

A Review On Antimicrobial Activity Of Aloe Barbadensis And Ocimum Gratissimum Against Acne Causing Bacteria

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Abstract

Acne vulgaris is a frequent, chronic skin disease that primarily occurs in teenagers and young adults. It arises as the result of a variety of factors, such as overproduction of oil, blocked hair follicles, bacteria—particularly *Cutibacterium acnes*—and immune system-driven inflammation. Though antibiotics have been utilized to treat acne for many years, they are gradually losing their efficacy as a result of developing resistance and adverse effects. Consequently, there is growing demand for natural and safer treatment alternatives. In this review, two promising medicinal plants—*Aloe barbadensis* (popularly referred to as *Aloe vera*) and *Ocimum gratissimum* (also known as clove basil)—are examined and their potential in the management of acne. *Aloe vera* has been long recognized for its calming, antibacterial, anti-inflammatory, and healing properties due to its dense composition of natural compounds such as polysaccharides, vitamins, and antioxidants. Clove basil, on the other hand, is loaded with potent compounds such as eugenol and flavonoids that not only combat bacteria, fungi, and inflammation but also contribute to reducing acne symptoms and breakouts when used singly or in combination with other therapies. Nevertheless, there must be additional clinical studies to prove their efficacy as well as to create standardized, dependable products. With increasing interest in natural and environmentally friendly skin care, these botanical alternatives could provide a safe and viable alternative in acne therapy.

Keywords: *Acne vulgaris*, *Aloe barbadensis* (*Aloe vera*), *Ocimum gratissimum*, Phytochemical, Acne treatment, Antioxidants, Antifungal.

1. INTRODUCTION

Acne is among the most common skin unrest, whose treatment dermatologists are still grappling with after years. It basically strikes teenagers, though it may occur at any age of life. It is nearly a cosmopolitan illness occurring in all the races and in 94% of 16-year-old boys and 82% of 16-year-old girls to some extent (Vora et al., 2017). The prevalence of severity of acne reaches 41% among 13-18-year-old girls and 35% in 17-20 year old boys (Kim et al., 2017).

A long-standing inflammatory disease of the pilosebaceous unit, acne vulgaris chiefly targets adolescents and young adults. Its pathogenesis is multifactorial, comprising hyperseborrhea, hyperkeratinization of the follicle, microbial colonization, and inflammation mediated by the immune system. Among the principal microbial pathogens involved, *Cutibacterium acnes* (previously *Propionibacterium acnes*) is a primary player in cutting the ignition and perpetuating inflammatory processes within the skin.

Sebaceous gland present on the skin secretes an oily substance known as 'sebum' which creates a favorable medium for the growth of *C. acnes*, especially under anaerobic conditions. The bacterium catabolizes sebum

triglycerides through lipase enzymes to produce free fatty acids that damage the follicular epithelium and evoke local inflammation. This leads to a cascade of immune reactions typified by the release of pro-inflammatory cytokines like interleukin-8 (IL-8), which invites neutrophils to the site of infection.

Activated neutrophils release reactive oxygen species (ROS) and proteolytic enzymes in an effort to kill the invading microbes. But their hyper-response also causes collateral damage to the tissues, sustaining inflammation, and giving rise to pustules, nodules, and cysts. Persistent existence of neutrophils, along with cellular debris and microbial residues, gives rise to pus and characteristic acne lesions.

Cutibacterium acnes (*Propionibacterium acnes*) is characterized as an obligate anaerobic organism. It is also implicated in inflammatory acne due to its capacity to activate complements and due to its capacity to convert sebaceous triglycerides into fatty acids that are chemotactically attracted to neutrophils. In contrast, *Staphylococcus epidermidis*, which is an aerobic organism, generally participates in superficial infections in the sebaceous unit (Burkhart et al., 1999).

The medicinal plants have drawn growing attention due to their antimicrobial susceptibility towards the pathogenic oral microorganisms. Plants that are used for traditional medicine have a broad variety of substances which can be utilized to cure infectious and chronic diseases (Ali et al., 2016).

Medicinal plants discovery has become significant in the identification of bioactive natural compounds with the ability to inhibit the mechanisms of various microbials. In the World Health Organization (WHO) report of antimicrobial resistance, in the year 2014, defeating the antibiotic resistance is the greatest challenge to the WHO of the next millennium. Plant screening for antimicrobial agents has become highly significant because WHO is promoting and urging in the utilization and development of medicinal plants traditional system of medicine resources. Consequently, the past decade saw an upsurge in the exploration of plants as the source of human infectious disease control (Mickymaray et al., 2016).

