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Research article

## From nature to skin: A Comprehensive Review of Anti-Acne Herbs and Their Efficacy

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**Abstract:** The human skin, the body's largest organ, serves as a vital barrier against various pathogens and environmental factors while playing a key role in fluid retention and overall homeostasis. Structurally, it consists of three distinct layers: the epidermis, dermis, and hypodermis-each contributing to essential physiological functions such as temperature regulation, sensory perception, and the synthesis of vitamin D under UV exposure. Skin disorders, particularly acne vulgaris, are prevalent worldwide, impacting over 80% of adults at some point in their lives. Acne is primarily triggered by bacteria, including *Propionibacterium acnes*, which boom in clogged pores. Conventional treatments for acne, such as antibiotics and retinoids, though effective, often lead to significant adverse effects, including skin irritation, dryness, and, importantly, the development of antibiotic resistance. In response to these challenges, there is an increasing shift towards herbal therapies, which are gaining popularity for their efficacy, lower toxicity, and minimal side effects. This paper provides a comprehensive review of the role of medicinal plants in acne treatment, emphasizing their phytochemical constituents and mechanisms of action. By exploring the antimicrobial, anti-inflammatory, and antioxidant properties of these natural remedies, the review highlights the potential of herbal treatments as safer and more sustainable alternatives to conventional therapies, offering new avenues for acne management with fewer risks and greater patient compliance.

**Keywords:** Epidermis, hypodermis, acne vulgaris, *Propionibacterium acnes*, antibiotics, medicinal plants

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### Introduction

The human skin serves as both the body's largest organ and its first line of defence, shielding us from various illnesses and assisting in the retention of bodily fluids. It is made up of different cells and structures. The dermis, hypodermis, and epidermis are the three layers of skin. They are all different in thickness and have important functions to perform. Skin functions include temperature regulation, senses, water resistance, UV light-induced vitamin D production, and insulation (Madison, 2003; Costa et al., 2010). Skin disorders are common medical problems that can affect people of all ages, from

infants to the elderly, and cause a range of injuries. Over a thousand different diseases can damage the skin, but most skin diseases are: rashes, scabies, vitiligo, psoriasis, pigmentation disorders, parasitic infections, and acne vulgaris (Srivastav et al., 2024). Amongst all, acne vulgaris is the most common dermatological condition, affecting more than 80% of adults (Proença et al., 2024). The Greek word "acme," which means "prime of life," is where the phrase acne originates. A skin condition known as acne can cause a breakout of lesions known as pimples or zits. Common pus-forming bacteria called *Propionibacterium acnes* and *Staphylococcus epidermidis* are in charge of causing different types of acne (Sinha et al., 2014). Acne can be categorized into whiteheads, blackheads, papules, pustules, nodules, and cysts (Agarwal & Jindal, 2023). There are numerous treatments for the treatment of acne based on their type and severity and include the usage of retinoid, isotretinoin, antibiotics, antimicrobials, and hormone therapy (Asad et al., 2002; Katsambas et al., 2004). The adverse effects of allopathic drugs include skin response, allergy, diarrhoea, skin irritation, and soreness at the injection site. They also include high treatment costs. Immunosuppressants can lead to appetite loss, cutaneous cancer, and immune system weakening (Ahuja et al., 2021). In addition, extended use of medications can lead to resistance of acne-causing bacteria to the drugs. Compared to allopathic medicines, herbal therapy is becoming more popular because of its low toxicity and side effects (Dey et al., 2014). This paper aims to provide a comprehensive review of the medicinal plants used in the treatment of acne, focusing on their phytochemical properties and therapeutic potential to offer safer, more effective solutions for acne management.

### **Aetiology and Progression of Acne**

The epidermal cells that surround hair follicles are constantly changing. Dead skin cells are transported to the skin's surface by sebum, which is generated by the sebaceous glands. During puberty, hormonal changes increase sebum production and the shedding of skin cells within the hair follicle. This accumulation of sebum and dead cells can clog the follicle, causing it to swell as more sebum is produced, resulting in a 'comedo.' In these clogged follicles, bacteria can multiply, leading to inflammation. Comedones are generally classified as 'closed' comedones, or whiteheads, which form when the plug remains under the skin, appearing as a creamy white or skin-coloured bump. An 'open' comedo, or blackhead, occurs when the buildup of sebum pushes the plug to the skin's surface, where it darkens due to exposure to air and the presence of melanin. Inflamed acne lesions, commonly known as pimples or 'zits,' can be painful and include small papules (red bumps), pustules (bumps with pus), and larger nodules and cysts. These lesions develop when bacteria and oil irritate the blocked follicle or when blocked follicles rupture, releasing bacteria, oil, and irritants into the surrounding skin. The bacteria *Propionibacterium acnes* (*P. acnes*), part of the skin's normal flora, multiply in clogged follicles. *P. acnes* produce lipase, an enzyme that breaks down triglycerides in sebum into free fatty acids and releases inflammatory molecules, contributing to the development of acne.

