Formulations and Applications of Topical Herbal Gels

Hiba Sabah Sabry*, Ihab Dahham Hammoodi, Maryam Alaayedi***, Ashti M.H. Saeed***

**Department of Pharmaceutics, Collage of Pharmacy, Mustansiriyah University, Baghdad / Iraq*

***Al-Esraa University ،Collage of Pharmacy, Baghdad / Iraq*

****Department of Pharmaceutics, Collage of Pharmacy, University of Karbala، Karbala / Iraq*

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Corresponding Author email:
hibasabah@uomustansiriyah.edu.iq
Orcid: https://orcid.org/0000-0003-2754-4641

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Abstract:

People have known how to employ plants for the basic requirements of having healthy and beautiful skin since the dawn of humanity. Herbal formulations have always drawn a lot of attention due to their potent efficacy in improving primary health care because of better cultural acceptability, better compatibility with human body. With minimal side effects compared to synthetic medications. Herbal face washes, creams and gels made of natural ingredients are used widely because they provide the skin with essential minerals and nutrients. Plant-derived ingredients, such as herbs, flowers, roots and essential oils, are largely reviewed in recent literature and utilized in natural topical products. This review focus on the general properties of gels, characteristics of gels, classification of gels, methods of preparation and evaluation. Also examples in natural ingredients prepared in topical gels with their applications. So, this review will help the researchers to find the way for further investigation about preparations and applications of topical herbal dosage forms.

Keywords: Herbal; Gel; Topical dosage forms; Spread ability.

تركيبات وتطبيقات المواد الهلامية العشبية الموضعية

هبه صباح صبري*,ايهاب دحام حمودي,مريم حسين عوده***,اشتي محمد حسين***

**قسم الصيدلانيات، كلية الصيدلة، الجامعة المستنصرية*

*** جامعة الاسراء، كلية الصيدلة*

****قسم الصيدلانيات، كلية الصيدلة، جامعة كربلاء*

خلاصة

لقد عرف الناس كيفية استخدام النباتات للمتطلبات الأساسية للحصول على بشرة صحية وجميلة منذ فجر البشرية. لقد جذبت التركيبات العشبية دائمًا الكثير من الاهتمام نظرًا لفعاليتها القوية في تحسين صحة الجلد بسبب قبولها الأفضل وتوافقها بشكل جيد مع جسم الإنسان لانها تسبب القليل من الآثار الجانبية مقارنة بالأدوية الاصطناعية. تُستخدم غسولات الوجه العشبية والكريمات والمواد الهلامية المصنوعة من مكونات طبيعية على نطاق واسع لأنها تزود البشرة بالمعادن والمواد المغذية الأساسية. االهم اجزاء النبات (الزهور والجذور والزيوت الأساسية) استخدمت بشكل كبير في الأدبيات الحديثة واستخدمت في تحضير العديد من المنتجات الموضعية الطبيعية. تركز هذه المراجعة على الخصائص العامة للمواد الهلامية وتصنيف المواد الهلامية وطرق التحضير والتقييم لها. وأيضا تتضمن أمثلة على المكونات الطبيعية المحضرة في المواد الهلامية الموضعية مع تطبيقاتها. لذا فإن هذه المراجعة ستساعد الباحثين على إيجاد طريقة لمزيد من البحث حول تحضيرات وتطبيقات أشكال الجرعات العشبية الموضعية.

الكلمات االمفتاحية: الاعشاب، الهلام، أشكال الجرعة الموضعية، قابلية الانتشار

Introduction:

The skin is a most extensive and readily accessible organ of the human body. It serves an essential physiological purpose, including defense against physical, chemical, and biological agents. It also plays a part in thermoregulation. It covers outside of the body and it presents ideal and multiple sites for administration of therapeutic agents for both local and systemic actions [1,2]. Most topical preparation is intended to be applied to the skin and hence basic information about skin (physiological function and biochemistry) is very significant for designing these formulations. The pH of the skin varies from 4 to 5.6, sweat and fatty acids secreted from sebum influence the pH of the skin surface. It is suggested that acidity of the skin helps in limiting or preventing the growth of pathogens and other organisms. [3]Maintaining healthy, clear and shiny skin requires a balanced diet and drink enough water. Substances meant to be rubbed, poured, spread, sprayed, or applied to any part of the body for different purposes [4]. The drug in a medicated application should access and retained in the skin, drug penetration into the skin depends on a number of factors including the physicochemical properties of the medicinal substance, the characteristics of the pharmaceutical vehicle and the condition of skin itself. Normal unbroken skin acts as a natural barrier, limiting both the rate and degree of drug penetration [5].

Skin generally consists of three parts, namely [6].:

1) The outer epidermis (waterproof layer).
2) The inner dermis which consists of connective tissue, blood vessels, hair follicles, sweat glands.
3) Hypodermis (subcutaneous tissue) which consists of delicate connective tissue. Figure (1) show cross section of the skin.