The growing prevalence of antibiotic resistance and recidivism of acne vulgaris have created more demand for alternative and sustainable therapeutic practices. Among various biological sources, medicinal plants have been of immense scientific interest due to their vast diversity of bioactive compounds known as phytochemicals, which exhibit broad-spectrum antimicrobial action.

A number of plants belonging to various taxonomic families have shown significant antimicrobial activity against bacteria implicated in acne, and this has largely been credited to secondary metabolites like alkaloids, flavonoids, terpenoids, phenolics, and essential oils. The plant compounds are active against microorganisms through mechanisms such as microbial cell membrane disruption, inhibition of enzyme systems, interference with quorum sensing, and modulation of host inflammatory pathways.

2. *Aloe barbadensis*

Aloe barbadensis, otherwise referred to as *Aloe vera*, is a succulent, fleshy plant that contains water in leaves and is a member of the Asphodelaceae family. While it naturally occurs on the Arabian Peninsula, it is presently cultivated extensively in tropical climates all over the globe, such as in India, Africa, and some parts of the Americas. *Aloe vera* has been employed for centuries as a natural treatment for burns, cuts, skin irritation, acne, and gastrointestinal problems. Today, it's also widely used as an ingredient in cosmetics and skin care products, particularly in moisturizers, gels, and shampoos, due to its calming and moisturizing properties.

Table 1 Taxonomical classification of *Aloe barbadensis*

CATEGORY	CLASSIFICATION
Kingdom	Plantae
Sub-Kingdom	Tracheobionta
Division	Magnoliophyta
Class	Liliopsida
Order	Asparagales
Family	Asphodelaceae
Genus	<i>Aloe</i>

Species	Aloe vera (L.) Burm.f.
Binomial Name	Aloe vera (L.) Burman f.

2.1 Phytochemical composition and properties of Aloe barbadensis.

Aloe barbadensis leaf juice, which comes from the Aloe vera plant, has attracted a lot of attention from researchers for its potential to help treat acne. Aloe vera is a succulent plant that has been used for centuries in traditional medicine because of its many healing properties. Some known properties of aloe vera includes inflammation, rapid wound healing, and maintaining the skin hydrated. Because of these benefits, it's commonly found in skincare products and treatments for various skin issues.

This review emphasizes the antimicrobial efficacy of Aloe barbadensis leaf juice (ALBJ), particularly against acne-associated microorganisms. The plant's therapeutic relevance lies in its ability to mitigate bacterial proliferation and reduce inflammation, two critical factors in the pathogenesis of acne. A detailed examination of Aloe vera's phytochemistry reveals a diverse composition of bioactive compounds that contribute to its dermatological benefits.

Aloe barbadensis belongs to the family Asphodelaceae and is characterized by thick, serrated leaves containing a mucilaginous gel. The gel extracted from the parenchymatous tissues of the leaves contains an array of phytochemicals responsible for its medicinal properties. Its key constituents include polysaccharides, anthraquinones, vitamins, minerals, enzymes, amino acids, and plant sterols, all of which contribute synergistically to its biological activity (Manvitha & Bidya, 2014; Sánchez-Machado et al., 2017).

Polysaccharides, primarily acemannan and glucomannans, are among the most significant constituents. These exhibit potent immunomodulatory, wound-healing, anti-inflammatory, and antimicrobial activities (Boudreau & Beland, 2006; Hamman, 2008). Anthraquinones such as aloin and barbaloin also contribute to Aloe's antimicrobial action, although their laxative properties and potential toxicity at high doses necessitate careful usage (Egbuna et al., 2020).

In addition, Aloe vera is abundant in antioxidant vitamins—A, C, and E—which scavenge free radicals, reduce oxidative stress, and promote dermal repair (Ahmed & Hussain, 2013). Its mineral profile, comprising zinc, magnesium, calcium, and selenium, is critical for maintaining skin structure, immune regulation, and tissue healing (Nandal & Bhardwaj, 2012). These elements are essential for skin homeostasis and contribute to the prevention and resolution of acne lesions.

