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PHYTOTHERAPEUTIC APPROACHES IN DERMATOLOGY: MECHANISMS, APPLICATIONS, AND EVIDENCE FROM MEDICINAL PLANTS

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ABSTRACT

Medicinal plants have gained substantial attention as potential therapeutic agents in dermatology because of their broad spectrum of pharmacological properties and long-standing use in traditional medicine. This narrative review evaluates the mechanisms of action, dermatological applications, and scientific evidence supporting medicinal plants used in the prevention and management of skin disorders. Relevant literature published between 2000 and 2025 was retrieved from major scientific databases, including PubMed, Scopus, SpringerLink, ScienceDirect, and MDPI. Evidence indicates that medicinal plants exert beneficial dermatological effects through multiple mechanisms, including anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, photoprotective, and wound-healing actions. Frequently studied medicinal plants include *Aloe vera*, *Azadirachta indica*, *Curcuma longa*, *Centella asiatica*, *Melaleuca alternifolia*, *Matricaria chamomilla*, and *Camellia sinensis*. These botanicals have shown promise in conditions such as acne vulgaris, psoriasis, eczema, Photoaging, wound healing, hyperpigmentation, and skin infections. Despite encouraging preclinical findings and some positive clinical outcomes, limitations remain regarding standardization, dosage consistency, formulation stability, and the quality of clinical evidence. This review highlights the therapeutic relevance of medicinal plants in dermatology and underscores the need for robust clinical validation and evidence-based formulation development to facilitate their integration into modern dermatological practice.

KEYWORDS: medicinal plants; dermatology; phytotherapy; skin diseases; phytochemicals; antioxidant; antimicrobial; anti-inflammatory; wound healing; herbal medicine.

1. INTRODUCTION

Skin diseases are among the most common health conditions worldwide and constitute a major public health concern because of their high prevalence, chronicity, psychosocial impact, and economic burden. Common dermatological disorders such as acne vulgaris, psoriasis, atopic dermatitis, eczema, chronic wounds, fungal infections, and hyperpigmentation affect millions of individuals globally and often reduce quality of life substantially (Hay et al., 2014). In addition to physical symptoms such as itching, inflammation, pain, scaling, and disfigurement, many skin diseases are associated with anxiety, depression, and social stigma.

Conventional dermatological therapies, including corticosteroids, antibiotics, retinoids, antifungals, and immunosuppressive agents, remain central to treatment. However, many of these interventions are associated with limitations such as local irritation, photosensitivity, skin atrophy, antimicrobial resistance, relapse after discontinuation, and concerns related to long-term safety (Reuter et al., 2010). These challenges have led to increasing interest in complementary and alternative approaches, particularly those based on medicinal plants and phytochemicals.

Medicinal plants have been used for centuries in traditional healing systems such as Ayurveda, Siddha, Unani, Traditional Chinese Medicine, and folk medicine for the treatment of skin disorders. The therapeutic value of these plants is attributed to their rich content of bioactive compounds, including flavonoids, polyphenols, terpenoids, alkaloids, tannins, glycosides, saponins, and essential oils (Działo et al., 2016). Unlike many synthetic drugs that are designed to act on a single target, medicinal plants often demonstrate **multi-target effects**, enabling them to modulate multiple pathological pathways simultaneously, including inflammation, oxidative stress, microbial colonization, barrier dysfunction, and impaired wound repair (Pan et al., 2014).

Among the most widely investigated medicinal plants in dermatology are *Aloe vera*, valued for its wound- healing and soothing properties; *Azadirachta indica* (neem), known for its antimicrobial and anti- inflammatory activities; *Curcuma longa* (turmeric), rich in curcumin with anti-inflammatory and antioxidant effects; and *Centella asiatica*, recognized for promoting collagen synthesis and tissue repair (Biswas et al., 2002; Bylka et al., 2014; Shukla et al., 1999). Other botanicals such as tea tree oil, chamomile, green tea, and licorice have also shown notable dermatological benefits.