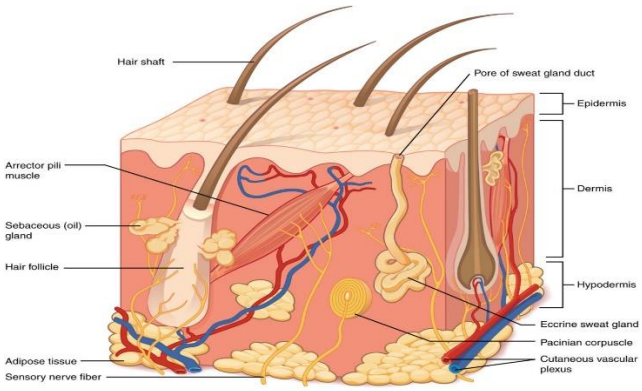

Figure (1): cross section of the skin [6].

The epidermis layer is permeable to some substances. The hydrophobic keratinized cells in the stratum corneum create an effective barrier against ionic compounds, while lipophilic substances can permeate at different rates. [7].

There are three major mechanisms of topical drug absorption: intracellular, intercellular, and Follicular as shown in Figure (2)

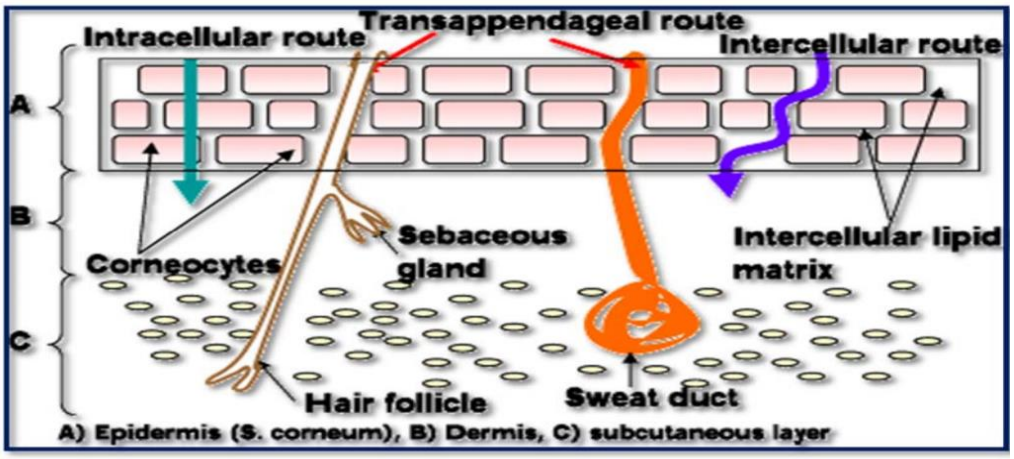

Figure (2): Mechanisms of drug Absorption from Topical Dosage Form [7].

Gels are a semisolid system in which the liquid phase is restricted inside a three-dimensional polymeric matrix which having a high level of physical or chemical cross-linking [8].

Pharmaceutical gels are most commonly created by dispersing hydrophilic polymer within a proper aqueous vehicle. When dissolved within the aqueous medium, the hydrophilic polymer, it will act as lyophilic colloids because it has a unique physical property resulted from self-association of the dissolved hydrophilic polymer and several interactions with the aqueous medium[9]. There are two forms of self-association which termed irreversible and reversible that can be described by lyophilic colloids which can be categorized as either type (1) or type (2) gel

- Type (1) Gel often termed hydrogels, the interaction between polymer chains is covalent and is facilitated by the molecules that cross link the adjacent chains which termed cross-linkers [10].

- Type (2) gel most widely used gel, the interactions between the polymer chains are reversible and are supported by weaker bonds, like hydrogen bonding, ionic bonds or Vander Waals interactions [10].

In pharmaceutical applications, water and hydroalcoholic solutions are most common. Many polymer gels exhibit reversibility between the gel state and sol, which is the fluid phase containing the dispersed or dissolved macromolecule. However, the formation of some polymer gels is irreversible because their chains are covalently bonded. The three-dimensional networks formed in two-phase gels and jellies are formed by several inorganic colloidal clays. The formation of these inorganic gels is reversible [11].

Properties of gels [11,12]**:**

- It should be easy to handle and apply, inert, and well-matched with other components.
- Throughout storage, it ought to keep its rheological characteristics.
- It should have thixotropic, emollient, and non-greasy properties.
- When exposed to shear forces created during topical application like shaking the bottle, or squeezing it, the gelling agent included in the preparation should readily break down and produce a solid-like consistency during storage.

Characteristics of gel

1. **Structure of gels**

A gel is composed of a polymer, either natural or synthetic, that forms a three-dimensional matrix within a liquid medium. Upon application, the liquid evaporates and the drug gets trapped in a gel film that forms a physical barrier on the skin. A gel's rigidity is a result of a network created by particles of the gelling agent interlocking as shown in Figure (3). The network structure and gel properties depend on the particles' nature and the type of form that creates the linkages. [13].

