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Herbal Gel for Managing skin-related problems of PCOS: A Review

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A B S T R A C T:

Polycystic Ovary Syndrome (PCOS) is a prevalent endocrine disorder among women of reproductive age, often associated with various skin-related manifestations such as acne, hirsutism, alopecia, and seborrhea. Conventional treatments involve hormonal therapies, which may have side effects and limitations. While conventional treatments exist, including hormonal therapy and retinoids, their long-term use is often associated with adverse effects and limited patient adherence. As a result, there is a growing interest in natural, plant-based remedies. This review evaluates the potential of herbal gels—topical formulations enriched with bioactive compounds—to manage PCOS-related skin conditions. The paper discusses commonly used herbs, their pharmacological actions, mechanisms, and evidence from preclinical and clinical studies highlighting their role as promising alternatives to conventional therapies [1]

Keywords: PCOS, herbal gel, acne, hirsutism, alopecia, natural remedies, phytotherapy, skincare

1. Introduction:

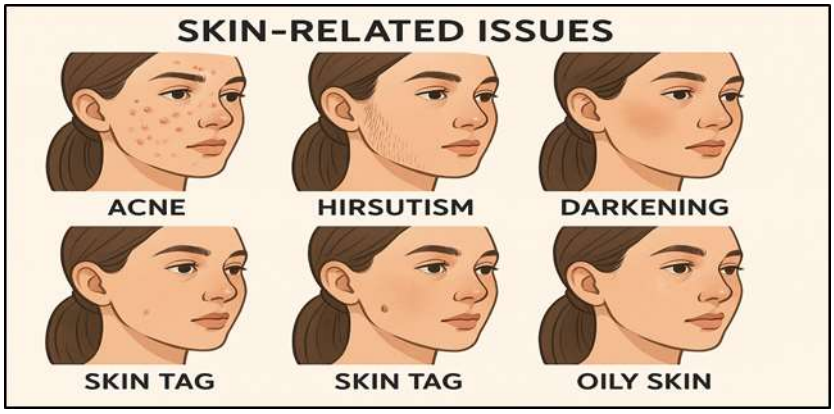
Polycystic Ovary Syndrome (PCOS) affects an estimated 6–20% of women of reproductive age worldwide and is a leading cause of infertility and metabolic disturbances. One of the hallmark features of PCOS is hyperandrogenism, which contributes to various cutaneous manifestations including acne, hirsutism (excessive hair growth), androgenic alopecia (hair thinning), and seborrhea (excessive oiliness of the skin). These symptoms, though not life-threatening, can severely affect psychological well-being, self-esteem, and overall quality of life. [2]

Traditional treatment approaches such as oral contraceptives, anti-androgens, and topical retinoids offer symptomatic relief but may come with significant side effects and long-term health risks. This has spurred increased interest in safer, more holistic treatment alternatives—especially those rooted in herbal medicine. Herbal gels, in particular, provide a promising topical solution owing to their ease of application, localized action, and potential for minimal systemic absorption. They can deliver a synergistic blend of bioactive compounds with anti-inflammatory, antimicrobial, and anti-androgenic properties, targeting the root causes of PCOS-related skin conditions.

This review delves into the role of herbal gels in managing PCOS-associated skin problems, exploring the scientific rationale behind their use, key herbs employed, and the current evidence supporting their efficacy [3], [4]

1.1 Skin-Related Manifestations of PCOS

- **Acne**: Due to increased sebum production and inflammation triggered by androgen excess.
- **Hirsutism**: Abnormal hair growth on the face and body due to androgen sensitivity.
- **Seborrhea**: Oily skin resulting from overactive sebaceous glands.
- **Stretch Marks**: Rapid weight gain, which is common in PCOS due to insulin resistance and hormonal imbalances, can result in stretch marks, particularly on the abdomen, thighs, and hips.
- **Skin Tags**: Small, benign growths of skin, often found in areas like the neck, armpits, and groin. They are linked to insulin resistance, which is common in PCOS.



2. Etiology of PCOS:

The factors associated with the etiology of PCOS may be

2.1 Environmental Factors

The environmental factors associated with the etiology of PCOS are depicted in detail in Figure 1.

