

Review

Plant-Based Remedies for Skin Disorders: Efficacy and Mechanisms of Action in Dermatological Treatments

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ABSTRACT

Skin disorders are among the most common health issues worldwide, affecting individuals of all ages and backgrounds. Traditional treatments for skin conditions often involve synthetic chemicals, which can cause side effects and long-term health risks. Plant-based remedies have gained attention in dermatology due to their natural origin, safety, and potential therapeutic benefits. This paper explores the efficacy of plant-based remedies in treating various skin disorders, including acne, eczema, psoriasis, and fungal infections. It examines the mechanisms of action of bioactive compounds found in plants, such as flavonoids, alkaloids, and terpenes, that contribute to their anti-inflammatory, antimicrobial, and antioxidant properties. The review also discusses the clinical evidence supporting the use of plant-based remedies and highlights the challenges and opportunities in incorporating these natural alternatives into dermatological treatments. By evaluating the role of plant-based nanoparticles in drug delivery systems, the paper aims to present a comprehensive overview of how plant-derived compounds can offer effective solutions for improving skin health while minimizing side effects associated with conventional therapies.

KEYWORDS: Skin disorders, Plant-based remedies, Dermatological treatments, Bioactive compounds, Anti-inflammatory, Antimicrobial, Antioxidant properties

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1. Introduction

Skin disorders are prevalent conditions that affect millions of individuals worldwide, leading to both physical and psychological distress. From common issues like acne and eczema to more complex conditions such as psoriasis and fungal infections, the impact of these disorders on quality of life is significant. Traditional dermatological treatments often rely on synthetic drugs that can be effective but may come with unwanted side effects, such as irritation, allergic reactions, or long-term health risks. In response to these concerns, there has been a

growing interest in exploring plant-based remedies as a safer, more natural alternative for treating skin conditions.(1)

Plants have long been used in traditional medicine for their therapeutic properties, and modern research is increasingly focusing on the bioactive compounds within plants that provide anti-inflammatory, antimicrobial, and antioxidant benefits. These compounds, including flavonoids, alkaloids, and terpenes, have shown promise in treating a wide variety of dermatological conditions. The use of plant-derived nanoparticles has further enhanced the

potential of these remedies, improving their bioavailability and targeted delivery to skin tissues. This paper aims to review the efficacy and mechanisms of action of plant-based remedies in the treatment of skin disorders, focusing on their role in modern dermatology. By examining both clinical evidence and the underlying biological mechanisms, we seek to provide a comprehensive understanding of how plant-based therapies can offer a viable solution for managing skin health while minimizing the risks associated with conventional treatments. The paper also explores the challenges and opportunities that lie in the integration of plant-based therapies into mainstream dermatological practice.(2)

2. Background of Skin Disorders

Skin disorders encompass a wide range of conditions that affect the skin's appearance and function, impacting individuals of all ages and backgrounds. These disorders can vary in severity, from mild irritations like rashes and acne to chronic conditions such as eczema, psoriasis, and rosacea, as well as infections caused by bacteria, fungi, or viruses. Skin conditions can have significant physical, psychological, and social consequences, often leading to discomfort, scarring, and lowered self-esteem. The prevalence of these disorders is high globally, with factors such as genetics, environmental influences, lifestyle choices, and immune system dysfunction contributing to their development. As a result, skin disorders represent a major health concern and are a leading cause of consultations in dermatology clinics. Despite advances in treatment options, many patients continue to seek alternative, less invasive solutions due to the side effects associated with traditional treatments.(3)

3. Plant-Based Therapies: A Historical Perspective

Plant-based therapies have been utilized for centuries in various cultures as a natural approach to treating a wide range of ailments, including skin disorders. Ancient civilizations, such as the Egyptians, Chinese, and Indians, have long recognized the healing properties of plants, incorporating them into their traditional medical practices. For instance, the use of aloe vera for soothing burns and wounds dates back to ancient Egypt, while turmeric has been a key ingredient in Ayurvedic medicine for its anti-inflammatory and healing properties. These natural remedies were often passed down through generations, valued not

only for their accessibility but also for their perceived safety and effectiveness.(4)

