easily absorbed through the skin.

GELS

Gels are semi-rigid systems in which the dispersion medium's strength is limited by three-dimensional particle interaction or macromolecule solubility in the dispersed phase.

The word "gel" comes from "gelatin," and both "gel" and "jelly" can be traced back. In Latin, Gelu means "drop" and gel means "freeze" or "freeze". This origin illustrates the fundamental concept of liquids as solids that do not flow but are elastic and retain some liquid properties. The term "gel" was first used to describe semisolids in the late 1800s, when chemists attempted to separate them based on phenomenological properties rather than molecular composition. The analytical methods needed to identify drug samples are not currently available [10].

Gels are harder than jellies due to increased crosslinking, higher physical density, or simply less liquid. Gel-forming polymers produce a variety of hardnesses, ranging from sols to slimes, jellies, gels, and hydrogels.

Some gel systems are as clear as water, while others are cloudy due to incomplete molecular dispersion (soluble or insoluble) or the absence of light-scattering aggregates.

With a few exceptions, the concentration of the gelling agent is usually less than 10%, ranging from 0.5% to 2. 0% more [11].

Structure of the gel:

The gel's hardness results from the presence of a network formed by the interconnection of granular gelling agents. The network structure of the gel and product is determined by the nature of the product and the type of oil used for coupling.

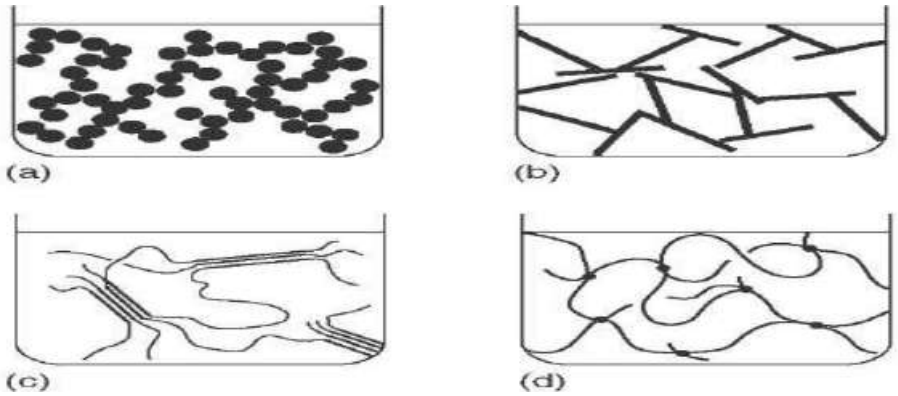

Figure 2: Structure of Gel

A single hydrocolloid product can have spherical or equidistant clusters of small or single macromolecules. These products are prepared using gel wax [12]. In linear macromolecules, the network is made up of entangled molecules, sometimes with small dots between them, or several molecules arranged in a crystalline arrangement, as illustrated in Figures 1(c) and (d), respectively. The attractive forces that hold the gelling agent particles together can vary from strong primary values (as in silicic acid gels) to weak hydrogen bonds and van der Waals forces.

These latter forces proved to be weak, and a slight increase in temperature typically causes the gel to liquefy.

IDEALPROPERTIES OF GEL: - [13]

- Ideally, gelling agents should be inert, safe, and not react with the other ingredients in the formulation.
- The gelling agent should have a solid-like consistency during storage and be able to withstand shear forces from squeeze tubes, shaken bottles, or topical application.

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- Antibacterial agents should be readily available.
- External gel should be non-sticky.
- Suitable antibacterial agents should be available.
- External gel should be non-sticky.
- Ophthalmic gel must be sterile.
- As the gel's effective cross-linking density increases, so does its apparent viscosity and strength.

However, depending on the molecular interactions between the polymer and the solvent, increasing temperature either increases or decreases apparent viscosity.

Characteristics of gels

Swelling

The gel expands and absorbs liquid as its volume increases. This could be considered the first stage of decomposition. The solvent penetrates the gel matrix, replacing gel-gel interactions with gel-solvent interactions. The limited swelling is usually caused by the degree of crosslinking in the gel matrix, which prevents complete dissolution. This gel swells significantly when the solvent mixture has a solubility parameter similar to the gelling agent.

Syneresis

Many gels systems contract when standing. The interstitial liquid is expelled from the gel and accumulates on its surface. This process, known as syneresis, occurs not only in organic hydrogels but also in inorganic hydrogels. In general, syneresis increases as the polymer concentration decreases. The shrinkage mechanism is associated with the relaxation of elastic stresses that occur during gel solidification.