FIGURE 1

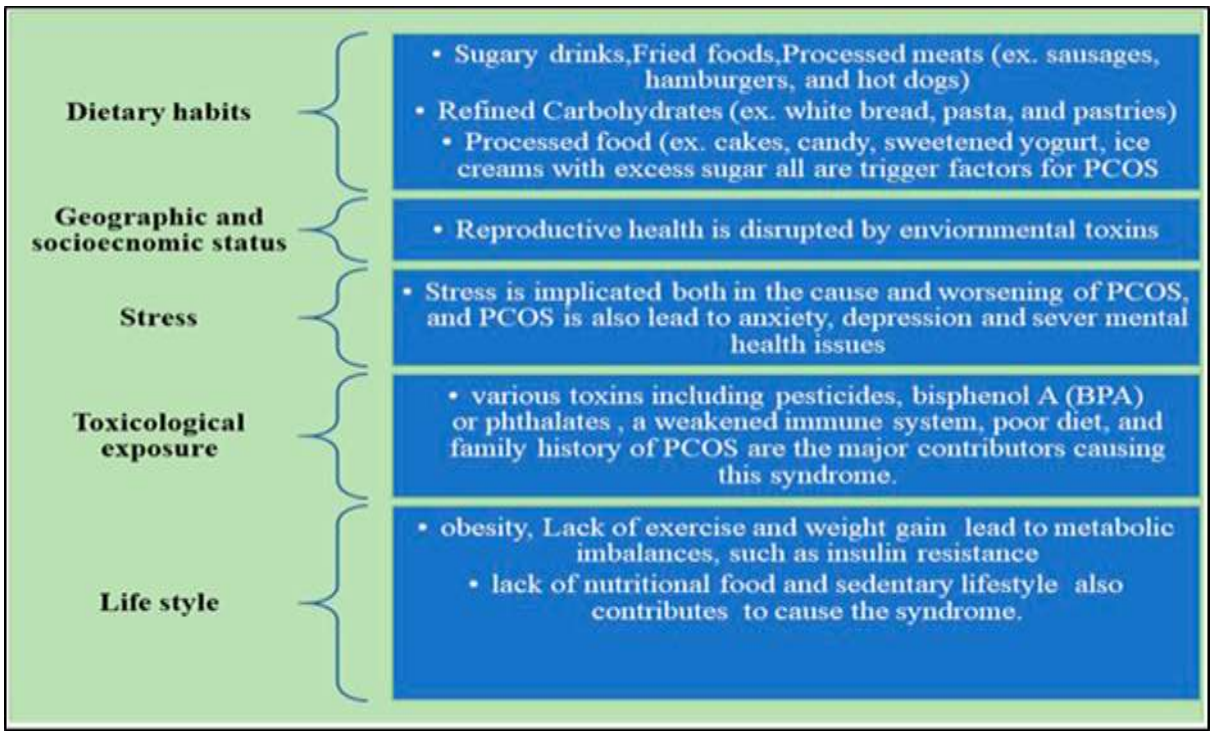


FIGURE 1. Environmental factors affecting PCOS.

The biggest contributor to PCOS is poor diet and disturbed lifestyle which is also proved in a survey. An elevated level of androgens prevents the release of the ovum from follicles. So, an unhealthy diet and a stressful lifestyle contribute to the worsening of the symptoms of PCOS. [5]

2.2 Genetic Factors

The genetic factors associated with the etiology of PCOS are depicted in Figure 2**.**