In more recent history, the scientific community began to investigate the pharmacological properties of plant-based compounds, leading to the isolation of bioactive molecules that could be used in modern medicine. Today, many pharmaceutical products are derived from plants, with plant-based therapies continuing to gain attention in dermatology. Their historical use as topical treatments for skin conditions such as acne, eczema, and wounds laid the foundation for contemporary research, which now focuses on understanding the mechanisms behind their therapeutic actions and potential for integration into modern healthcare systems.(5)

4. Bioactive Compounds in Plants and Their Therapeutic Benefits

Bioactive compounds in plants are naturally occurring chemical substances that contribute to the therapeutic properties of plant-based remedies. These compounds include alkaloids, flavonoids, terpenoids, phenolics, and essential oils, each of which exhibits specific biological activities that can benefit human health, particularly in the treatment of skin disorders. For example, flavonoids, which are potent antioxidants, help neutralize free radicals, reducing oxidative stress and inflammation in the skin. This makes them effective in managing conditions like acne, eczema, and psoriasis, where inflammation plays a key role.

Alkaloids, such as those found in plants like neem and chamomile, are known for their antimicrobial properties, which help combat bacterial and fungal infections on the skin. Terpenoids, which are abundant in essential oils like lavender and tea tree oil, also exhibit antimicrobial and anti-inflammatory effects, making them useful for treating conditions like acne and fungal infections. Furthermore, phenolic compounds, such as those found in green tea, possess antioxidant and anti-inflammatory properties that protect the skin from damage caused by environmental stressors and support skin regeneration.(6)

In addition to their therapeutic effects, these bioactive compounds often work synergistically, enhancing each other's efficacy when used in combination. As such, plant-based therapies offer a holistic approach to dermatological treatments, providing a natural alternative to synthetic drugs with fewer side effects.

5. Role of Plant-Derived Nanoparticles in Drug Delivery Systems

Plant-derived nanoparticles have emerged as a promising tool in drug delivery systems, particularly in the treatment of skin disorders. These nanoparticles, often formed from plant-based materials such as plant polysaccharides, proteins, or lipids, offer several advantages in improving the bioavailability, stability, and targeted delivery of therapeutic compounds. Their natural origin makes them biocompatible and biodegradable, reducing the risk of toxicity compared to synthetic nanoparticles.(7)

In dermatology, plant-derived nanoparticles can be used to encapsulate bioactive compounds found in plants, enhancing their stability and facilitating controlled release. For instance, nanoparticles can improve the penetration of active ingredients like flavonoids, alkaloids, and terpenes into the skin layers, ensuring that the therapeutic compounds are delivered directly to the site of action. This is particularly important for treating chronic skin conditions, where deep tissue penetration is often required for effective treatment.

Additionally, plant-derived nanoparticles have the potential to increase the solubility of poorly water-soluble compounds, enabling more effective treatment of conditions like acne and psoriasis. The surface properties of these nanoparticles can also be modified to enable targeted delivery to specific skin cells, further enhancing the therapeutic effects while minimizing side effects. Overall, the integration of plant-derived nanoparticles into drug delivery systems holds great promise for advancing plant-based therapies in dermatology, providing more efficient, sustainable, and safer treatment options for skin disorders.(8)

6. Prevalence and Impact of Skin Disorders

Skin disorders are among the most common health problems worldwide, affecting individuals of all ages, ethnicities, and socioeconomic backgrounds. It is estimated that up to 30% of the global population is affected by some form of skin condition at any given time. Conditions such as acne, eczema, psoriasis, and rosacea are particularly widespread, with acne being the most prevalent, especially among adolescents and young adults. Chronic skin conditions like eczema and psoriasis affect millions of people worldwide, causing persistent symptoms that require long-term management.(9)

The impact of skin disorders extends beyond physical discomfort, often leading to significant psychological distress. Individuals with visible skin conditions frequently experience social stigma,

which can result in feelings of self-consciousness, depression, and anxiety. For example, acne, though commonly associated with adolescence, can persist into adulthood, affecting one's confidence and quality of life. Conditions like eczema and psoriasis, which often involve flare-ups and relapses, can lead to emotional strain due to their unpredictable nature and visible symptoms.