Ageing

Colloidal systems typically exhibit slow spontaneous aggregation. This process is known as aging. Aging in gels causes a dense gelling network to form over time. Inner demonstrated that the process is similar to the initial gelation process and continues once the fluid medium of the newly formed gel is lost. Gels are rigid because they contain a network of interconnected gelling particles. The network structure and properties of the gel are determined by the particle type and bond strength.

Rheology

Gelling agent solutions and flocculated solid dispersions are pseudoplastic, which means they flow non-Newtonian and have a decrease in viscosity as shear rate increases. The elongated structure of inorganic particles dispersed in water is disturbed by the applied shear stress, which causes the breaking of inter particulate bonds, resulting in a greater tendency to flow.

Similarly, is used for large molecules, and the applied shear stress straightens the molecules and reduces flow resistance.

Gel Uses

1. As an oral medication delivery system.
2. External preparations designed for direct application to the skin, mucous membranes, or eyes.
3. A long-acting drug that is injected into a muscle or implanted within the body.
4. Tablet granulation binder, suspension protectors, oral liquid thickeners, and suppository bases.
5. In cosmetic products such as shampoos, perfumes, dentifrices, and skin and hair care solutions.
6. Catheter lubricant.
7. Base for patch testing.
8. NaCl gel for electrocardiograms.
9. Sodium fluoride and phosphate gel for dental hygiene.

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Classification of gels. [15]

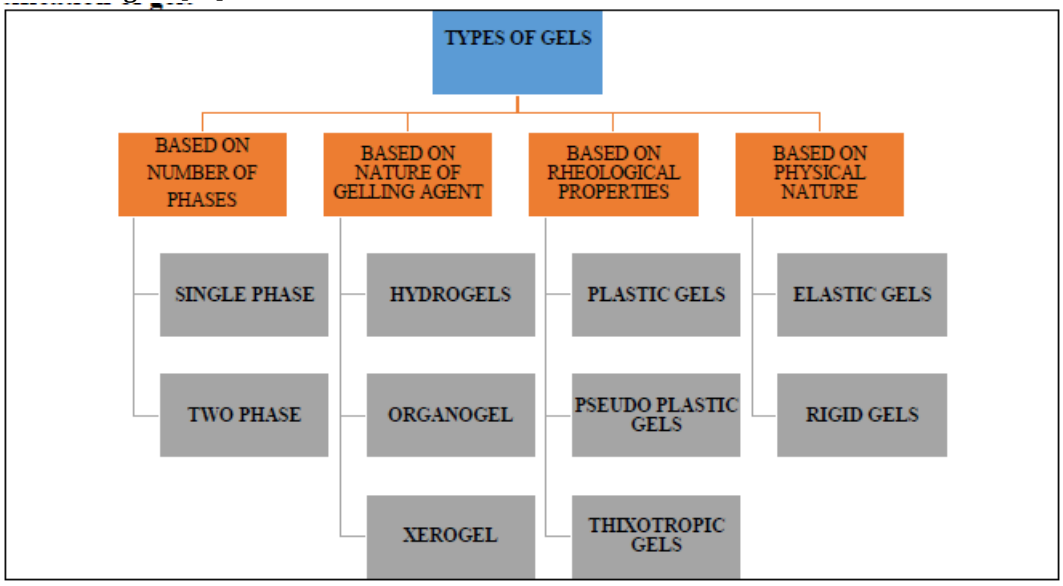

Figure 2: Classification of gels

BASED ON NUMBER OF PHASES

Colloid phase: They are divided into:

a) **Inorganic (Two-phase) system:** If the dispersion size of the dispersed phase is too large, there exists a system that forms the three-dimensional structure of the entire gel. Small flocks. Unlike larger molecules and gel structures, this body is not always stable. They should be thixotropic semi-solids when stationery and liquid when mixed.

b) **Organics (single-phase systems):**These consist of large organic molecules arranged in a helix and dissolved in a continuous phase. Large organic molecules, whether natural or synthetic polymers, were previously referred to as gels, and they tend to come together in competition or be held together by van der Walls.

BASED ON NATURE OF GELLING AGENT

Hydrogel (water-based)

Hydrogels are networks of hydrophilic polymer chains that disperse in water. These are natural or synthetic polymer networks with a high absorbency. Because of their high-water content, they are somewhat flexible.