### **Types of acne**

There are mainly six types of acne, as mentioned in Figure 1 (Kameswararao et al., 2019; Agarwal & Jindal, 2023).

- Whiteheads: They stay underneath the surface of skin and are minuscule.
- Blackheads: They ascend to the outer layer of skin and are dark in colour due to the tint.
- Papules: There are noticeable, painful little pinkish bumps on the skin.
- Pustules, often known as zits or pimples, have a red base and a discharge tip. They could be noticed on the surface of the skin.
- Nodules: Clearly visible on the skin's surface. These are large, painful pimples that are deep beneath the skin and visible on the surface.
- Cysts: Easily noticeable on the epidermis. They are uncomfortable, discharge-filled, permanently implanted, and prone to scarring.

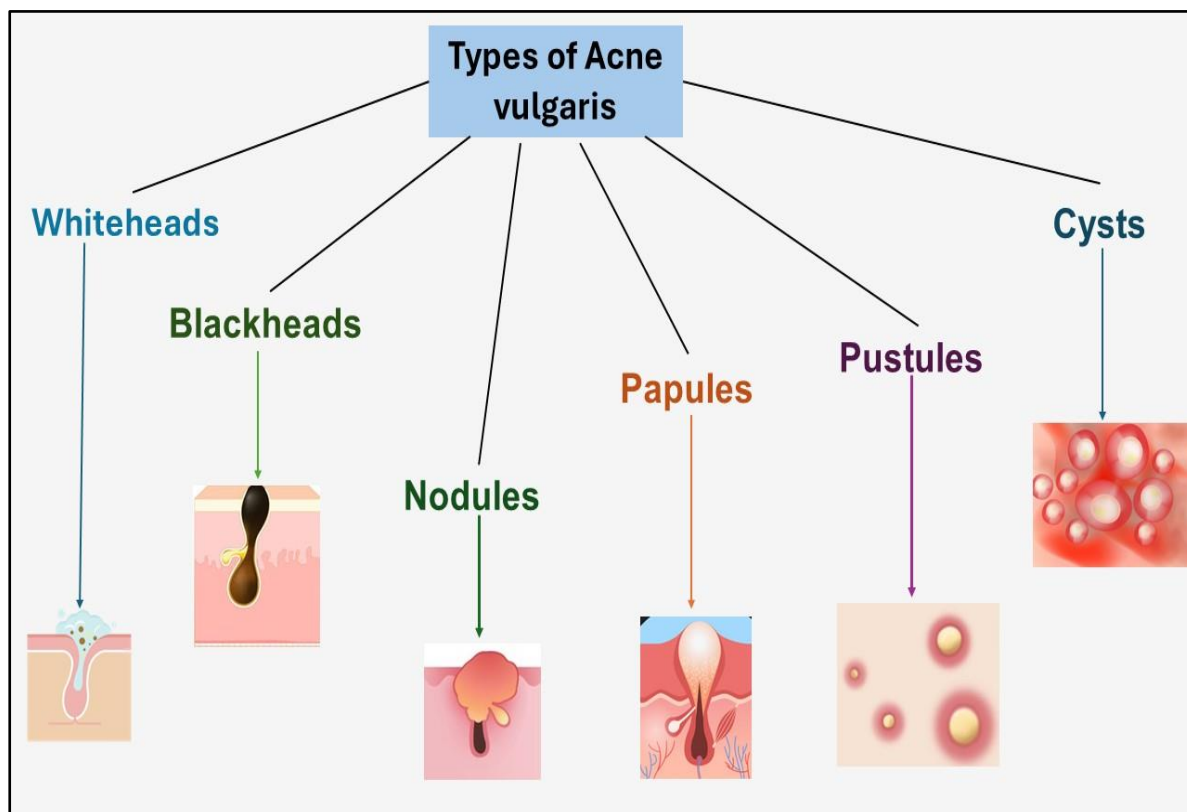


Figure 1: Types of Acne vulgaris

### Allopathic treatment of acne and its side effects

The European standards state that acne vulgaris treatment is determined by the kind and severity of the patient's acne as well as their preferences and complications (Nast et al., 2016; Fox et al., 2016). *Propionibacterium acnes* is a common inhabitant of the pilosebaceous glands of the human skin, and acne is caused by infection; therefore, topical and oral antibiotics were employed to treat it. For over 40 years, antibiotics have been the key acne treatment. Clindamycin, triclosan, tetracycline, minocycline, erythromycin, and metronidazole are common topical and oral antibiotics. Clindamycin, which is available as a solution, lotion, or gel at 1% dosage, was the most popular topical antibiotic for acne treatment. Salicylic acid is also used to treat acne since it is a good cleanser with anti-inflammatory and mild comedolytic properties. Physical treatments, such as phototherapy and lesion excision, can be beneficial in certain cases of acne. Innovative therapy techniques and various combinations have been developed for topical medications, including antibiotics, benzoyl peroxide, and