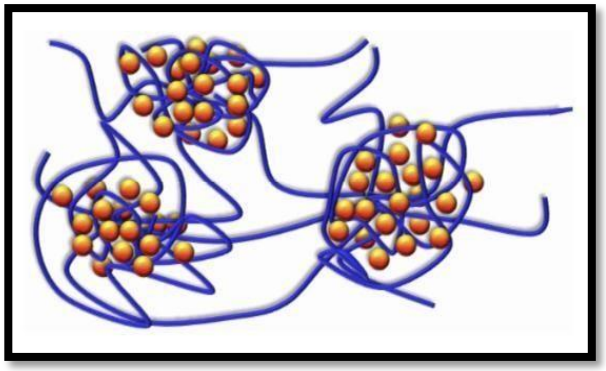

Figure (3): structure of gel [13]

The composition of the particles and the kind of force used to form links define the gel's structure and characteristics. [14].

2.**Rheology:** The gelling agents' solutions and flocculated solids' exhibit non-Newtonian flow behavior because they are pseudo-plastic. Shear stress causes the inter-particulate association to break down, disrupting the weak structure of the inorganic particles dissolved in water and strengthening their tendency to flow [14].

3.Syneresis:

On standing, numerous gels contract sudden ly and ooze a liquid medium,
which is known as syneresis. As the concen tration of gelling specialists diminishes, the degree of syneresis increments.
Syneresis implies the
first gel was thermodynamically unsteady [15].

4.Swelling: A large amount of liquid is absorbed and the volume increases when a polymer is in contact with the solvent (this consider an initial phase of dissolution). We refer to this process as swelling. The solvent permeates the gel matrix during this process, substituting gel-solvent interactions for gel-gel interactions. Because the degree of cross-linking inhibits the dissolution, the process of swelling is restricted. If the solvent mixture has a solubility characteristic like that of the gellant, this gel swells significantly. [16].

5.Aging: Is the term used to describe the general slower rate of aggregation observed in colloidal systems. As a result, the gelling agent gradually begins to form a denser network. [17].

Mechanism of gel formation:

Gels are formed by 3 types of cross-linking, which are;

1) **Ionic cross-linking:** Ionic bond formation is the cause of the gels' formation. The interaction of the charges on the polymer and the solvent results in ionic bonds.

For instance: When calcium ions are present, polysaccharide alginate gels and can encase enzymes. Gel can also be produced by pH changes; an example of this would be pectin producing gel at an acidic pH.[18].

2) **Chemical cross-linking:** When a polymer is combined with two or more monomers, an irreversible covalent bond with a high molecular mass is formed between the monomers. These polymers are insoluble, and adding a specific solvent makes them swell and produce gel. It is possible to observe chemical cross linking in polymers with free or unbound groups. They cause the polymer's viscosity to increase because of the irreversible binding. For example, to help illustrate this: Chemical cross-linking is created by polyacrylic acid with several carboxylic acid groups and glycols with hydroxyl groups. [19].

3) **Physical cross-linking:** Hydrogen bonds, crystalline component solubilization, temperature changes, concentration variations, and hydrophobic interactions can all lead to the formation of gels. Examples of these gels include dextran gel, poly (N-isopropyl acrylamide) gel, and cellulose gels**.** [20].

Preparation of gel:

There are five distinct methods available for preparing them on a large scale. Specifically:

1- **Cold method:** this method is used for heat labile drugs or when the vehicle itself is
heat labile. To create a homogenous mass, all the constituents are mixed at a low temperature. Solution A is created by mixing penetration enhancers (or any additives) with polymer while Solution B is created by combining the medication (drug) with the solvent then solution B is added to Solution A with continuous stirring [21].

2- **Dispersion method:** After the polymer has been thoroughly dissolved in water for approximately two hours, the remaining excipients are added and mixed until a homogenous mass is formed. [22].

3- **Thermal changes:** Gel is created when lipophilic colloids are exposed to temperature changes; cooling a concentrated hot solution will produce gel. The reason for the gel formation process is that the degree of hydration decreases with decreasing temperature . For examples, cellulose derivatives, gelatin, agar sodium oleate, and guar gum. Some materials like cellulose ether are soluble in water due to hydrogen bond. The creation of a gel is caused by the disruption of hydrogen bonds at higher temperatures therefore, this technique cannot be used as a standard for creating gels [23].

4- **Chemical reaction:** The chemical reaction between the molecules of the solute and solvent produces gels· the gel structure can be obtained by increasing the reactant concentration as in the formation of aluminum hydroxide gel through the interaction of aluminum salt with sodium carbonate in the aqueous medium. Also, the production of silica gel involves the chemical reaction between sodium silicate, acids, and water [24].