Given the increasing scientific and clinical interest in plant-based dermatological therapies, a comprehensive synthesis of the available evidence is timely and relevant. Therefore, the aim

of this narrative review is to examine the role of medicinal plants in dermatology, with a particular focus on their **mechanisms of action, therapeutic applications, and supporting scientific evidence**.

2. METHODS

This study was conducted as a **narrative review** to provide a broad and integrative synthesis of the available literature on medicinal plants used in dermatology. A narrative review design was selected because it is particularly suitable for summarizing and interpreting findings from heterogeneous sources, including in vitro experiments, in vivo animal studies, clinical trials, and review articles. Such an approach allows a flexible yet comprehensive examination of both mechanistic and therapeutic evidence relevant to herbal dermatology (Ferrari, 2015; Green et al., 2006).

A comprehensive literature search was performed using multiple electronic databases to maximize the retrieval of relevant studies. The databases searched included **PubMed, Scopus, SpringerLink, ScienceDirect, and MDPI**. These databases were selected because they index a broad range of biomedical, pharmacological, dermatological, and phytochemical literature. The search strategy included combinations of controlled vocabulary and free-text terms such as **"medicinal plants dermatology," "herbal skin treatment," "phytochemicals skin mechanisms," "plant-based dermatology," "natural products skin disorders," "anti-inflammatory herbal skin,"** and **"wound healing medicinal plants."** Boolean operators (**AND**, **OR**) were used to refine search results and improve relevance. In addition to database searching, the reference lists of selected articles were manually screened to identify additional pertinent studies, in accordance with recommended review methodologies (Siddaway et al., 2019).

The review included literature published between **2000 and 2025**, thereby capturing both foundational and contemporary research in dermatological phytotherapy. Studies were eligible for inclusion if they were **peer- reviewed articles** that focused on medicinal plants or plant-derived compounds used in dermatological conditions and if they provided either **mechanistic evidence** (e.g., anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, or wound-healing effects) or **clinical evidence** relevant to skin health and disease. Both experimental and clinical studies were considered to ensure a broad and meaningful synthesis of the available evidence.

Studies were excluded if they were **non-English publications**, unrelated to dermatological applications, duplicated across databases, or lacked sufficient scientific rigor and

methodological clarity. Editorials, non- peer-reviewed content, and studies with insufficient relevance to the review topic were also excluded. These criteria were applied to improve the reliability and quality of the included literature (Ekor, 2014; Moher et al., 2009).

The extracted literature was analyzed using a **qualitative thematic synthesis** approach, which is appropriate for integrating findings from studies with diverse methodologies and outcomes. The selected studies were organized into key thematic categories, including **medicinal plants used in dermatology, major phytochemicals, mechanisms of action, and disease-specific dermatological applications**. This thematic grouping facilitated a structured interpretation of the literature and helped identify major trends, strengths, limitations, and future research priorities in the field (Popay et al., 2006).

3. RESULTS

3.1 Medicinal Plants and Their Dermatological Applications

A wide range of medicinal plants have been investigated for dermatological applications, with evidence supporting their use in wound healing, inflammatory skin conditions, infections, photoaging, and pigmentary disorders. The therapeutic value of these plants is largely attributed to their phytochemical constituents, which exert biological effects relevant to skin physiology and pathology.

Among the most extensively studied botanicals, *Aloe vera* has demonstrated significant utility in burns, wounds, and inflammatory skin conditions due to its polysaccharides, anthraquinones, and mucilaginous compounds that support wound healing, hydration, and anti-inflammatory activity (Shukla et al., 1999). *Azadirachta indica* (neem) contains bioactive compounds such as Nimbidin and azadirachtin and is widely recognized for its antimicrobial and anti-inflammatory properties, making it relevant for acne, eczema, and skin infections (Biswas et al., 2002). *Curcuma longa* (turmeric), primarily through curcumin, exhibits potent anti-inflammatory and antioxidant actions and has shown potential in psoriasis, dermatitis, and other inflammatory dermatoses (Aggarwal & Harikumar, 2009). *Centella asiatica* is another important medicinal plant used in dermatology, particularly for wound healing and scar management, owing to compounds such as asiaticoside that stimulate collagen synthesis and angiogenesis (Bylka et al., 2014).