Moreover, the economic burden of skin disorders is substantial, with individuals spending significant amounts on treatments, and healthcare systems allocating resources for dermatological consultations and interventions. The high prevalence, combined with the physical, emotional, and financial impacts, underscores the need for effective, accessible, and sustainable treatment options, including plant-based remedies, to address these widespread issues.(10)

7. Plant-Based Therapies: A Historical Perspective

Plant-based therapies have been a cornerstone of healthcare across various cultures for thousands of years, with many civilizations utilizing plants for their healing properties long before the advent of modern medicine. In ancient Egypt, for example, plants like aloe vera were used to treat burns and skin conditions, while the Greeks and Romans relied on herbs such as lavender and thyme for their medicinal benefits. Traditional Chinese medicine (TCM) and Ayurveda, systems of medicine that have existed for over two millennia, also heavily emphasize the use of plant-based remedies for treating a variety of ailments, including skin disorders. Plants such as ginseng, turmeric, and neem have been integral in these practices, valued for their anti-inflammatory, antimicrobial, and healing properties.(11)

With the dawn of modern science, interest in plant-based therapies surged, particularly as researchers began isolating and understanding the active compounds found in plants. The field of pharmacognosy, which studies the medicinal properties of natural products, emerged, leading to the discovery of several plant-derived drugs. The medicinal use of plant extracts, such as salicylic acid from willow bark (used in aspirin), and the alkaloid morphine from the opium poppy, revolutionized modern medicine. This shift highlighted the potential for plant-based compounds to provide effective treatments for a range of conditions, including dermatological issues.

In recent years, there has been a renewed interest in plant-based therapies, especially in the field of dermatology. With the growing concern over the side effects of synthetic chemicals in conventional skin treatments, many are turning to natural alternatives. The long-standing historical use of plants in treating skin disorders laid the foundation for contemporary research, which now focuses on understanding how plant-derived compounds can be used effectively in modern dermatological practices.(12)

8. Mechanisms of Action of Plant-Based Compounds

The therapeutic effects of plant-based compounds in the treatment of skin disorders are primarily due to their bioactive properties, which include anti-inflammatory, antimicrobial, antioxidant, and wound-healing actions. These compounds interact with various biological pathways in the body to address the underlying causes of skin conditions.(13)

Anti-inflammatory Action: Many plant-derived compounds, such as flavonoids, terpenes, and phenolic acids, possess strong anti-inflammatory properties. These compounds inhibit the activity of pro-inflammatory cytokines and enzymes like cyclooxygenase (COX) and lipoxygenase (LOX), which are involved in the inflammatory response. By reducing inflammation, these compounds help alleviate symptoms of conditions like eczema, psoriasis, and acne, where inflammation plays a central role in the disease process.

Antimicrobial Activity: Certain plant-based compounds, particularly alkaloids, essential oils, and saponins, exhibit potent antimicrobial effects. They can target a broad spectrum of bacteria, fungi, and viruses, making them effective in treating skin infections such as acne, fungal dermatitis, and wound infections. For instance, tea tree oil, known for its antimicrobial properties, is commonly used in acne treatments to reduce the presence of *Propionibacterium acnes*, the bacteria responsible for acne breakouts.

Antioxidant Effects: Oxidative stress, caused by an imbalance between free radicals and antioxidants in the skin, is a significant factor in the development of aging and skin damage. Plant compounds like flavonoids (found in green tea) and polyphenols (found in grapes and pomegranates) neutralize free radicals, thereby protecting the skin from oxidative damage, preventing premature aging, and promoting healthier skin.