5- **Flocculation method:** gels are created by the addition of accurate amount of salt to create the age state precipitation, but it is not enough to cause full precipitation. The precipitant's high concentration can be avoided by the quick mixing. For example: ethyl cellulose and polystyrene dissolved in

benzene can be gelled by quickly mixing with a non-polar solvent such as petroleum ether. When salts are added to hydrophobic substances, coagulation and gelation are rarely observed; as a result, the gels that are produced exhibit thixotropic behavior. Because of the salting-out effect, proteins do not gel when salt is added to hydrophilic materials like gelatin or acacia. [25].

Evaluation of gel

Physical appearance

Colour: The gel formulations' colors were recorded after being examined against black and white backgrounds. [26]

Consistency: The skin was used to test the consistency. [26].

Homogeneity: : All developed gels have been set in container were examined visually to ensure homogeneity ,The results are tabulated [27]

Grittiness: The formulations were examined microscopically for the presence of any appreciable particulate matter which was seen under light microscope. the gel preparation should be free from particular matter and from grittiness as desired for any topical preparation [27]

Skin irritation studies: For research on skin irritation, Wistar rats of both sexes weighing 150–200 gm were employed. The skin that was still whole was used. Three days prior to the experiment, the rat had its hair removed. Test animals were administered the gels containing the extracts. The back of the animal used as a control received a gel base application. The animals received daily treatments for up to seven days, after which the treated skin was visually inspected for edema and erythema**.** [28].

pH: the pH of the prepared gel formulation was measured with the use of a digital pH meter, by dissolving one gram of gel in 100 milliliters of distilled water. The measurement was carried out at 1, 30, 60, and 90 days after preparation to detect any change with time. The measurement was done in triplicate, and average values are calculated [29].

Washability: The washability test was done by applying a small amount of prepared gel formulations over the skin, then washed with water, the length of time it took to wash with water was measured**.**

The formulations should have good washability [30]

Spreadability: It shows the extent of the area in which the gel quickly spreads upon application to the skin. By measuring the spreading diameter of 1 g of gel between two horizontal plates (20 cm x 20 cm) after one minute, the spreadability of the gel formulations was ascertained. 125 grams was the standard weight that was applied to the upper plate [30].

Extrudability: Standard capped collapsible aluminum tubes were filled with the gel formulations, and the ends were crimped shut to seal. It was noted how much each tube weighed. The tubes were clamped after being positioned between two glass slides. After covering the slides with 0.5 gm, the cap was taken off. Weighing was done on the amount of extruded gel that was collected. It was determined what percentage of the extruded gel was excellent (>90% extrudability, good), good (>80% extrudability), and fair (>70% extrudability). [31]

Viscosity: the viscosity of the herbal gel was measured by using Brookfield viscometer at 25◦c, speed of 12 rpm with 64 No spindle. After the sample had reached equilibrium after two minutes, the reading was taken. [31]

In vitro diffusion study

The diffusion studies of the prepared gels can be carried out by using cellophane membrane. Cellophane membranes can be used to conduct diffusion studies on the prepared gels by placing in a cellophane membrane, and 250 milliliters of phosphate buffer (pH 7.4) was used as the dissolution medium for the diffusion studies, which were conducted at 37 ± 1°. At every one, two, three, four, five, six, seven, and eight hours, five milliliters of each sample were taken out and substituted with an equivalent volume of fresh dissolution. [32].

Microbial evaluation

The prepared gels were examined microbiologically. Sterilized nutrient agar medium was supplemented with bacterial sub-cultures, which were added and vigorously shaken to guarantee even distribution of the organisms (5 X 105 cfu/ml). After that, the agar medium was divided equally among sterilized petri dishes, with each petri dish holding roughly 45–50 mL of the medium. After that, the medium was left to stand to solidify. Next, using a sterile cork borer (6 mm diameter), cups were created. To enable the drug to diffuse throughout the agar matrix, formulations were poured into the bored cavities and stored in a cool environment. For 24 hours, it was incubated at 37ºC. The measured diameter of the zones of total inhibition [33].

Most widely used gelling agents with their features were shown in Table (1).

Table 1. Examples of gelling agents and their features [34,35.36]

Name	Gelling Strength	Chemical Nature	Gelling Features
Alginic acid		. •Alginic acid, sometimes referred to as algin, is a natural polymer, An edible polysaccharide	• Viscosity varies with changes in molecular weight and concentration; • Insoluble in water.
Carbomer	0.5–2%	*Synthetic polymer	• They are naturally acidic, but neutralization makes them more viscous.
Carboxymethylcellulose	3–6%	Semi-synthetic polymers	• Viscose gels are produced at high concentrations. • Viscosity decreases outside of the pH range of 4 to 10, where it remains stable.
Carrageenan	0.3–2%	Repetition galactose units	• Shows good gelling properties on increased temperature.
Colloidal silicon dioxide	2–10%	Colloidal Silica is a polymeric form of silicon and it occurs naturally	• Viscosity is unaffected by temperature and is insoluble in water. When the pH is acidic, viscosity rises.