These gels have unique physicochemical properties, including:

- Ability to absorb large volumes of aqueous fluid (typically 100 times the original mass) while possessing a three-dimensional structure.
- Hydrogel exhibits robust mechanical properties and resists fracture after frequent exposure to pressures up to 1 kPa.
- Hydrogel exhibits excellent flexibility.

Uses of Hydrogels

- Sustained Release Drug Delivery Systems.
- Rectal Drug Delivery and Diagnosis
- Hydrogel-coated wells have been used in cell culture.
- Used as scaffolds in tissue engineering.
- Environmentally sensitive sensors.
- Contact lenses (silicone hydrogel, polyacrylamide, or polymacon).
- Electrocardiogram medical electrodes.
- Healing Wraps

Hydrogel Dressing

Hydrogel dressings differ from other dressings in that they can add moisture to dry wounds. They are thus used to promote autolytic debridement (the release of protein-rich exudate from wound surface capillaries containing phagocytes and other materials that engulf dead cell debris and bacteria), as well as to keep gritty wounds clean by maintaining a moist healing environment. The Hydrogel Dressing is made up of a swollen three-dimensional network of hydrophilic polymers with a high-water content.

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Figure 4: Hydrogel dressing

Hydrogels can be applied to wounds in to forms, which have different wound care properties and uses:

1. An amorphous gel that can take the shape of a wound (filler). 2. A sheet or elastic film.
2. Sheet or elastic film

Amorphous Gel for wounds (filler)

Contains 70-95% water and is produced by natural (e.g., alginate or carboxymethylcellulose) or synthetic (e.g., polyvinylpyrrolidone, polyacrylamide) polymerization followed by dispersion in water. The rheological properties of the gel differ significantly between commercial products, depending on the specific polymer used and its concentration in the dressing. These differences may have an impact on clinical use and handling characteristics. For example, the apparent viscosity of an amorphous gel may influence its ability to fill all or part of a wound cavity and then remain on the wound bed. Subsequent packaging, for example, whether the dressing is packaged in a tube, spray bottle, or foil pouch, will depend on the dressing's rheological behavior under shear.

When diluted with exudate, the amorphous gel gradually loses its structure, allowing the polymer to disperse. As a result, when the gel is applied directly to a wound, it is typically covered with a secondary dressing, such as foam or gauze. Any exudate is absorbed into the gel as moisture evaporates through the secondary dressing. Saturated gauze is created by impregnating it with an amorphous hydrogel, which is sometimes used to fill deeper wounds.

Elastic sheet or film: a reticulated structure (between 6% and 30%) that physically traps water to form a strong sheet that can be cut to fit a wound. Despite their high water content, some hydrogels can swell to absorb small to moderate amounts of exudate. Hydrogel Sheets do not require a secondary dressing because they are made of a semi-permeable polymer layer with or without bonded edges, allowing you to control the amount of water vapor that passes through the dressing.

Hydrogel dressings are appropriate for all stages of wound healing, with the exception of infected or heavily exuding wounds. They do not absorb much exudate, and the gel's high water content can cause maceration of the skin and bacterial growth in infected wounds, resulting in an unpleasant odor. Although these dressings must be changed frequently, they are gentle on delicate tissue and are appropriate for burns and other painful wounds. Primary dressings include amorphous gels and impregnated gauzes, whereas hydrogel sheets can be used as both primary and secondary dressings.

Figure 5: Medical grade silicone and adhesive & gel on MBK Tape solution

Organogel

Organogold is a non-crystalline, non-vitreous thermoreversible solid composed of a liquid organic phase trapped within a 3D cross-linked network. Fluids include vegetable oil, organic solvents, and mineral oils.

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Figure 7: Organogel

Xerogel

This is a dried solid gel that shrinks indefinitely. It generally maintains high porosity (15-50%) and a large surface area (m2/g). Examples include strips of gum tragacanth, beta-cyclodextrin, dry cellulose and polystyrene, gelatin sheets, and acacia tears.

Figure 6: Betadine gel

Based on rheological properties

Generally, gels exhibit non-Newtonian flow properties.

They are classified as:

Plastic gels: The Bingham body sees plastic flow as aluminium hydroxide. Flocculated suspensions, such as tragacanth gum, sodium alginate, and sodium CMC dispersions, are the so-called plastic flow, and the renogram shows the results of the gel on which elastic gel will deform and flow.