Other plants of interest include *Melaleuca alternifolia* (tea tree), which is known for its antimicrobial activity against acne-associated organisms; *Matricaria chamomilla* (chamomile), valued for its soothing and anti- inflammatory effects in eczema and dermatitis; *Camellia sinensis* (green tea), rich in catechins with antioxidant and photoprotective benefits;

and *Glycyrrhiza glabra* (licorice), which has demonstrated anti- inflammatory and depigmenting effects relevant to inflammatory and pigmentary disorders (Carson et al., 2006; Nichols & Katiyar, 2010; Reuter et al., 2010).

Table 1: Medicinal plants, major phytochemicals, mechanisms, and dermatological uses.

Plant	Major Phytochemicals	Mechanisms	Dermatological Uses
Aloe vera	Polysaccharides, anthraquinones	Anti-inflammatory, wound healing	Burns, wounds, psoriasis
Azadirachta indica	Nimbidin, azadirachtin	Antimicrobial, anti-inflammatory	Acne, eczema, infections
Curcuma longa	Curcumin	Anti-inflammatory, antioxidant	Psoriasis, dermatitis
Centella asiatica	Asiaticoside, madecassoside	Collagen synthesis, angiogenesis	Scars, wounds
Melaleuca alternifolia	Terpinen-4-ol	Antimicrobial	Acne
Matricaria chamomilla	Apigenin, bisabolol	Anti-inflammatory, soothing	Eczema, dermatitis
Camellia sinensis	Catechins	Antioxidant, photoprotective	Photoaging
Glycyrrhiza glabra	Glycyrrhizin, glabridin	Anti-inflammatory, depigmenting	Hyperpigmentation, dermatitis

3.2 Mechanisms of Action of Medicinal Plants in Dermatology

The beneficial effects of medicinal plants in dermatology arise from multiple interconnected biological mechanisms. These mechanisms are particularly important because many skin disorders involve overlapping pathways such as inflammation, oxidative stress, microbial dysbiosis, impaired barrier function, and delayed tissue repair.

3.2.1 Anti-inflammatory activity

Inflammation is a central feature of many skin diseases, including acne vulgaris, psoriasis, eczema, and dermatitis. Several plant-derived compounds exert anti-inflammatory effects by modulating inflammatory mediators such as cytokines, prostaglandins, and transcription factors. Curcumin from *Curcuma longa* is one of the most extensively studied phytochemicals in this regard and has been shown to inhibit nuclear factor- kappa B (NF-κB), tumor necrosis factor-alpha (TNF-α), cyclooxygenase-2 (COX-2), and other inflammatory pathways (Aggarwal & Harikumar, 2009). Chamomile and licorice also possess anti-inflammatory constituents that may help alleviate erythema, irritation, and itching associated with inflammatory dermatoses (Reuter et al., 2010; Tabassum & Hamdani, 2014).

3.2.2 Antioxidant activity

Oxidative stress contributes significantly to skin aging, inflammation, UV-induced damage, and chronic inflammatory skin disorders. Many medicinal plants are rich in polyphenols and flavonoids that neutralize reactive oxygen species (ROS) and protect cellular structures from oxidative damage. Green tea catechins, especially epigallocatechin gallate (EGCG), have demonstrated substantial antioxidant and photoprotective effects, making them valuable in Photoaging and UV-related skin damage (Nichols & Katiyar, 2010). Plant phenolics more broadly have also been recognized for their therapeutic relevance in skin disorders associated with oxidative imbalance (Działo et al., 2016; Michalak, 2023).