Enzymes present in Aloe vera, including amylase and lipase, support exfoliation through the breakdown of dead skin cells, aiding in skin renewal and the prevention of follicular obstruction. Amino acids in the gel serve as the foundational components of skin proteins and contribute to collagen synthesis, enhancing skin elasticity and repair mechanisms (Jadhav et al., 2020).

Collectively, these phytochemicals account for the antimicrobial, anti-inflammatory, and regenerative properties of Aloe vera. The bioactive synergy among these compounds enhances the plant's efficacy in managing acne by targeting both microbial factors and the inflammatory responses associated with acne pathophysiology. Scientific literature supports the view that Aloe vera can be a beneficial adjunct or alternative to conventional acne therapies, with a favorable safety profile when used topically on various skin types.

2.2 Aloe Vera Helps with Acne: A Look at the Scientific Evidence.

Recent advancements in dermatological research have thoroughly explored the therapeutic potential of Aloe barbadensis leaf juice (ALBJ) for acne treatment. Numerous studies indicate that Aloe vera is effective in decreasing acne severity and enhancing skin health, which has made it a focal point in both clinical and cosmetic dermatology (Bilal et al., 2023; Hajheydari et al., 2014). A considerable body of work has examined its antibacterial properties, particularly its ability to inhibit the proliferation of *Propionibacterium acnes* (now classified as *Cutibacterium acnes*), a major contributor to acne development. Laboratory studies have demonstrated that Aloe vera extracts are capable of suppressing bacterial growth, indicating strong natural antimicrobial potential (Abiya et al., 2018).

In addition to laboratory-based findings, clinical trials—especially double-blind, placebo-controlled studies—have shown that applying Aloe vera topically can significantly reduce both the number and intensity of acne lesions.

Participants using Aloe vera-containing formulations consistently reported better outcomes compared to placebo groups (Hajheydari et al., 2014; Mazzarello et al., 2018). These benefits are largely due to Aloe vera's anti-inflammatory effects, which help relieve acne-related symptoms such as swelling, redness, and irritation (Mazzarello et al., 2018; Zhong et al., 2021).

Moreover, Aloe vera's healing benefits extend beyond its antibacterial and anti-inflammatory actions. The bioactive components, particularly its polysaccharides and essential vitamins, are known to promote wound healing and aid in tissue regeneration, which can reduce the long-term impact of acne, such as scarring and postinflammatory hyperpigmentation (Hamman, 2008; Saleem et al., 2022). However, therapeutic outcomes may vary depending on individual skin characteristics, acne severity, and formulation differences (Ghosh et al., 2011). Altogether, the evidence supports the use of Aloe barbadensis leaf juice as a supportive agent in acne care. Its combined antibacterial, anti-inflammatory, and skin-repairing properties highlight its value as a natural alternative or adjunct to conventional acne treatments. Nonetheless, further comprehensive studies are needed to determine the most effective product formulations and application guidelines to ensure safe and consistent therapeutic use (Jiang et al., 2016; Lanka, 2018).

2.3 Aloe Vera in Combination Therapies.

Aloe barbadensis leaf juice is often incorporated into skincare products alongside other acne-fighting compounds to improve treatment outcomes (Goyal & Jerold, 2021). It is commonly formulated with well-established agents like benzoyl peroxide, salicylic acid, and retinoids. For instance, Aloe vera used in conjunction with benzoyl peroxide may enhance antibacterial efficacy while simultaneously reducing the skin irritation frequently associated with benzoyl peroxide treatments (Zuberi et al., 2022; Kapoor & Lata Saraf, 2011; Tanghetti & Popp, 2009).

Similarly, salicylic acid, a widely used exfoliant known for its pore-cleansing capabilities, may lead to dryness or sensitivity. Aloe vera, when co-administered, may help counteract these side effects by calming the skin, promoting cellular turnover, and assisting in the healing of acne lesions (Kanlayavattanakul & Lourith, 2011). These synergistic interactions suggest Aloe vera's potential as a supportive agent in integrated acne management regimens, enhancing both therapeutic efficacy and patient tolerance.