Wound Healing and Regeneration: Several plant compounds, such as those in aloe vera and calendula, are known to accelerate wound healing by promoting collagen synthesis, improving tissue regeneration, and enhancing cell proliferation. These compounds stimulate the repair of damaged skin and help reduce scarring, making them effective in treating minor burns, cuts, and other skin injuries.

Immunomodulatory Effects: Some plant-based compounds, like those found in echinacea and neem, help modulate the immune response. They can enhance the body's defense mechanisms, promoting the healing of skin disorders caused by immune system dysfunction, such as psoriasis and atopic dermatitis.(14)

9. Clinical Evidence Supporting Plant-Based Skin Remedies

Clinical evidence supporting the use of plant-based remedies in treating skin disorders has been steadily growing, with numerous studies highlighting their efficacy and safety. Research has shown that plant-derived compounds offer significant therapeutic benefits, particularly in managing common dermatological conditions such as acne, eczema, psoriasis, and wound healing.(15)

Acne Treatment: Several studies have demonstrated the effectiveness of plant-based compounds in treating acne. A clinical trial published in the *Journal of Dermatology* found that topical applications of tea tree oil, which contains terpinen-4-ol, significantly reduced acne lesions and inflammation compared to a placebo. The antimicrobial properties of tea tree oil help target *Propionibacterium acnes*, the bacteria responsible for acne, while also reducing redness and swelling.

Eczema and Psoriasis: Clinical trials have shown that plant-based remedies such as aloe vera, chamomile, and turmeric are beneficial in managing eczema and psoriasis. A study published in *Phytomedicine* found that aloe vera gel significantly reduced symptoms of eczema, including itching and inflammation, when applied topically. Similarly, turmeric, with its active compound curcumin, has been shown to reduce inflammation and improve the condition of psoriatic skin by inhibiting pro-inflammatory cytokines. The anti-inflammatory and antioxidant properties of these plants contribute to symptom relief and disease control.

Wound Healing: The healing properties of plant-based therapies are well-documented, particularly in the use of aloe vera and calendula. A clinical study published in the *American Journal of Clinical*

Dermatology found that aloe vera accelerated the healing of minor burns and wounds, reducing pain and inflammation while promoting tissue regeneration. Calendula, a plant known for its antimicrobial and anti-inflammatory effects, has been shown to enhance wound healing by stimulating collagen production and promoting cell regeneration, according to a study published in *Wounds*.

Fungal Infections: Fungal skin infections, such as athlete's foot and ringworm, have also been successfully treated with plant-based remedies. A study in the *Journal of Ethnopharmacology* showed that tea tree oil effectively reduced fungal infections by inhibiting the growth of *Candida albicans* and *Trichophyton rubrum*, common pathogens associated with fungal skin conditions. Additionally, extracts from garlic and oregano have demonstrated antifungal activity in clinical trials, supporting their use in treating dermatophyte infections.

Anti-aging and Skin Protection: Clinical evidence also supports the use of plant-based antioxidants, such as green tea polyphenols and grape seed extract, in protecting the skin from oxidative damage and reducing signs of aging. A study published in *Skin Pharmacology and Physiology* found that green tea extract, rich in catechins, helped reduce sun damage and improved skin elasticity in individuals with photodamaged skin. Similarly, grape seed extract has been shown to protect the skin from UV-induced damage and promote collagen synthesis, which is vital for maintaining skin firmness and reducing wrinkles.