retinoids. While these combinations can enhance treatment efficacy, they also increase the likelihood and severity of side effects such as dryness, scaling, erythema, discomfort, burning, stinging, and itching. Minocycline in particular carries a higher risk of serious adverse effects compared to other tetracyclines. It can induce hypersensitivity reactions, affecting organs such as the liver, kidneys, lungs, or multiple organs within the first few weeks of treatment, a condition known as Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome. With long-term use, minocycline may also lead to autoimmune disorders, including Systemic Lupus Erythematosus and autoimmune hepatitis. Additionally, Central Nervous System (CNS) symptoms, such as dizziness, occur more frequently with minocycline compared to other tetracyclines. Long-term treatment can also lead to hyperpigmentation of the skin. Therapy with these medications typically lasts from several weeks to months, and in some cases, even years. Prolonged exposure to oral antibiotics exerts significant selective pressure, fostering the emergence of resistant *P. acnes* strains. Resistance develops in approximately 50% of individuals treated with both topical and oral antibiotics. The possibility of *P. acnes* resistance increases with the

duration of antibiotic use. In a prospective study involving 151 patients, resistance rates were 0% in patients who had never used antibiotics, 6.25% in those on short-term antibiotics (6–18 weeks), and 21.6% in patients on longer antibiotic courses.

The rise of antibiotic-resistant *Propionibacterium acnes* and the numerous side effects, as shown in Figure 2, associated with prolonged antibiotic use have driven individuals to seek holistic treatments. Medicinal plants, with their vast therapeutic potentials, have emerged as a viable and cost-effective alternative to traditional antibiotic therapies (Fabbrocini et al., 2010; Amrita et al., 2012; Brănișteanu et al., 2015; Shadab et al., 2018).