3.2.3 Antimicrobial activity

Microbial colonization and infection are implicated in several skin conditions, including acne, folliculitis, superficial fungal infections, and infected wounds. Tea tree oil from *Melaleuca alternifolia* has shown broad- spectrum antimicrobial activity and is especially relevant in acne management because of its effects against acne-associated bacteria and inflammatory lesions (Carson et al., 2006). Neem and several other medicinal plants also exhibit antibacterial and antifungal properties, supporting their use in infected or microbially aggravated skin conditions (Biswas et al., 2002; Bittner Fialová et al., 2021).

3.2.4 Wound-healing and tissue regenerative effects

The skin’s ability to repair itself is crucial in burns, ulcers, abrasions, surgical wounds, and chronic wounds. Medicinal plants may support wound healing through collagen synthesis, fibroblast proliferation, angiogenesis, epithelialization, and modulation of inflammation. *Aloe vera* has long been recognized for its beneficial effects in wound repair, partly due to its ability to enhance collagen deposition and improve tissue regeneration (Shukla et al., 1999). *Centella asiatica* is particularly important in scar management and wound healing because asiaticoside and related triterpenes stimulate fibroblast activity and collagen production (Bylka et al., 2014; Sharma et al., 2021).

3.2.5 Immunomodulatory activity

Some medicinal plants may also regulate immune responses, which is particularly relevant in inflammatory and immune-mediated skin disorders such as psoriasis and eczema. Neem, turmeric, and licorice are among the plants reported to influence immune pathways and cytokine signaling, thereby helping to regulate exaggerated inflammatory responses (Pan et al., 2014; Reuter et al., 2010).

Table 2: Major mechanisms, molecular targets, and clinical outcomes.

Mechanism	Representative Molecular Targets/Processes	Example Plants	Potential Clinical Effects
Anti-inflammatory	TNF-α, NF-κB, COX-2, IL-6	*Curcuma longa*, *Matricaria chamomilla*	Reduced inflammation, erythema, irritation
Antioxidant	ROS scavenging, lipid peroxidation	*Camellia sinensis*, *Aloe vera*	Photoprotection, anti-aging, reduced oxidative stress
Mechanism	**Representative Molecular Targets/Processes**	**Example Plants**	**Potential Clinical Effects**
Antimicrobial	Cell membrane disruption, microbial inhibition	*Melaleuca alternifolia*, *Azadirachta indica*	Acne control, infection reduction
Wound healing	Collagen synthesis, fibroblast proliferation, angiogenesis	*Centella asiatica*, *Aloe vera*	Tissue repair, scar reduction
Immunomodulatory	Cytokine regulation, immune signaling	*Azadirachta indica*, *Glycyrrhiza glabra*	Relief in inflammatory dermatoses

3.3 Disease-Specific Dermatological Applications

3.3.1 Acne vulgaris

Acne vulgaris is a multifactorial inflammatory condition involving excess sebum production, follicular hyper keratinization, microbial colonization, and inflammation. Tea tree oil and neem have been frequently studied for acne due to their antimicrobial and anti-inflammatory effects. Tea tree oil, in particular, has shown promise in reducing inflammatory lesions and acne severity (Carson et al., 2006). Neem may further contribute by suppressing microbial growth and inflammatory responses (Biswas et al., 2002).

3.3.2 Psoriasis and dermatitis

Psoriasis and dermatitis involve chronic inflammation, altered keratinocyte proliferation, and immune dysregulation. Curcumin has been investigated for psoriasis because of its anti-inflammatory effects and ability to modulate signaling pathways involved in disease progression (Aggarwal & Harikumar, 2009). Chamomile and licorice may also help reduce irritation, redness, and inflammation in dermatitis and eczema (Tabassum & Hamdani, 2014).

3.3.3 Wounds, burns, and scars

Aloe vera and *Centella asiatica* have shown particular promise in wound healing, burns, and scar management. *Aloe vera* has soothing, moisturizing, and regenerative effects, while *Centella asiatica* promotes fibroblast proliferation and collagen synthesis, making it useful in

both acute wounds and scar remodeling (Bylka et al., 2014; Sharma et al., 2021; Shukla et al., 1999).