Gelatin	10–20%	Semisynthetic polymer uses water to create thermally reversible gels •	• Water soluble. In order to achieve the desired viscosity, gels are made by raising the temperature and then cooling it down.
Guar gum	1–5%	Its has excellent spreadability and viscosity, therefore it can be a more affordable option..	• Particle size, temperature, swelling time, rate of agitation, and pH all affect viscosity.
Hydroxyethyl cellulose		Closure Ethers	• The gelling process is influenced by pH and temperature. Viscosity improves in basic pH and decreases at high temperatures.
Hydroxypropyl cellulose	2–5%	semi-synthetic polymers	• As concentration and mixing with anionic polymer increase, viscosity increases.Viscosity is reduced by temperature changes and pH other than neutral.
Hydroxypropylmethyl cellulose	1–10%	• semi-synthetic polymers	• Gels remain stable within the pH range of 3-11. • Viscosity is influenced by molecular weight, solvent composition, and concentration.
Poloxamer	15–20%	Synthetic polymers •Poloxamers are a class of non-ionic, water-soluble triblock copolymers composed of polar building blocks (poly ethylene oxide) and non-polar building blocks (poly propylene oxide)..	• Viscosity rises with concentration and is soluble in water. A pH range of 5–7% is ideal.
Polyvinyl alcohol	2.5–10%	• Synthetic polymers	• Variations in temperature affect viscosity. • • Viscosity is increased when borax is added.

			• The ideal pH range is 5–8.
Sodium alginate	10–20%	• Natural polymers	• Viscosity rises with low concentrations of electrolyte, alcohol, glycerol, glycols, and sugars; • They form viscous gels in water; • They are stable at pH levels between 4 and 10. In pH values above or below this range, viscosity decreases.

Classification of gel

- **On the basis of solvent:**

Depending on the type of solvent used, gels can be classified as hydrogel (water based), organogel (non-aqueous solvent), Xerogels and Aerogels[37].

a) Hydrogel: Polymeric structures known as hydro-gels have exceptional physicochemical properties that enable them to absorb large amounts of water and are therefore perfect for drug delivery and biomedical applications. Hydro-gels will eventually be identified through in-situ gelation with the ability to exemplify cells and medicines, setting them apart from other hydrophobic polymers. Hydro-gels can be made with synthetic or natural polymers. Hydro-gels are water-enhanced three-layered frameworks that are usually made of hydrophilic polymerst effect [37].

b) Organogel: is a class of gel composed of a liquid organic phase within a three-dimensional cross-linked network and it is a non-crystalline, non-vitreous thermoreversible solid. Examples of organogel plastibase (low molecular weight polyethylene packed up in mineral oil & short Cooled). they could be utilized in food, cosmetics and medications [38].

c) Xerogels and Aerogels: Solid gels which have low solvent concentration are known as xerogels. It is a solid formed from a gel by drying with unlimited shrinkage. It is regularly retaining high porosity (15-50%) and massive surface area (150-900 m2/**g),** along with very small pore size (1-10 nm). When solvent evaporate or removed by freeze drying technique, result in formation of a highly porous, low-density material known as an aerogel. Heat treatment of a xerogel at higher temperature produces viscous sintering and efficiently transforms the porous gel into a thick glass.The drying process will thus decide whether an aerogel or xerogel will be formed [39].

- **Based on rheological properties:**

Gels generally demonstrate non-Newtonian flow behavior. They are categorised as :[40].

(a) Plastic gels:

The Bingham body exhibit plastic flow, The rheogram plot for bingham bodies of flocculated suspensions of aluminum hydroxide that exhibit plastic flow, indicates the yield value of the gels, or the point at which the elastic gel bends and begins to flow [40].

(b) Pseudo-plastic gels:

The viscosity of these gels decreases by increasing shear rate and has no yield value. The rheogram is obtained by cutting the length of the molecular chain of the linear polymer. When shear stress increases, the solvent will release from the gel matrix as the chaotic molecules start to align their long axes downstream. Liquid dispersion of tragacanth, sodium alginate, Na CMC, etc.

shows pseudo-plastic flow. These gels become less consistent with an increase in shearing rate independent of yield value. The rheogram is created by the shearing motion of the straight polymer's long chain particles. . When the shearing force is applied again the disarranged molecules begin to align their long axis in the direction of flow with the release of solvent from gel matrix [41].

(c) Thixotropic gels:

The bonds between particles in these gels are so weak that can be broken by shaking. When particles collide and reconnect (reverse isothermal gel-sol-gel transition) the solution will return to the gel. The resulting solution will revert back to gel due to the particles colliding and linking together again. This occurs in colloidal systems with non-spherical particles to build up a scaffold like structure, for examples: kaolin, bentonite and agar [42].

- **Based on physical nature:**

(a) Elastic gels: Gels made of agar, pectin, guar gum, and alginates all exhibit elastic behavior. The fibrous molecules are joined at the point of connection by weak interactions like dipole attraction and hydrogen bonds. If the molecule has a free -COOH group, additional bonding happens through a salt bridge of type -COO-X-COO between two nearby strand networks**.** For example, Carbenate with Alginate [43].