FIGURE 2

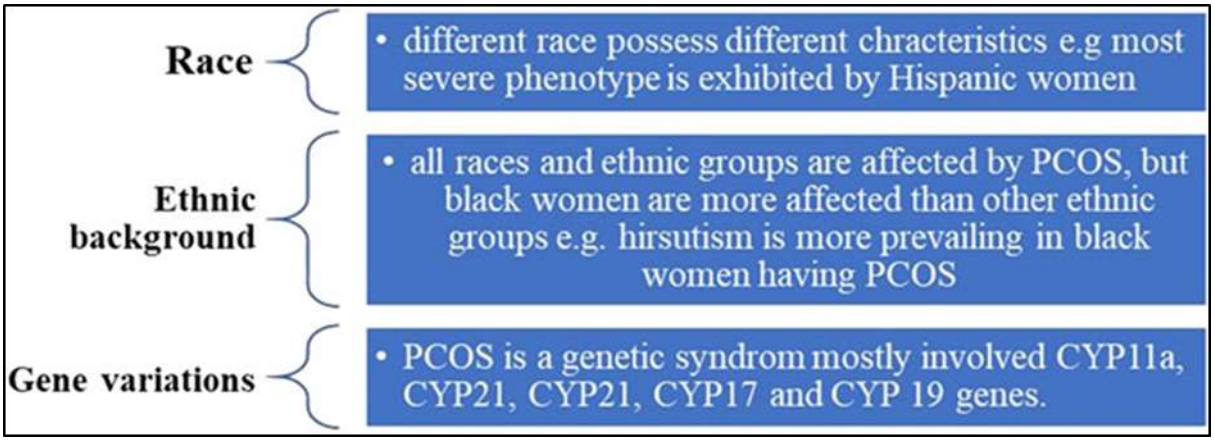


FIGURE 2. Genetic factors associated with PCOS.

These factors provide additional insight to determine the epidemiology, prevalence, and presence of PCOS.

Based on these factors, PCOS is divided into four different types.

1) Insulin resistance PCOS: high level of insulin is the common and highly prevalent reason for PCOS [6]

2) Adrenal PCOS: stimulation of adrenal secretions during early puberty causes adrenal PCOS; patients with adrenal PCOS generally experience more stress due to excess DHEAS (dehydroepiandrosterone sulfate, an androgen of adrenal glands. [7]

3) Inflammatory PCOS: chronic low-grade inflammation is generally found in PCOS patients

4) Post-pill PCOS: e.g., caused by contraceptive pills and hormonal disturbances

Increased insulin levels and insulin resistance also contribute to the pathogenesis of PCOS.

3. Pathogenesis of PCOS:

3.1 Hormonal Imbalance

Some major hormones that play a key role in the pathogenesis of PCOS are discussed as follows, as shown in Figure 3.

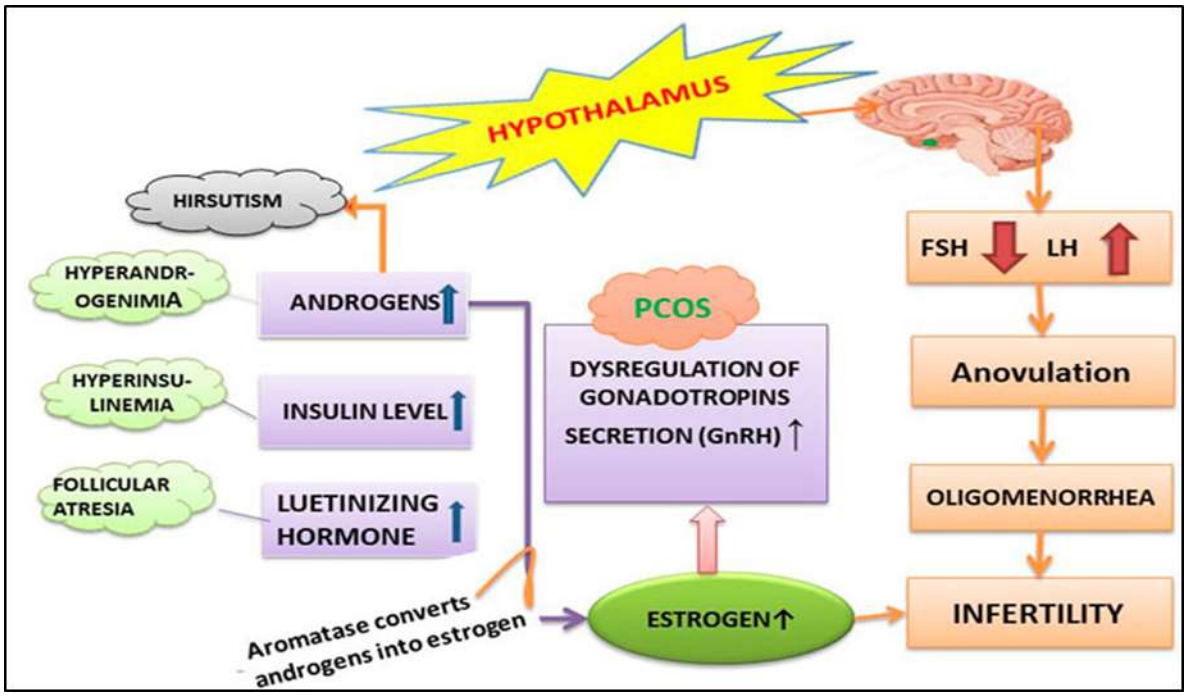


FIGURE 3. Hormonal imbalance associated with PCOS.