Pseudoplastic gel: These gels have no yield value and decrease in viscosity as shear rate increases. The renogram is obtained by cutting the length of the linear polymer's molecular chain. As shear stress increases, the gel matrix releases solvent as the chaotic molecules align their long axes downstream.

Thixotropic Gels: The bonds between particles in these gels are weak enough to be broken by shaking. When particles collide and reconnect (the reverse isothermal gel-sol-gel transition), the solution returns to the gel.

Based on physical strength:

They are divided into

Elastic gels:Gels containing agar, pectin, guar gum, and alginates exhibit elastic behavior. Weak forces like dipole attraction and hydrogen bonds hold fibre molecules together at specific points. If the molecule contains a free -COOH group, additional interactions occur between two adjacent chains of a -COO-X-COO salt bridge. For example, alginate and Carbopol.

Rigid Gels: This can be formed from macromolecules to which the framework is linked by primary bonds. For example, in silica gel, silicic acid molecules are attached by Si-O-Si-O bonds, giving a polymer structure with a pore network.

Preparation of gel [16]

Dispersion method: Add polymer to water for 2 hours or until fully saturated, then add other ingredients and mix until combined. A homogeneous product

Cold Method: To achieve a homogeneous mass using the cold method, all components must be mixed at a low temperature of approximately 50°C. The penetrant and polymer are combined to form a compound.

A. which is then combined with a solvent to form the compound.

B. Next, pour solution B into solution A while continuously stirring to mix the drug in the solvent.

Chemical Reaction: In this chemical reaction, the gel is formed by chemical interactions between the solvent and another solvent. Prepare silica gel and aluminium hydroxide gels.

Flocculation: This method of agglomeration involves adding enough salt to restore it, but not enough to cause it to precipitate completely, resulting in gelatin.

Effect of temperature: The solubility of lipophilic colloidal agar decreases with decreasing temperature of solvent.

Gelling agents

When these substances are added to an aqueous mixture, they increase its viscosity while leaving other properties, such as taste, unchanged.

Types of gelling agents

Natural polymers: Natural polymers include proteins, polysaccharides, natural gums like tragacanth, carrageenan, pectin, agar, and alginic acid.

Semi-synthetic polymers: cellulose derivatives include methylcellulose, hydroxyethyl cellulose,

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hydroxypropyl methylcellulose, and carboxymethylcellulose.
Synthetic polymers: such as carbomer 934[17]

Gel formation mechanism:
Gels have three types of crosslinks, [18, 19].
a) Chemical crosslinks
b) Physical crosslinks
c) Ionic crosslinks

Chemical crosslinking

Chemical crosslinking is also present in the assembly of groups. When cross-linking compounds bind polymers together, a negative reaction occurs between the additive compounds and free radicals. After reaching a certain concentration, this reaction increases viscosity and results in gel formation34. For example, polyacrylic acid contains polycarboxylic acids.

Physical crosslinking:

Changes in concentration, temperature, crystalline component dissolution, and so on. In such cases, it is possible to obtain a hydrogen gel solution. Communication
The physical crosslinking is shown as cellulose gel and Sephadex 34.

Ionic crosslinking:

Crosslinking occurs, costing like a polymer (S) or different particles (exchange), resulting in a gel. Ionic bonds are formed when charges on molecules combine. For example, in the presence of calcium ions, polysaccharide alginate forms a gel matrix; calcium ions form a gel matrix; and the gel matrix encapsulates some compound 35 (enzyme).

Table 1. Evaluation parameters of gel preparation: [20, 21]

S.No.	EVALUATION TEST	PARAMETER	INSTRUMENTATION
1.	pH test	Sample: 1 gram gel solution in 100 mL distilled water, left for 2 hours. The pH was measured three times, with the average value calculated.	pH can be measured using a digital pH meter
2.	Drug content	1 g gel dissolved in 100 mL of a suitable solvent, volume. Aliquots of varying concentrations were prepared using appropriate dilutions and measured absorbance.	
3.	Viscosity studies	The gel was rotated at 0.3, 0.6, and 1.5 RPM during the study. The resulting dial readings are recorded at each speed. Viscosity was determined by dealing the X factor specified in the brook field viscometer catalogues.	Brookfield viscometer
4.	Spreadability	Indicates the extent of the gel's spread when applied to the affected areas or skin. Efficiency depends on spreading value. The time in seconds it takes for two slides to fall off from gel that is kept between the slides and follow the path of a specific lead is expressed as spreadability. The	Can be made with model :- Spreadability [s] = M x L/T Where Can be made with model :- Spreadability [s] = M x L/T Where