(b) Rigid gels: Macromoles with a primary valence bond joining the framework can be used to create this. As an example, the Si-O-Si-O link forms a polymer structure with a network of pores by holding the silica molecules in silica gel. [43].

- **On the Basis of Drug Delivery:**

Pharmaceutical gels are widely used as carriers in drug delivery systems. These gels could be grouped under:

a) Sustained/controlled release gels:

Controlled medication delivery systems give Many: lower dose recurrence, which increases patient compliance; keep blood level within a desired range by limiting fixation fluctuation and decrease side effects. Because of their dispersion component, gels can be used as controlled drug delivery systems. In these systems, medicine is delivered through a water-insoluble polymeric network. Pharmaceuticals use hydrogels, aerogels, and organogels as supported or controlled drug delivery systems [44].

Controlled release through swelling which is a strategy to release the entrapped drugs from gels. As a gel swells, the mesh size increases (The extent of swelling of the gel is a balance between forces that make network deformation and the osmosis that leads to water absorption) The swelling behavior can be sensitive to various external conditions, including temperature pH, ionic strength and light. These cues have been widely exploited in drug delivery. pH-responsive swelling is mainly significant for oral and cancer delivery systems. For this application, the gel minimal welling in the acidic stomach, thus the drug is protected and entrapped physically. When the gel passes down the intestinal tract where the pH is neutral, the network will be swell, allowing for rapid drug diffusion. alginate is one of the more commonly used Polymer [45].

b) Fast release gels:

Gels with superabsorbent and fast swelling properties can be used for pills that dissolve quickly. Fast release gels can be used to treat acute disorders that require prompt onset of action. [46].

c) Bioadhesive gels:

Bioadhesive gels are used for the delivery of ophthalmic, mucoadhesive, transdermal, vaginal, and cutaneous medications. Cross-linked polyacrylic corrosive gel-framing bioadhesive polymers can adhere to mucosal surfaces for prolonged periods of time and

exhibit regulated drug delivery at the site of ingestion [46].

D) Smart polymer gels:

Sensitive gels show an excellent physiochemical shift in response to little changes in their environment, which includes pH, temperature, light, attractive area, and ionic components. These changes are reversible, so when the reason is removed, the gel may return to its original [47].

Natural ingredients in topical herbal gel products

Herbal medicines are used in about 75-80% in many countries, for primary health care due to better cultural acceptability, good compatibility with human body with less side effects [48].

Topical herbal gel products are medicinal preparations designed to be applied topically to the body's various exterior regions in order to exhibit topical effects. In previous centuries, skin care procedures have traditionally employed natural ingredient preparations. Clinical studies have revealed the anti-inflammatory, anti-allergy, moisturizing, pro-collagen, anti-aging, anti-hyperpigmentation, wound healing, and free radical scavenging properties of this herbal ingredient. Herbal products preferred more than synthetic products, so these preparations are more common [49].

Examples of some herbal constituents and their benefits:

1. Sweet almond oil: Contains vitamin E and its antioxidants, it helps to exfoliate and prevent fine lines and dryness [50].
2. Jojoba oil: moisturizing skin and acting as an antioxidant [50].
3. Saffron Extract: Have anti-inflammatory, antiseptic properties help remove tan, even out complexion and calm irritated skin [51].
4. Chickpea flour: it helps remove dead skin layer and fine hair from face and body. a good source of important vitamins such as riboflavin, niacin, thiamin, folate and the vitamin A precursor β-carotene and zinc [52].
5. Extracts of turmeric: This herb is wonderful source of fiber, vitaminB6, potassium, magnesium and vitamin C. protects skin from damage and works as a natural antioxidant [53].
6. Licorice extract: repairs the skin and heals the damage caused by the sun also it has pharmacological efficacy to treat acne vulgaris and the associated postinflammatory hyperpigmentation [54].
7. Carrot oil: helps remove tan and sports from the skin while revealing natural glow [55].
8. coriander extract: The antibacterial activity of the aqueous extract against Propionibacterium acne and Staphylococcus epidermidis [56].
9. Walnut beads: It helps exfoliate and scrub off dead cells from the upper layer of the skin [57].

Regulation and Safety of Herbal Medications

The general idea that herbal drugs are very safe and free from side effects is false because Plants have several constituents, some of them are toxic. However, the side effects of most herbal drugs are less if they used properly compared with synthetic drugs, the most common side effects that have been reported for herbal medicines are predictable toxicity on over-dosage, allergic reaction and interaction with conventional drugs [57-58].

On the other hand, several manufacturing problems such as misidentification of plants, absence of standardization, bad

manufacturing practice, contamination, incorrect storage condition [58].