Figure 1 Plant of Aloe barbadensis

3. Ocimum gratissimum

Ocimum gratissimum, commonly referred to as clove basil, wild basil, or African basil, is a popular medicinal herb that's been extensively used throughout Africa, Asia, and other parts of the tropics. It has been a respected component of traditional medicine for centuries, not just for its use in treating ailments but also for its spiritual and cultural significance. Indeed, the World Health Organization has estimated that roughly 80% of the population in developing nations continues to use traditional medicine for their basic healthcare (WHO, 2002). In India, clove basil has a treasured position in Ayurveda, where it has been utilized over generations for skin

infections, digestive issues, and diarrhea. It is even referred to in the old text Charaka Samhita, where it is hailed as an "elixir of life" (Saxena & Sharma, 2015).

Ocimum gratissimum can grow to a height of 1 meter with fragrant leaves, dark brown stem, and flowers that are cream in color. It can grow in tropical and subtropical regions and has spread far and wide to places such as Africa, Madagascar, Southern Asia, Hawaii, Brazil, and Mexico (Paton et al., 2008). It is a resilient plant and can easily spread rapidly, at times to the point of outcompeting indigenous species (Randrianarivelojosia et al., 2003).

3.1 Medicinal Benefits and Properties

Ocimum gratissimum is filled with natural substances that render it a potent medicinal plant:

3.1.1. Antioxidant Power

It is utilized to prepare antioxidant powders because it contains high amounts of bioactive compounds like flavonoids, phenolic acids, eugenol, and vitamins C and E. These compounds assist in fighting oxidative stress by quenching free radicals. Preparation starts with the harvesting of fresh leaves that are subsequently washed, sun-dried (to maintain sensitive antioxidants), and pulverized into a fine powder. In others, secondary extraction with water or ethanol can be performed to concentrate the antioxidant contents. The extracts are dried by processes such as freeze-drying or spray drying to increase potency. The final powder is kept in airtight, light-proof containers to preserve its stability and efficacy. This powder, which is rich in antioxidants, is globally used in nutraceuticals, functional foods, cosmetics, and pharmaceuticals for its natural capacity to enhance immune function, retard aging, and safeguard the body against cellular damage.

3.1.2. Anti-Acne properties

Ocimum gratissimum (clove basil) assists in the control of inflammation caused by acne because of its high concentration of anti-inflammatory substances such as flavonoids, phenolic acids, and eugenol. Such bioactive substances act through suppressing the formation of pro-inflammatory cytokines and enzymes such as COX-2, which are accountable for redness, swelling, and inflammation in inflamed acne. Studies in experimental animals, such as carrageenan-induced paw edema in rats, have demonstrated the reduction of inflammation by *Ocimum gratissimum* extracts by 50–200 mg/kg. Its essential oil is also calming when used topically, soothing irritated skin and minimizing acne-related redness and pain. Aside from its anti-inflammatory activity, *Ocimum gratissimum* is also endowed with robust antibacterial activity against *Propionibacterium acnes* and *Staphylococcus aureus*, the causative agents of acne, providing a twin therapeutic benefit. Such dual action is especially beneficial in natural therapy for acne.

3.1.3. Antibacterial Activity

Ocimum gratissimum (clove basil) possesses strong antimicrobial activity due to its high content of essential oils and bioactive compounds such as eugenol, thymol, carvacrol, flavonoids, and alkaloids. These compounds act by disrupting the microbial cell membrane, causing leakage of crucial cell contents and ultimately causing cell death. Some of the compounds also interfere with bacterial enzymes and protein synthesis, while others interfere with microbial metabolic processes. The plant shows efficacy against many bacteria including *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., and *Pseudomonas aeruginosa*, and fungi like *Candida albicans* and *Trichophyton rubrum*. Its antimicrobial activity varies based on its form, being the most in the essential oils and ethanol extracts. *O. gratissimum* is widely used in traditional medicine to cure skin infections, gastrointestinal diseases, and wounds and has greater potential for use in the pharmaceutical, food preservation, and cosmetic industries based on its intrinsic antimicrobial property (Akinyemi et al., 2006; Pessoa et al., 2002; Ilori et al., 1996).