3.1.1 Androgen

The ovary of an adolescent with PCOS produces androgens excessively (hyperandrogenism), e.g., testosterone, which prevents the maturation of ovarian follicles. So, an immature ovum will be formed that does not release properly, thus leading to anovulation. The ovum and sperm meet for fertilization, and the unavailability of the fully mature ovum is responsible for the conception problem in PCOS patients. A high level of testosterone is also observed in women with PCOS. However, it is seen in cell function studies of PCOS patients that the androgen response is much exaggerated after its stimulation by exogenous HCG or by endogenous gonadotropin after treatment with exogenous gonadotropin-releasing-hormone (GnRH) analog. It was also observed that the human theca cells culture of PCOS patients produces 20 times more androstenedione than similar cells of normal people [8]

3.1.2 Insulin

Hyperinsulinemia and insulin resistance are two common contributing factors of anovulation in PCOS patients. Hyperinsulinemia is higher insulin levels in the blood, and it mostly happens when the production of insulin is higher than its clearance. Androgens also cause insulin resistance, as described in Figure 3.[9] doi:10.2337/diab.38.9.1165 A study conducted in non-obese or less obese PCOS patients suggested that therapy with antiandrogens or androgen suppression improved the insulin sensitivity to a great extent but did not fully restore the insulin sensitivity to normal. Reduction of abdominal adiposity and weight loss in obese patients with PCOS also improved insulin sensitivity when compared with the weight-matched controlled subjects. The exact causes of metabolic abnormalities remain unclear, but abnormalities in insulin secretion and signaling remain the major cause which was studied in female rhesus monkeys, in which impairments in insulin secretion and action were observed when exposed to androgen excess *in vitro*.

3.1.3 Luteinizing Hormones

It was suggested from different studies that an increased level of insulin is also a contributing factor for anovulation in women with PCOS; it induces premature arrest of follicle development by interacting with LH to augment steroidogenesis. If an unexpected ovulatory cycle occurs and the LH level is monitored regularly for several weeks, it could be seen that the serum LH concentrations suddenly drop to the standard range. It was also observed in rhesus monkeys and ewes (prenatally androgenized) that the LH secretion remains higher than normal (although significantly lower than in anovulatory subjects). When animals are exposed *in utero* to androgens, a permanent decline in hormonal negative feedback on the hypothalamic-pituitary axis occurs, thus stimulating the androgen's hypersecretion. The mechanism behind this hypersecretion is not clear; however, recent studies have suggested that in anovulatory patients, the major reason for the hypersecretion of LH is irregular negative feedback on LH secretion that is mediated by either estradiol or progesterone. [10]

4. Signs and Symptoms of PCOS:

The signs and symptoms of PCOS have a lot of variations and also have interindividual differences. The major symptoms are presented in Figure 5.

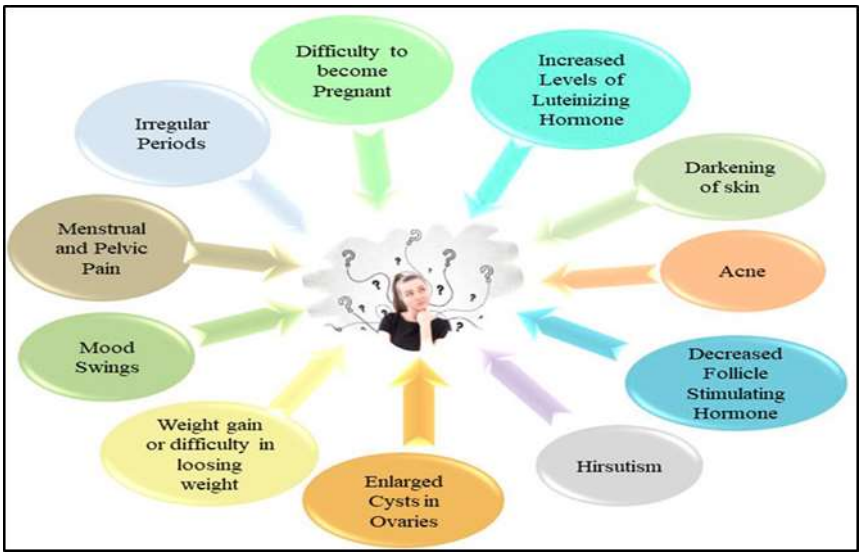


FIGURE 5. Signs and symptoms of PCOS.