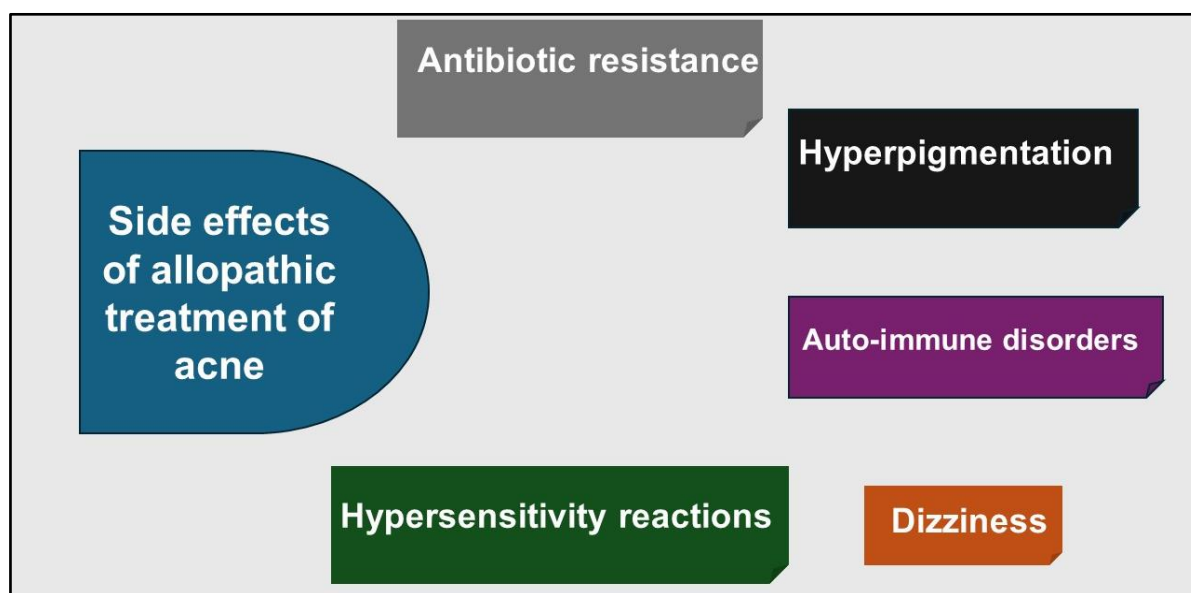


Figure 2: Side effects of using allopathy to cure acne

### Importance of medicinal herbs for the treatment of acne

Recently, many studies have proved that medicinal plants can effectively treat acne vulgaris due to the presence of several phytochemicals in their various parts (Proença et al., 2024). 80% of the population is already using products derived from plants or other natural sources to cure acne because these products target the root cause of the acne and not only alleviate the symptoms of acne, unlike allopathy (Nasri et al., 2015). Additionally, herbal therapies, used for centuries to treat acne, involve various extracts, oils, and ayurvedic preparations. These natural remedies offer several advantages over traditional treatments, including fewer side effects and a broader range of benefits. New herbal formulations can enhance acne treatment effectiveness and tolerance. These herbal remedies are effective against many Gram-positive and Gram-negative bacteria. For instance, Sunder Vati, an Ayurvedic formulation, is effective and well-tolerated when taken orally for acne vulgaris. Other herbal formulations, like Purin tablets and Klarina cream, contain multiple herbal extracts and are recommended for moderate to severe acne due to their minimal side effects compared to modern medicine. Certain herbal extracts, such as *Angelica dahurica*, *Rhizoma coptidis*, and *Psidium guajava*, are more effective than antibiotics and retinoids. These herbal agents are effective not only because of their antimicrobial properties but also due to their antioxidant and anti-inflammatory effects, which help reduce inflammation and the production of reactive oxygen species (ROS). Herbal extracts and oils can be used alone or in combination therapies. For example, combining 2% ocimum oil with aloe vera gel enhances anti-acne activity due to the synergistic effects. The side effects of herbal treatments are generally much less severe than those associated with modern drugs, making them a more appealing option for many individuals. Overall, natural substances from medicinal plants, with their antibacterial and anti-inflammatory properties, have become a popular and cost-effective alternative for acne

treatment. These remedies offer a holistic approach, aligning with the growing trend toward natural and integrative healthcare solutions (Patel et al., 2015; Shadab et al., 2018).

### Anti-acne potential of medicinal plants

***Aloe barbadensis* (Aloe vera):** The botanical name of Aloe vera is *Aloe barbadensis*, and it belongs to the Asphodelaceae family. Its botanical classification is given in Table 1 (Das et al., 2015). Often referred to as the "miraculous herb," Aloe vera is renowned for its outstanding therapeutic properties. Its primary benefits are attributed to its antibacterial and astringent qualities. Aloe vera is rich in vitamins A (beta-carotene), C, and E, which function as antioxidants, as well as vitamin B12, folic acid, and choline (Khunt et al., 2023). These antioxidants play a crucial role in neutralizing free radicals. Aloe vera contains six antiseptic agents: lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols, and sulfur. These compounds exhibit inhibitory effects on fungi, bacteria, and viruses. The inner leaf of the Aloe vera plant produces a thick, translucent, or slightly yellowish substance known as Aloe vera gel, as shown in Figure 3.



Figure 3: Aloe vera gel yielded by the leaves of the plant

The raw gel from Aloe vera can be applied directly to affected areas, offering numerous benefits due to its anthraquinones, such as aloin and emodin, which are phenolic compounds known for their laxative effects, as well as analgesic, antibacterial, and antiviral properties. Aloe vera consists of several phytochemicals due to which it exhibits therapeutic activities, as provided in Table 2 (Arunkumar & Muthuselvam, 2009; Rehman et al., 2016; Setiawan et al., 2020).

Usage: To cure acne, blemishes, or any other skin concerns, it can be applied in different ways, as shown in Figure 4.