Overall, the clinical evidence strongly supports the inclusion of plant-based remedies in dermatological treatments. Their efficacy in managing a wide range of skin disorders, combined with their natural origin and minimal side effects, positions them as valuable alternatives to synthetic treatments. However, further research and well-designed clinical trials are necessary to fully understand their mechanisms and optimize their use in dermatological care.(16)

10. Plant-Based Nanoparticles and Their Role in Drug Delivery

Plant-based nanoparticles have emerged as a revolutionary tool in drug delivery systems, particularly for skin-related treatments. These nanoparticles are derived from plant materials such as polysaccharides, proteins, lipids, or plant-based polymers, and they offer significant advantages over traditional drug delivery systems. Their natural origin makes them biocompatible, biodegradable,

and environmentally friendly, which is especially important in dermatology where safety is paramount.

Enhanced Bioavailability and Targeted Delivery:

One of the key advantages of plant-derived nanoparticles is their ability to enhance the bioavailability of bioactive compounds that might otherwise be poorly absorbed by the skin. By encapsulating active ingredients such as flavonoids, terpenes, or alkaloids, these nanoparticles improve the stability and solubility of the compounds, allowing for deeper penetration into the skin layers. This is particularly beneficial for treating conditions like psoriasis, eczema, and acne, where targeted delivery to specific skin cells is essential for effectiveness.

Controlled Release and Reduced Side Effects:

Plant-based nanoparticles allow for controlled and sustained release of therapeutic compounds, which helps in maintaining therapeutic levels over a prolonged period. This controlled release minimizes the risk of side effects, as the active ingredients are gradually released, ensuring that high concentrations do not cause irritation or damage to the skin. This is particularly useful in the treatment of chronic skin conditions, where long-term management is required.(17)

Improved Skin Penetration: Due to their nanoscale size, plant-based nanoparticles can penetrate the skin more efficiently than larger particles or conventional formulations. This improves the therapeutic action of the encapsulated compounds by allowing them to reach deeper layers of the skin, where they can have a more significant effect. For example, nanoparticles made from plant-based materials like chitosan or cellulose have been shown to enhance the penetration of drugs into the dermis and epidermis, the deeper layers of the skin.

Antioxidant and Anti-inflammatory Effects:

Many plant-based nanoparticles are rich in natural antioxidants and anti-inflammatory compounds, which can provide additional therapeutic benefits. For instance, nanoparticles derived from green tea polyphenols or turmeric curcumin have demonstrated anti-inflammatory and antioxidant properties that can help reduce oxidative stress and inflammation in the skin. This makes them particularly useful in treating inflammatory skin conditions such as acne, rosacea, and atopic dermatitis.

Targeted Action for Skin Disorders: The surface properties of plant-based nanoparticles can be

modified to enhance their specificity for certain types of skin cells. By functionalizing the nanoparticles with targeting molecules such as antibodies or peptides, they can be directed to specific areas of the skin, increasing the efficiency of the treatment. This targeted approach ensures that the therapeutic compounds are delivered precisely where needed, minimizing the risk of unwanted systemic effects.

Sustainability and Safety: Unlike synthetic nanoparticles, plant-derived nanoparticles are biocompatible, biodegradable, and generally considered safer for use on the skin. Their natural origin makes them less likely to cause long-term harm or irritation, which is particularly important in skincare products. Furthermore, the sustainability aspect of using plant-based materials in nanoparticle production contributes to their appeal in green chemistry and eco-friendly skincare formulations.(18)

11. Rise of Plant-Based Remedies in Dermatology

The rise of plant-based remedies in dermatology reflects a growing trend toward natural and holistic approaches to skincare, driven by increasing concerns over the side effects and long-term risks associated with synthetic chemicals. This shift toward plant-based therapies is largely influenced by both consumer demand for safer, eco-friendly alternatives and scientific research supporting the efficacy of plant-derived compounds.

Growing Consumer Awareness: In recent years, there has been a significant increase in consumer interest in natural, organic, and sustainable skincare products. People are becoming more aware of the potential harm caused by chemical-based ingredients in conventional dermatological treatments, such as corticosteroids, parabens, and synthetic fragrances. This has led to a surge in demand for plant-based remedies, which are often perceived as safer, gentler, and less likely to cause irritation or adverse reactions. Products containing natural ingredients like aloe vera, tea tree oil, and calendula have gained popularity due to their well-known healing properties and minimal side effects.