3.1.4. Antifungal Activity

Ocimum gratissimum (clove basil) has a powerful antifungality mostly based on its high content of bioactive compounds such as eugenol, thymol, carvacrol, and linalool in its essential oil. Such compounds act by disturbing the cell membrane of fungi, resulting in leakage of cellular materials and eventually cell death. Research has revealed that *O. gratissimum* efficiently suppresses the growth of most fungal pathogens such as *Trichophyton rubrum*, *Microsporum canis*, *Rhizoctonia* sp., *Alternaria* sp., and *Colletotrichum* sp., which are typical to skin diseases and plant infections. Both the essential oils and the hot water, ethanol, or hexane extracts have shown strong antifungal activity, with the hexane extract typically displaying maximum inhibition. Conventionally, the plant is applied in traditional herbal medicines to cure fungal diseases like ringworm and athlete's foot, whereas

contemporary uses are in antifungal creams, sprays, food preservation, and agricultural disease management. The above findings identify the therapeutic value of *Ocimum gratissimum* as an antifungal phytochemical agent.

3.1.5. Phytochemical Profile

Ocimum gratissimum (African basil or clove basil) is a herb that contains a rich mixture of a broad range of phytochemicals that underlie its medicinal value. These are flavonoids, phenolic acids, eugenol, alkaloids, tannins, saponins, steroids, and glycosides.

The oil of *O. gratissimum* is particularly prized for its high eugenol content (30–65%), as well as thymol, linalool, and carvacrol, that collectively impart potent antimicrobial activity. Phytochemical type and concentration depend on the solvent for extraction—aqueous and ethanol extracts contain flavonoids and phenols, whereas hexane extracts provide higher essential oils.

Qualitative phytochemical tests have confirmed the presence of these compounds through standard methods like Ferric Chloride Test for phenols, Salkowski's for steroids, and Mayer's for alkaloids. These phytochemicals not only offer medicinal benefits but also form the basis for the plant's use in traditional remedies and modern formulations for treating infections, inflammation, oxidative stress, and more.



Figure 2 Plant of *Ocimum gratissimum*

4. CONCLUSION

This research highlights the therapeutic utility of herbal plant remedies, namely *Aloe barbadensis* (Aloe vera) and *Ocimum gratissimum* (clove basil), to treat *acne vulgaris*, an inflammatory cutaneous disorder. Acne is fueled by microbial colonization, overproduction of sebum, and inflammation mediated by the immune system. Natural agents are becoming increasingly popular following the limitations and drug resistance issues posed by conventional therapies. Aloe vera has antimicrobial, anti-inflammatory, antioxidant, and wound-healing effects primarily caused by its high phytochemicals such as polysaccharides, anthraquinones, and vitamins. In addition to fighting *Cutibacterium acnes*, it strengthens the effectiveness of traditional acne medications when applied simultaneously. Likewise, *Ocimum gratissimum* has powerful antibacterial, anti-inflammatory, antifungal, and antioxidant properties caused by substances such as eugenol and flavonoids. Its action against acne-producing bacteria and inflammation renders it a useful holistic skin remedy. Generally, the two plants offer promising, safe, and efficient solutions for the treatment of acne, but clinical studies are required to standardize their formulations and maximize their application.

5. Future Aspects

The potential future application of medicinal plants like *Aloe barbadensis* (Aloe vera) and *Ocimum gratissimum* (clove basil) in the fight against acne-causing bacteria has great promise across many frontiers. Both plants display potent antimicrobial activity against *Cutibacterium acnes* and *Staphylococcus aureus*, which opens the door towards creating natural topical products such as gels, creams, and cleansers. With increasing antibiotic resistance, these innovative plant-derived agents are on the horizon as promising alternatives or adjuncts to traditional antibiotics, reducing dependency and risks of resistance. Their combination with conventional

dermatological therapies, including benzoyl peroxide or salicylic acid, can maximize therapeutic activity with a decrease in side effects, giving credence to the theory of Ireland synergistic herbo-synthetic mixtures. In addition, their anti-inflammatory, antioxidant, and wound-healing properties are compliant with the increasing trend of individualized and integrated acne care. Further improvement in nanotechnology may further enhance delivery and efficacy of these phytochemicals using nanoformulations. For consistency and effectiveness, future studies will require standardization of phytochemical profiles, identification of optimal dosages, and clinical trials for the verification of safety and therapeutic effects. Moreover, as the interest in sustainable and green skincare among consumers increases, Aloe vera and clove basil are excellent candidates for plant-derived, biodegradable, and cruelty-free cosmetics. Nonetheless, to fully integrate them into contemporary dermatological practice, stronger clinical verification is needed, specifically to know more about their long-term implications and interactions with other therapeutic drugs.

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