Literature review on topical herbal gels:

Anti-acne herbal gel [59]

Usage of herbal medicine has increased in many countries. Acne is a skin condition which result from over production of oil in sebaceous glands. It is rarely considered as disease. A non-oily topical gel formulation was suitable for treating this condition by using carbopol 940. The prepared gels were evaluated for various physical parameters like pH, colour, odour, grittiness, viscosity, homogeneity, spreadability, skin irritancy. Vitex agnus castus leaves, Nigella sativa seeds, and Butea monosperma flowers were the plants used to make the herbal gels that treat acne. gel formulations were subjected to microbial study against *Propionibacterium acnes*. The result showed that zone of inhibition of prepared gels was equivalent to the standard ciprofloxacin and thus can be a better alternative to allopathic treatment. The plant extracts were filtered, concentrated and dried in a rotary evaporator then refrigerated. Different ratios of polymer, additives, and plant extract were used to prepare gel formulations. A carbopol dispersion in water was mixed with additives (glycerin) and preservatives (methyl paraben) then left overnight. Water was added to bring the volume up to 100 ml. After that, triethanolamine was added to create the desired consistency in the gel. Table (2) Show the main composition of herbal gel

The prepared herbal gels were evaluated using both microbiological and physical criteria. All gels were yellowish orange in colour with transparent appearance of all gels, pH of all gel formulations was between 6.8 and 7.1. they are non-irritant when applied to the skin, The best formula according to the results of the physical and microbiological evaluation, was bacteriostatic and produced outcomes similar to those of standard ciprofloxacin, with a 27 mm zone of inhibition.

The results show that the prepared herbal gel formulations were bacteriostatic at lower concentration while they are bactericidal at higher concentration also, they have efficacy comparable to allopathic drugs and they will be a better option. However, the chemical stability of these gels is under progress to establish shelf life and determine chemical parameters of evaluation for these formulations.

Polyherbal gel for anti-inflammatory activity [60]

three medicinal plants for the creation of polyherbal gels, Cynodon dactylon (L.) Pers, Cassia tora Linn., and Cassia alata Linn. were chosen due to their strong anti-inflammatory potential. The dried methanolic extracts of Cynodon dactylon (L.) Pers., Cassia tora Linn, and Cassia alata Linn were used to prepare the gels. Studies on skin irritation, viscosity, spreadability, pH, and homogeneity of the polyherbal gel formulations were assessed. Rat paw edema produced by formalin and carrageenan were used to measure the anti-inflammatory properties. In both acute and chronic models, it was discovered that the individual and polyherbal gel of Cassia alata Linn, Cassia tora Linn, and Cynodon dactylon (L.) Pers had anti-inflammatory properties. When compared to individual gels, the polyherbal gel also demonstrated a synergistic effect that could be helpful for the treatment of local inflammation.

Dried methanolic extracts of Cassia tora Linn., Cassia alata Linn., and Cynodon dactylon (L.) Pers were used to prepare the gel, along with 1% carbopol-940 gelling agent. Both single-plant extract gels and multiherbal gels were made. Diclofenac sodium gel was prepared using the same process as a standard.

When compared to a standard Diclofenac gel, the study's data demonstrated that the polyherbal gels made from the dried methanolic extracts of Cassia tora Linn., Cassia alata Linn., and Cynodon dactylon (L.) Pers.f. had a significant anti-inflammatory activity. Phytochemical tests revealed that the methanolic extracts contained glycosides, carbohydrates, flavonoids, steroids, and resin. These substances may inhibit the synthesis of prostaglandins and bradykinins or counteract their effects. When compared to individual gels, the polyherbal gels demonstrated a synergistic effect that may be helpful for the treatment of local inflammation .

Herbal gel containing Allium cepa extract (61)

Allium cepa extract and carbopol 934 were utilized to create a topical gel formulation, along with different excipients. The herbaceous plant Allium cepa (onion). It has been consumed for centuries due to its great nutritional value and health benefits. It contains flavonoids. Plant extract is applied to prevent hair loss. To create a non-greasy formulation, Allium cepa extract was added to gel at a specific stage of preparation. The physical appearance of various gel formulations was assessed, studies on the comparability of drug excipients, pH, spreadability, homogeneity, in vitro diffusion, and viscosity were carried out.

A measured amount of carbopol 934 was placed into a 250 ml beaker, which was then gradually filled with 50 ml of distilled water. The mixture was then rapidly stirred using a mechanical stirrer. It was further mixed to form a gel base after being given time to swell. Five milliliters of distilled water and the required quantity of methyl paraben were dissolved with the aid of heat on a water bath. Propylene glycol was added once the solution had cooled. The required amount of Allium cepa extract was then added to the above mixture, and the remaining distilled water was added to bring the volume up to 100 ml. All the ingredients were well mixed and constantly swirled. Triethanolamine was added to the formulation to increase the value of pH of herbal gel to be close to the pH of skin and also to obtain a gel at required consistency then the Prepared herbal gel was kept in container and stored in dry and cool place.