Scientific Validation of Plant-Based Compounds:

Research into the bioactive compounds found in plants has provided scientific validation for the use of plant-based remedies in dermatology. Studies have shown that many plant-derived compounds, such as flavonoids, terpenes, and polyphenols, possess anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. These

compounds target the underlying causes of skin conditions like acne, eczema, and psoriasis by reducing inflammation, fighting infections, and promoting skin regeneration. Clinical trials and laboratory studies have further demonstrated the therapeutic benefits of plants such as turmeric, chamomile, and lavender, paving the way for their integration into modern dermatological treatments.(19)

Shift Toward Holistic and Preventative Care:

Another reason for the rise of plant-based remedies is the increasing focus on holistic and preventative skincare. While conventional dermatology often emphasizes treating symptoms with chemical formulations, plant-based approaches tend to focus on healing the skin from within, restoring balance, and preventing future flare-ups. Plants like neem, aloe vera, and calendula work not only to soothe existing skin conditions but also to strengthen the skin's natural barrier and improve its resilience over time. This holistic perspective aligns with broader trends in healthcare, where consumers are seeking natural, preventive solutions rather than relying solely on pharmaceutical treatments.

Sustainability and Eco-Friendly Practices: As environmental concerns continue to grow, sustainability has become a key factor in the rise of plant-based remedies. The demand for eco-friendly and cruelty-free products has prompted many companies to develop skincare lines that prioritize plant-derived ingredients over synthetic chemicals. Additionally, plant-based ingredients are often biodegradable and require fewer resources to produce compared to their synthetic counterparts, making them more sustainable for both consumers and the planet. This eco-conscious approach to dermatology has further fueled the popularity of plant-based remedies.

Integration into Modern Dermatology: As more dermatologists and healthcare professionals recognize the benefits of plant-based remedies, there has been a gradual integration of these treatments into mainstream dermatology. Many dermatologists now recommend plant-based ingredients as adjunctive therapies for managing conditions like acne, eczema, and psoriasis. The use of plant-derived compounds in clinical settings, often in conjunction with conventional treatments, allows for a more balanced and personalized approach to skin health. Moreover, advancements in formulation technologies, such as plant-derived nanoparticles, have enhanced the efficacy and delivery of these

natural ingredients, making them more effective in treating complex skin conditions.(20)

In summary, the rise of plant-based remedies in dermatology is a response to consumer demand for safer, more natural alternatives to synthetic treatments. Supported by scientific research and a growing emphasis on sustainability, plant-based therapies are becoming an integral part of modern skincare. As awareness and research continue to expand, the role of plant-based remedies in dermatology is likely to grow, offering more effective and eco-friendly solutions for managing a wide range of skin conditions.

12. Conclusion

In conclusion, plant-based remedies represent a promising and effective alternative to conventional dermatological treatments, offering a natural approach to managing a wide range of skin disorders. With their anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties, plant-derived compounds such as flavonoids, terpenes, and polyphenols have shown significant therapeutic potential in treating conditions like acne, eczema, psoriasis, and fungal infections. The growing consumer demand for safer, eco-friendly, and sustainable skincare products, combined with increasing scientific validation of the efficacy of plant-based treatments, has led to their rising popularity in dermatology.

The integration of plant-based therapies into modern dermatology is further enhanced by innovations in drug delivery systems, such as plant-derived nanoparticles, which improve the bioavailability and targeted delivery of active compounds to the skin. While challenges remain, such as the need for more extensive clinical trials and the optimization of formulations, the future of plant-based remedies in dermatology looks promising. By continuing to explore and harness the healing potential of plants, dermatology can offer patients safer, more sustainable, and effective treatment options that prioritize both skin health and overall well-being.

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