5. Conventional Treatment Limitations:

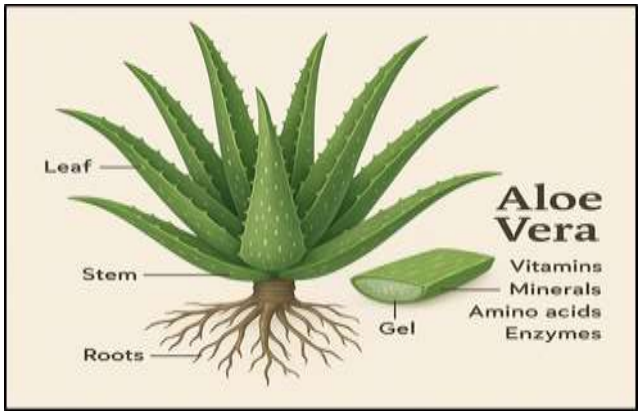
Pharmacological treatments such as oral contraceptives, anti-androgens, and retinoids provide relief but may cause systemic side effects, contraindications, and long-term safety concerns.

6. Herbal Alternatives:

An Overview Herbal therapies leverage bioactive compounds such as flavonoids, tannins, alkaloids, and saponins that exhibit anti-inflammatory, anti-androgenic, and antimicrobial properties. These compounds, when formulated in gel form, can enhance skin penetration, stability, and patient compliance.

❖ **Common Herbs Used in Herbal Gels for PCOS-Related Skin Conditions**

6.1. Aloe Vera (Aloe barbadensis miller):



Polycystic Ovary Syndrome (PCOS) is a hormonal disorder that often manifests in skin-related symptoms such as acne, seborrhoea, hyperpigmentation, and hirsutism. Aloe Vera (Aloe barbadensis miller) has been widely used in dermatology due to its anti-inflammatory, antimicrobial, wound-healing, and moisturizing properties. Its ability to soothe irritated skin, regulate sebum production, and promote skin repair makes it an excellent base for herbal gel formulations targeting PCOS-related skin concerns. [11]

- Active Components of Aloe Vera Relevant to Skin Problems

Aloe Vera gel contains over 75 active compounds, including:

Polysaccharides (Acemannan): Promote skin hydration and wound healing.

Glycoproteins: Reduce inflammation and redness. Salicylic Acid: Acts as a natural exfoliant and acne treatment.

6.2. GREEN TEA: (Camellia sinensis)

Polycystic Ovary Syndrome (PCOS) is a common endocrine disorder that affects women, often leading to skin-related issues such as acne, excessive oil production, hyperpigmentation, and inflammation. Green Tea (Camellia sinensis) is rich in polyphenols, catechins, and antioxidants, which offer anti-inflammatory, antimicrobial, sebum-regulating, and skin-brightening properties. Incorporating Green Tea into an herbal gel formulation can provide a natural, non-irritating treatment for managing PCOS-related dermatological conditions.

- Active Constituents: Tannins- Astringents – Tighten pores and reduce excess oil on the skin.

Flavonoids – Antioxidant- Enhances skin elasticity, protects it from UV damage, and reduces dark spots and hyperpigmentation.

6.3 Neem (Azadirachta indica):

Medicinal plant known for its antibacterial, antifungal, anti-inflammatory, and antioxidant properties. PCOS-related skin conditions such as acne, oily skin, hyperpigmentation, and inflammation are linked to hormonal imbalances and oxidative stress. Neem contains bioactive compounds that help control acne-causing bacteria, reduce excess sebum, lighten dark spots, and promote skin healing, making it an ideal ingredient in an herbal gel formulation for PCOS skin issues.