The goal of this research project was to create a novel herbal gel formulation for topical use. In-vitro diffusion study, pH, homogeneity, appearance, spreadability, viscosity, and preparation of the herbal gel were all assessed further. Consequently, it was determined that the use of polymer in the successful preparation of Allium cepa herbal gels allowed the gel to have improved application properties.

The novel topical herbal gel might be an alternative treatment in patients with acne vulgaris (62)

Acne vulgaris (AV) is one of the most predominant skin disorders appearing in pre- and post-adolescent periods. Fresh rosemary leaves were used to prepare hydroalcoholic extract by using high analytical graded pharmaceutical excipients. For preparation of herbal gel, firstly, the preserved water was prepared using methylparaben 0.2% and propylparaben 0.04%. Later, Carbopol 940 was added to some amount of preserved water with continuous stirring until fully dissolved. Then, 2mg of hydroalcoholic rosemary extract was added, after complete dispersion, the remaining water was added and mixed. The herbal gel was finally produced by addition a few drops of triethanolamine

Evaluation of herbal gels' physical and rheological properties, including appearance, pH, spreadability, and viscosity, were measured and recorded.they conducted a randomized controlled trial study to

determine the impact of rosemary gel in patients with Acne Vulgaris and compared it with clindamycin/benzoyl peroxide gel. Group A, clindamycin 1% with benzoyl peroxide 5% gel; Group B, rosemary gel. The result showed that papules, pustules and total number of inflammatory lesions were declined in both study groups. The rosemary gel provided better clinical effectiveness, which was correlated to high level of patient satisfaction and enhancement in their quality of life.

Herbal Hair Gel for Hair Growth Potential [63]

Hair loss or alopecia is a common patient complaint and a source of significant psychological and physical distress. Natural products in the form of herbal formulations are available on the market and are used as hair tonic, hair growth promoter, hair conditioner, hair-cleansing agent, antidandruff agents, as well as for the treatment of alopecia. Eclipta alba L. Hassk. is an annual herbaceous plant, commonly known as king of hairs. Lippia nodiflora is the important member of the family verbenaceae showing a variety of medicinal uses. The fresh plants were collected, washed with distilled water to removed unwanted foreign materials and like soil and dried at room temperature. It was then grounded by using mechanical device. Then the powdered plant material was passed through sieve no 40 and extracted to exhaustion in a soxhlet apparatus. The ethanolic extract was further fractionated by ethyl acetate and preserved in airtight containers and kept at 4˚C until further use.

Five different herbal hair gel formulations were prepared by using carbopol gel base. The gel formula contains methyl paraben, glycerine, poly ethylene glycol (PEG), carbopol 934, PVP and triethanolamine. Taking two grams of Carbopol 934 with specific quantity of extracts and dispersed in 80 ml of distilled water with continuous stirring on a magnetic stirrer at 800 rpm for 1 h. Glycerin 3 ml was added to the mixture then it neutralized by addition of drops of triethanolamine. Mixing was continued until a transparent gel was formed.

The prepared gel formulation was applied topically over the shaved skin of black mice and monitored for 30 days. The length of hair and the different cyclic phases of hair follicles like anagen and telogen phases were determined at different time periods. From the study, topical use of the prepared gel produced a significant increase in the rate of hair growth compared with negative control. It is concluded that the ethyl acetate soluble fraction of ethanolic extract of E. alba (5 %) and L. nodiflora (5 %) combination gel formulation exhibits more potency on hair growth activity.

Marketed herbal gels examples are shown in Table 2.

Table (2): Marketed herbal gels [64-65]

products	composition	uses
	• Papaya • Lemon • Orange • Aloe Vera • Cucumber • Licorice	Herbal gel (face gel) use for lightening and improve skin tone
	• Aloe Vera • New Zealand Manuka Honey.	Aloe Vera Gel provides a soothing effect, and is perfect for application after sunburn, acne prone skin and eczema. it encourages the skin to heal with minimal scarring.
	• Curcuma longa • Glycyrrhiza glabra root extract • Paedaria foetid PL, ext • Eucalyptus globulus	Ayur Mastilep Topical Herbal gel for control of mastitis, Helps in strengthening the keratin layer of the teat canal lumen and enhances the udder defence mechanism.
		Topical Anesthetic Gel (Herbal)-Felis Gel Reduces the pain and discomfort of dental procedures.
		Herbal Mouth Ulcer Gel Relieving pain from mouth ulcers, cold sores, denture irritation, teething and Prevents teeth ache.

Conclusion

The use of the medicinal plant as a primary health care was popular from ancient time because plants provide many health benefits for human. The current review includes written research on the effective production of herbal gels. Herbal gels can be successfully prepared by using different polymers (HPMC, Carbopol, and Sodium CMC) which made the gel with better application property which they can be quickly spread over the surface.Various physicochemical properties of the advanced gels are investigated, including pH, consistency, spreadability, extrudability, drug content, in vitro drug release, and skin irritation testing.Herbal ingredients opened the way to formulate cosmetic products without any harmful effect. Herbal gels are considered as supporting and productive way to improve the appearance of skin.

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