3.3.4 Photoaging and photoprotection

Green tea and other antioxidant-rich botanicals have been studied for protection against UV-induced oxidative stress and Photoaging. Catechins may reduce oxidative damage, inflammation, and DNA injury induced by ultraviolet exposure, suggesting a role in both prevention and adjunctive management of photoaging (Michalak, 2023; Nichols & Katiyar, 2010).

3.3.5 Skin infections

Plant-derived compounds have also demonstrated utility in skin infections due to their antibacterial, antifungal, and anti-inflammatory properties. A growing body of evidence supports the relevance of medicinal plants and their active constituents in the management of skin infections, although more standardized clinical evidence is still needed (Bittner Fialová et al., 2021; Sitarek et al., 2020).

3.4 Evidence Summary

Overall, the literature indicates **strong preclinical support** for the use of medicinal plants in dermatology, with numerous in vitro and in vivo studies demonstrating beneficial biological activities. However, while clinical evidence is promising, it remains comparatively limited, heterogeneous, and sometimes difficult to compare due to differences in extraction methods, formulations, doses, study designs, and outcome measures (Reuter et al., 2010; Sitarek et al., 2020). This highlights the need for greater standardization and high-quality clinical trials.

4. DISCUSSION

Medicinal plants have emerged as a highly relevant therapeutic resource in dermatology because they provide a **multi-target therapeutic approach**, which is especially advantageous in skin diseases characterized by complex and overlapping pathological mechanisms. Many dermatological conditions involve a combination of inflammation, oxidative stress, microbial imbalance, immune dysregulation, and impaired wound healing. In this context, plant-derived therapies offer a broader pharmacological spectrum than many conventional single-target agents (Działo et al., 2016; Reuter et al., 2010).

One of the most important strengths of medicinal plants is their rich reservoir of **bioactive phytochemicals**, including flavonoids, phenolic acids, tannins, terpenoids, alkaloids, and

glycosides. These compounds can act synergistically to produce anti-inflammatory, antioxidant, antimicrobial, wound-healing, and immunomodulatory effects. Such multi-component, multi-pathway actions are particularly valuable in chronic inflammatory skin disorders such as psoriasis, eczema, and acne vulgaris. For example, curcumin from *Curcuma longa* has shown the ability to inhibit inflammatory mediators and transcription factors, whereas green tea catechins help reduce oxidative stress and UV-mediated damage (Aggarwal & Harikumar, 2009; Nichols & Katiyar, 2010). Similarly, tea tree oil and neem exhibit antimicrobial actions that are highly relevant in acne and superficial skin infections (Biswas et al., 2002; Carson et al., 2006).

Another notable advantage of phytotherapeutic approaches is their potential accessibility and affordability, particularly in resource-limited settings where access to expensive dermatological treatments may be restricted. Traditional use also provides an ethnopharmacological basis for further scientific exploration, and many plant-based remedies continue to be widely used in community healthcare settings.

Despite these strengths, several important limitations and challenges remain. One of the most significant issues is the **variability in plant composition**, which may arise from differences in species, plant part used, geographical origin, cultivation practices, harvest timing, post-harvest processing, and extraction techniques. Such variability can lead to inconsistent therapeutic outcomes and poor reproducibility between studies and products (Ekor, 2014).

Another major limitation is the **lack of robust clinical evidence**. Although preclinical studies are abundant and frequently encouraging, high-quality randomized controlled trials remain relatively limited for many botanicals. Existing clinical studies often suffer from small sample sizes, short follow-up periods, variable formulations, inadequate blinding, or inconsistent endpoints. As a result, translating promising laboratory findings into reliable clinical recommendations remains challenging.

Safety must also be considered carefully. Although medicinal plants are often perceived as inherently safe because they are ―natural,‖ this assumption is not always justified. Herbal products may cause allergic contact dermatitis, irritation, phototoxicity, contamination-related adverse effects, or interactions with conventional drugs (Ernst, 2000). In dermatology, where topical formulations are frequently applied to compromised skin barriers, careful safety assessment is especially important.