- Active Constituents:
- Azadirachtin- Limonoid- Antibacterial: Kills acne-causing bacteria, Antifungal Prevents fungal acne and skin infections.
- Nimbidin- Terpenoid- Anti-Inflammatory: Reduce redness, swelling, and irritation Helps soothe eczema and dermatitis.
- Nimbin- Terpenoid – Antioxidant: Protects skin from free radical damage and aging

6.4 Turmeric (Curcuma longa):

Curcumin is found in Curcuma longa rhizomes. It is used as a food additive and possesses anti-inflammatory, antioxidant, antihyperlipidemic, and hypoglycemic properties. Reddy et al evaluated the benefit of Curcumin in female Wistar rats with PCOS. Five groups of animals were used. Letrozole was used to induce PCOS. The animals were given Curcumin and a comparison was made with that of clomiphene citrate which is used in the treatment of PCOs

- Active constituents: *Demethoxycurcumin
- Anti-inflammatory: Similar to curcumin, this compound has anti-inflammatory effects that can help soothe irritated skin.

* Bisdemethoxycurcumin

- Skin Protection: This compound also possesses antioxidant properties, further supporting skin healing and protection from environmental stressors.
- Anti-aging: Its anti-inflammatory properties can promote healthier skin and delay the signs of aging, a common concern for people with PCOS.
- **Tea tree oil (Melaleuca alternifolia)**: Effective against acne-causing bacteria and reduces inflammation.

6.5 Licorice (Glycyrrhiza glabra):

Licorice: (Glycyrrhiza glabra) is a medicinal herb widely used in skincare for its anti-inflammatory, skin-brightening, and anti-androgenic properties. Women with PCOS often experience acne, hyperpigmentation, oily skin, and hirsutism due to elevated androgen levels. Licorice contains bioactive

compounds that help regulate sebum production, reduce post-inflammatory hyperpigmentation, and inhibit 5-alpha reductase, which plays a role in excessive hair growth. [12]

- Active Constituents: -

Liquiritin - Flavonoid – Promotes skin lightening by dispersing melanin. Reduce uneven skin tone.

Isoflavones- Phytoestrogen – Balance androgen helps reduce excess hair growth.

Polysaccharides- Hydrator – Provides moisturization, making skin soft and smooth.

6.6 Spearmint (Mentha Spicata):

Spearmint (Mentha spicata) is a medicinal herb with anti-androgenic, anti-inflammatory, antioxidant, and antimicrobial properties, making it beneficial for PCOS-related skin concerns. Women with PCOS often experience acne, oily skin, hirsutism (excess hair growth), and inflammation due to high androgen levels. Spearmint has been scientifically studied for its ability to reduce androgen levels, which can help control acne and excessive oil production. Its antioxidant compounds also support skin healing and rejuvenation, making it a valuable ingredient in an herbal gel formulation for PCOS-related skin issues.

- Active Constituents:

Rosmarinic Acid- Polyphenol- Anti-Inflammatory: Reduces redness, swelling, and irritation.

Carvone- Terpenoid- Controls oil production and prevents clogged pores.

Menthol- Cooling Agent- Provides a soothing, cooling, reducing inflammation.

7. Gel:

7.1 Definition:

A *gel* is a semi-solid system consisting of a dispersion of small or large molecules in an aqueous or hydroalcoholic liquid phase, which is rendered jelly-like by the addition of a gelling agent. Gels are commonly used for topical applications due to their smooth texture, cooling effect, and ability to deliver active ingredients directly to the site of action.

Topical gels are ideal carriers for herbal bioactives as they allow for localized delivery, enhanced skin penetration, non-greasy feel, and improved patient compliance. [13]