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		less time it takes, the better spreadability. It can be designed using the formula.	
5.	Extrusion studies	Before being placed inside the container, formulations are packed into collapsible tubes. This is determined in terms of mass (gm). A 0.5 cm strip should be removed from the gel within 10 seconds.	
6.	Skin irritation study	This study used male and female guinea pigs weighing 400-500 grams. They feed the animals naturally and have unlimited access to water. The hair was shaved from the back, and 5 ml of each sample was collected at intervals of 1, 2, 3, 4, 5, 6, 7, and 8 hours, followed by an equal amount from the middle of the new section. Then, using the pH-free guinea pig, check the chemical content of the sample. The 4 cm area on each side is closed blank, with one side being the measurement and the other being the control. The gel is used twice a day, with each application controlling allergic reactions. Save the reading results at any speed.	
7.	In-vitro diffusion studies	A Franz diffusion cell was used to examine gel dissolution emissions from cellophane membranes. A 0.5 gel sample is used to cover the cellophane membrane. Diffusion studies were conducted at 37.5 ± 0.5oC with 250 ml of pH buffer (PH 7.4) as the separation medium.	Franz diffusion cell
8.	In-vivo studies	It was carried out on six male Wistar albino rats, divided into three groups. Carefully apply 100 mg of the prepared gel to each cloth twice, one hour and two hours apart. Calculate the percent inhibition using a mercury volume meter.	
9.	Stability	It is obtained through freeze-thaw cycles. The product was stored at	

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		4°C for one month, then at 25°C for one month, and finally at 40°C for one month, and syneresis was observed. Keep the gel at room temperature and check for acid exudate separately.	

Applications of Polymer Gels in Drug Delivery
Oral gels Delivery

Gels are used for fast disintegrating oral tablets due to their ultra-porous properties, oral adhesive tablets/patches due to their rapid swelling and super-absorbing properties, gels floating in gastrointestinal fluids, and gels for gastric retention due to mucoadhesive properties. Targeted gels are advanced gels classified as intelligent gels that release drugs in response to environmental stimuli, as well as gels that respond to specific pH values or microbial flora in the colon.

Parenteral Administration

Thin gels and in situ gels are used in parenteral formulations. These gels help to control and prolong drug release into the systemic circulation. Hydrogels, also known as in-situ cross-linked polymer systems, in-situ polymer precipitation systems, temperature-sensitive gelation systems, and in-situ cure organogels, have been studied for parenteral formulations in order to improve patient compliance and dosing intervals without compromising or enhancing the effect of pharmacotherapy (Bari 2010). An injectable organogel containing estradiol-loaded l-amino acid derivatives has been developed to address the issue of sudden and sustained estradiol drug delivery (Yang et al., 2012). Clotrimazole vaginal gel with β-cyclodextrin was developed to enhance patient compliance and treatment efficacy for vaginitis.

Ocular drug delivery

In situ and nanostructured gels for ophthalmic drug delivery. Ophthalmic drug delivery has been used for a variety of drug molecules, including antibacterial, anti-inflammatory, and autonomic agents. The low bioavailability and therapeutic efficacy of traditional ophthalmic drug delivery systems are due to excessive tear production and rapid drug elimination from the ocular cavity. To address this issue, in situ gels for ophthalmic agents were developed. Compared to other conventional eye drops, the in situ gel releases the drug in a more controlled and prolonged manner due to improved anterior corneal contact.
Indomethacin sustained release has been reported to last 8 hours (Schoenwald 1990).

Nasal drug delivery systems

Shelke, et al. (2016) Formulation and optimization of an intranasal estriptan hydrobromide thermoreversible gel that targets the brain. Ethanol bodies were created by injecting soy lecithin and ethanol into a solution.

Ethanol was mixed into a thermoreversible, mucoadhesive gel matrix made from Carbomer 934 and Poloxamer 407. The findings indicate that ethosomes thermoreversible gels may be a viable alternative for intranasal brain-targeting drug delivery. To increase the therapeutic efficacy of drugs. Salunke and Patil (2016) developed a mucoadhesive in situ gel with ibuterol sulphate for nasal administration. Formulations have been developed that can be tested for physiological ion levels after nasal administration. It was concluded that nasal administration of salbutamol sulphate using an in-situ gel containing gellant gum is a reliable method. These systems may be suitable for delivering protein and peptide drugs through the nose (Wu et al., 2007).