Future research should therefore prioritize **standardization, mechanistic clarification, formulation science, and clinical validation**. Advanced analytical techniques such as HPLC, LC-MS, and GC-MS can help standardize extracts and identify active constituents.

Novel drug delivery systems—including liposomes, nanoemulsions, hydrogels, and nanoparticles—may enhance skin penetration, stability, and therapeutic efficacy of plant-derived compounds. Furthermore, well-designed clinical trials are needed to establish efficacy, dosage, safety, and long-term outcomes across specific dermatological indications.

Overall, the present review supports the view that medicinal plants represent a scientifically meaningful and clinically promising area within dermatology. However, their full integration into mainstream dermatological practice will depend on the generation of stronger and more standardized evidence.

5. CONCLUSION

Medicinal plants represent a promising and increasingly important therapeutic approach in dermatology due to their diverse pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, and wound-healing effects. Their ability to influence multiple pathological pathways simultaneously makes them particularly relevant in complex skin disorders such as acne, psoriasis, eczema, chronic wounds, and photoaging.

The available evidence indicates that medicinal plants such as *Aloe vera, Azadirachta indica, Curcuma longa, Centella asiatica*, tea tree, chamomile, and green tea possess meaningful dermatological potential. These botanicals may serve as useful alternatives or adjuncts to conventional therapies, particularly where safety, cost, tolerability, or long-term management are important considerations.

Nevertheless, despite the growing body of supportive literature, several barriers continue to limit broader clinical implementation. These include inconsistency in phytochemical composition, insufficient standardization, limited high-quality clinical trials, and concerns regarding formulation stability and safety. Addressing these limitations through rigorous pharmacological research, standardized manufacturing, and evidence-based clinical studies will be essential.

In conclusion, medicinal plants hold substantial promise for modern dermatology. Their future role will likely expand as traditional knowledge continues to be integrated with contemporary scientific validation, formulation innovation, and clinical evidence.

Author Contributions

Single author contributed to all aspects.

Conflict of Interest

None.

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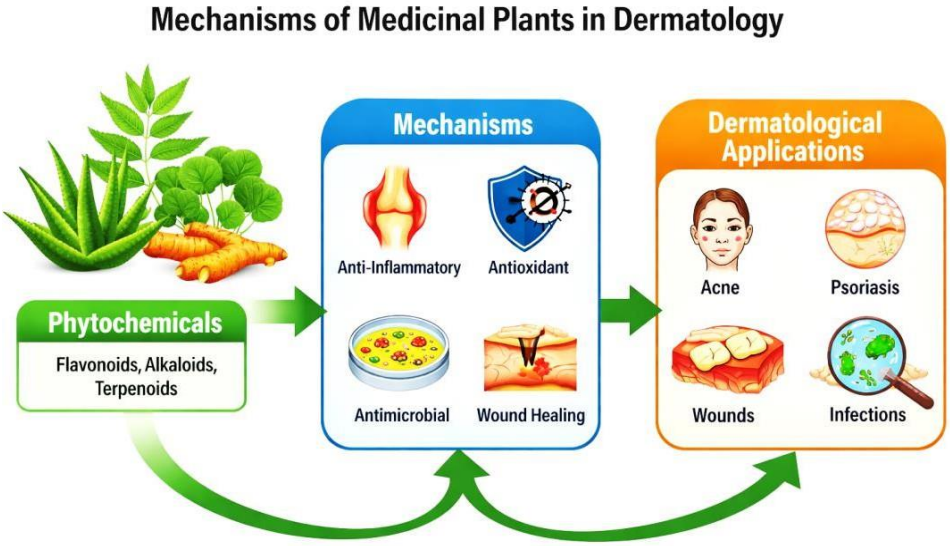

Figure 1. Major mechanisms of action of medicinal plants in dermatology, including anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, and wound-healing effects.

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