7.2 Types of Gels: [14] [15] [16]

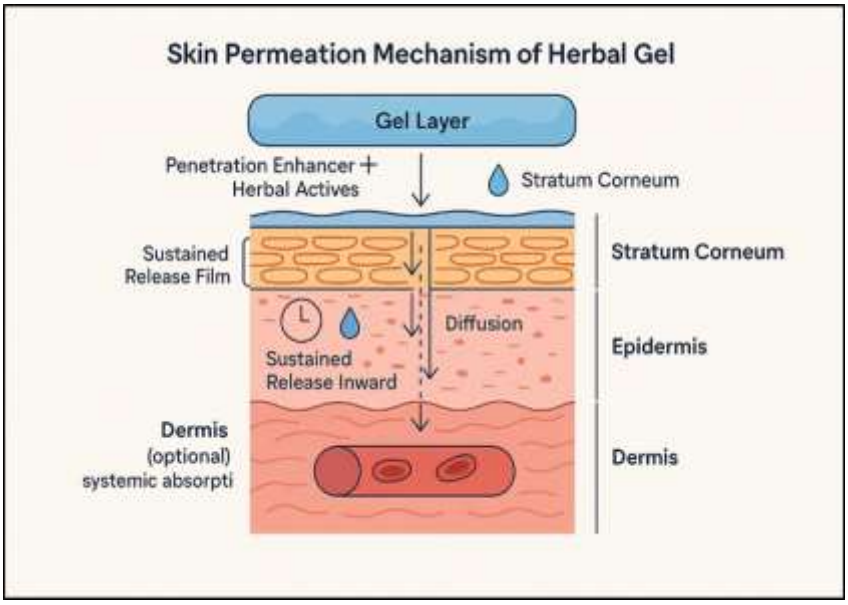
1. **Hydrogels**
   - Composed primarily of water as the dispersion medium.
   - Provide excellent hydration and are suitable for delivering water-soluble herbal extracts.
   - Examples: Aloe Vera gel, herbal hydrogels with neem or tea tree extracts.
2. **Organogels**
   - Contain organic solvents (like ethanol or isopropyl alcohol) instead of water.
   - Suitable for lipophilic (oil-soluble) herbal components.
   - Provide better solubility for essential oils and certain plant-derived terpenoids.
3. **Emulgel**
   - A hybrid system combining the properties of gels and emulsions (oil-in-water or water-in-oil).
   - Effective for incorporating both hydrophilic and lipophilic herbal actives.
   - Offers enhanced penetration and sustained release of actives.
4. **Oleogels (Lipid-based gels)**
   - Formed using oils or fats as the base with appropriate gelling agents.
   - Suitable for dry or sensitive skin where occlusion and moisturization are needed.
   - Less commonly used in PCOS skincare but may be considered for alopecia formulations.
5. **Nanogels**
   - Advanced formulations where the gel matrix contains nanosized particles or carriers.
   - Offer superior penetration, controlled release, and increased bioavailability of herbal compounds.
   - Emerging as a novel platform for phytotherapy.

Significance in PCOS Skin Management:

Gels serve as a versatile medium for delivering herbal actives to treat skin issues like acne, hirsutism, and alopecia. Their non-greasy, cooling, and fast-absorbing nature makes them preferable over creams or ointments, especially for oily or acne-prone skin commonly seen in PCOS.

7.3 Mechanism of Gel in Skin Permeation

Topical gels enhance drug/herb delivery to the skin by facilitating the penetration of active compounds across different layers of the skin. The mechanism depends on several factors such as the composition of the gel, the type of active ingredient, and the condition of the skin barrier. [17]



Key Mechanisms:

- **Hydration of Stratum Corneum:**

Gels hydrate the outermost layer of the skin (stratum corneum), causing it to swell and become more permeable, allowing easier passage of active compounds.

- **Diffusion Gradient:**

Active herbal ingredients diffuse from the gel into the skin due to a concentration gradient — moving from a high concentration in the gel to a lower concentration in the skin.

- **Interaction with Skin Lipids:**

Some gel components (e.g., ethanol, essential oils) disrupt the tightly packed lipids in the stratum corneum, improving penetration.

- **Use of Penetration Enhancers:**

Herbal gels often contain natural enhancers like terpenes (from eucalyptus, tea tree oil) or solvents that temporarily increase skin permeability.

- **Sustained Release Effect:**

Gels can form a thin film on the skin, allowing the sustained release of the herbal actives over time for prolonged therapeutic effect.

8. Evidence from Studies:

➢ **Several studies support the efficacy of herbal gels:**

- A study on turmeric gel showed a significant reduction in acne lesions.
- Neem and tea tree oil gel formulations reduced inflammation and bacterial load in acne vulgaris.
- Aloe Vera-based gels improved hydration and reduced erythema in sensitive skin.

➢ **Advantages of Herbal Gels** [18]

- Non-invasive, localized treatment
- Minimal side effects
- Enhanced patient adherence
- Cost-effective and easy to formulate.

9. Challenges and Future Perspectives:

Challenges include standardization of herbal extracts, stability of active ingredients in gel form, and lack of large-scale clinical trials. Future research should focus on formulation optimization, advanced delivery systems, and long-term efficacy studies.

10. Conclusion:

Herbal gels represent a promising avenue for managing skin-related complications in PCOS. With increasing demand for natural and safe therapies, these formulations can complement or even substitute conventional treatments, provided their efficacy and safety are established through rigorous scientific evaluation.

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