Rectal and Vaginal Delivery

In situ polymer gels are used in a variety of rectal/vaginal drug delivery methods. Renber et al. (2016) investigated the mucoadhesive in situ gel of clotrimazole for the treatment of vaginal candidiasis. In vivo distribution studies show that the polymer gel formulation remains on the vaginal mucosa for up to 24 hours after administration. Masudi et al. (2016) investigated and compared the efficacy of a vaginal gel containing 5% barberry and 2% metronidazole base versus metronidazole gel alone in the treatment of bacterial vaginosis.

Topical/transdermal drug delivery

Nanogels are appealing candidates for transdermal drug delivery applications.

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Transdermal drug delivery systems improve patient compliance, reduce dosing frequency, avoid first-pass metabolism, and can easily stop drug action after system removal. Transdermal delivery allows for the accumulation of high concentrations of the drug in the target area. Nanogels have high drug loading, biocompatibility, and biodegradability, which are critical characteristics for developing effective TDDS (Mavuso et al., 2016).Topical treatments are a common application in dermatology practice. Topical drug administration is dependent on the physical chemistry of the skin and how the patient applies the product. The carrier type can also have an impact on the topical's effectiveness. Nanogels may be a more effective way to treat skin diseases (Feldman 2014).

Table 2:Marketed Formulations of Pharmaceutical Gels: -

S.No.	Brand Name	Formulae	Uses
1.	Nixoro Gel	Benzalkonium + Choline Salicylate + Lignocaine	Drugs For Aphthous Ulcers
2.	Liveasy Wellness Pain Relief Gel	Diclofenac Diethylamine, Linseed Oil, Menthol & Methyl Salicylate Gel Benzyl Alcohol (Preservative in Gel Form	Helps to alleviate pain caused by injuries. Has a gel formula that is easily absorbed by the skin. Helpful for people experiencing swelling and inflammation caused by a sprain, strain, or osteoarthritis.
3.	V Gel	Rosa damascena, Cardamom, Triphala.	The antimicrobial, antibacterial, and antifungal properties of V-Gel effectively combat the organisms that cause vaginitis.
4.	Mcaffeine Oil-Free Coffee Face Moisturizer Gel	Hyaluronic Acid & Pro-Vit B5	Hyaluronic Acid & Pro-Vit B5
5.	Cetaphil Sun Spf 30 Gel	Methylene bis-benzotriazole , Bis-Ethylhexylphenol methoxyphenyl triazine, Diethylamino hydroxy benzoyl hexyl benzoate, Ethylhexyl methoxycinnamate	Protect your skin from harmful UV radiation, which can cause sunburn, wrinkles, and skin cancer.
6.	Lite Glo Face Wash	Glycolic Acid, Witch Hazel (anti-inflammation flowering plant), Mandelic Acid, Carrageenan and Zinc Gluconate	Mild exfoliation, oil control, and combating acne and pimples
7.	Silverex Ionic Gel	ETHYL ALCOHOL-4%V/V + SILVER NITRATE-0.2%W/W	Burns, cuts, wounds
8.	A-CN	Clindamycin, Nicotinamide	Treats mild to moderate acne
9.	Genteal Gel	Hydroxypropyl Methylcellulose	alleviates dry eye conditions Provides temporary relief from the burning sensation due to dryness.
10.	TOSTI Gel(Oral)	Triamcinolone acetonide	Inflammatory and allergic conditions, Mouth sores

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11.	Atonide Gel	Desonide	Seborrheic otitis externa (ear infection). Dermatitis (skin inflammation). Contact allergic dermatitis is an itchy skin rash caused by allergies. Winter dermatitis (a skin disease that occurs in winter) Eczema is a dry, itchy, inflamed skin condition. Psoriasis (a skin disorder characterized by raised, rough, reddened areas covered in dry, fine silvery scales). Diaper rash.
12.	Trexjoy	Methotrexate	Psoriasis

II. CONCLUSION

Gels are semisolid formulations widely accepted in society. The skin is the most accessible part of the body, making it particularly vulnerable to injury. Cuts, burns, and wounds are best treated with topical formulations such as gels. Because of the obvious benefits, research and development into the formulation of pharmaceutical gels for wound healing has increased in recent decades. Pharmaceutical gels are expected to remain an interesting and appealing area of research for many years to come as the pharmaceutical field and industry advance. In the coming years, gel preparation, formulation, and evaluation will be carried out using more advanced technologies and methods.The demand for herbal constituent-based gels is increasing day by day.

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