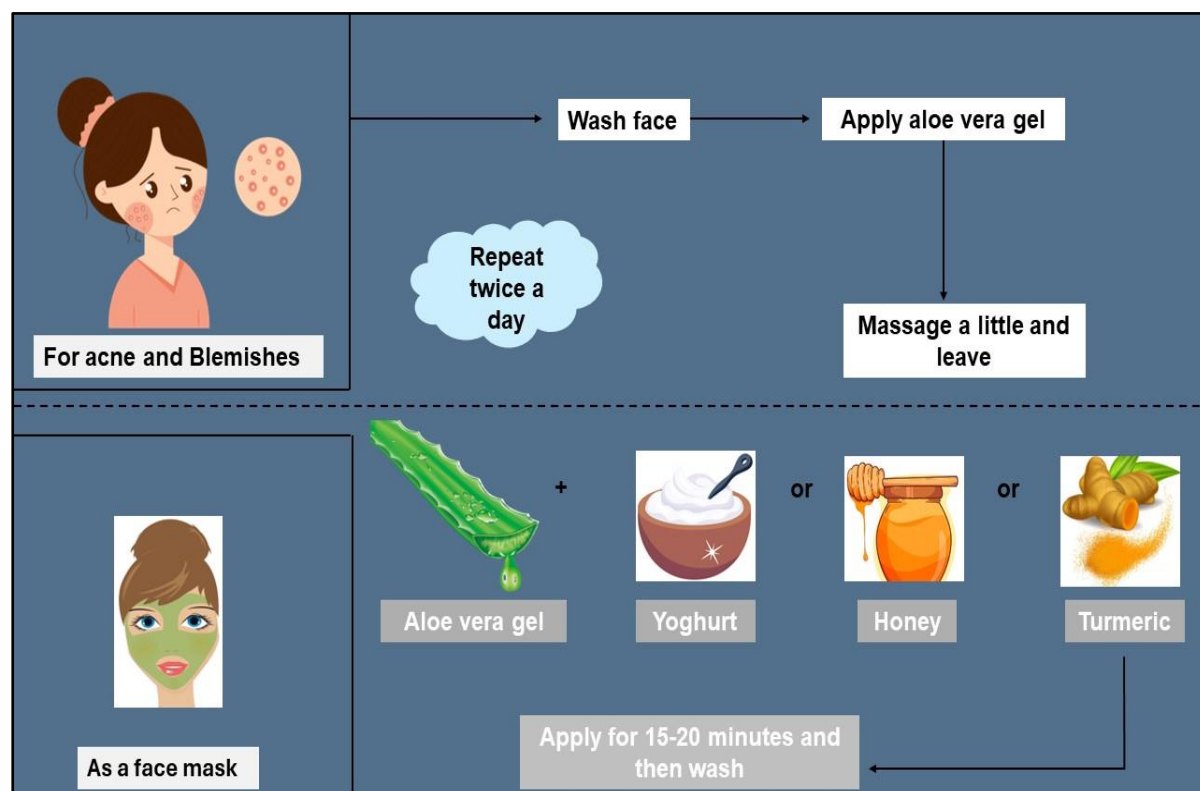


Figure 4: Application of aloe vera for different concerns (Jamil et al., 2016)

***Azadirachta indica* (Neem):** This is an evergreen plant belonging to the Meliaceae family. Table 1 mentions the botanical classification of Neem (Muñoz-Valenzuela et al., 2007). This plant belongs to India and Sri Lanka (Reddy & Jain, 2019). Neem trees vary in size, typically growing from medium to large and can reach heights of 15-20 meters (49-66 feet) or more. The leaves are complex, pinnate, and arranged alternately, with each leaf generally comprising eight to fifteen leaflets. Neem trees produce small, fragrant white flowers in clusters known as panicles. The fruits are oval-shaped with a drupe-like texture similar to olives. They start green when young and turn yellow as they ripen. It is primarily recognized due to its anti-inflammatory and anti-bacterial properties. It also controls the oil production (Behar et al., 2014). The primary chemical constituents include triterpenoids and tetranortriterpenes found in the seed oil, while the bark and leaves contain nimbolin, nimbin, gedunin, tannin, and volatile oils (Patel & Venkatakrishna, 1988; Jerobin et al., 2015; Singab et al., 2022). Table 2 mentions commonly found phytochemicals in neem along with their functions.

Usage: Its oil needs to be diluted before applying to the skin because it is very strong. It should be mixed with almond, coconut, or jojoba oil. With the help of a cotton ball or fingers, it should be applied to the affected areas (Aneesa, 2016).

***Ocimum sanctum* (Tulsi):** Commonly known as Tulsi, its botanical classification is given in Table 1 (Nahak et al., 2011). It is a herbaceous plant that grows around 30-60 centimeters tall, as shown in Figure 5. Considering its morphology, its shapes can be of many shapes, and it has a square cross-section of stems. Its flowers are tiny and grouped in spikes. When crushed, it emits a fragrant scent (Kumar et al., 2022). Tulsi is a very popular and affordable herbal remedy due to its anti-acne, anti-ageing, and antioxidant properties. It has been proven effective against leukoderma, snakebites, rashes, and pimples (Pattanayak et al., 2010; Cohen, 2014). Table 1 includes its phytochemicals, including ocimene, linalool, apigenin, ursula acid, and eugenol, which are responsible for their anti-inflammatory and anti-bacterial properties (Deshmukh et al., 2015).

Usage: The information about mode of application is provided in Figure 5.

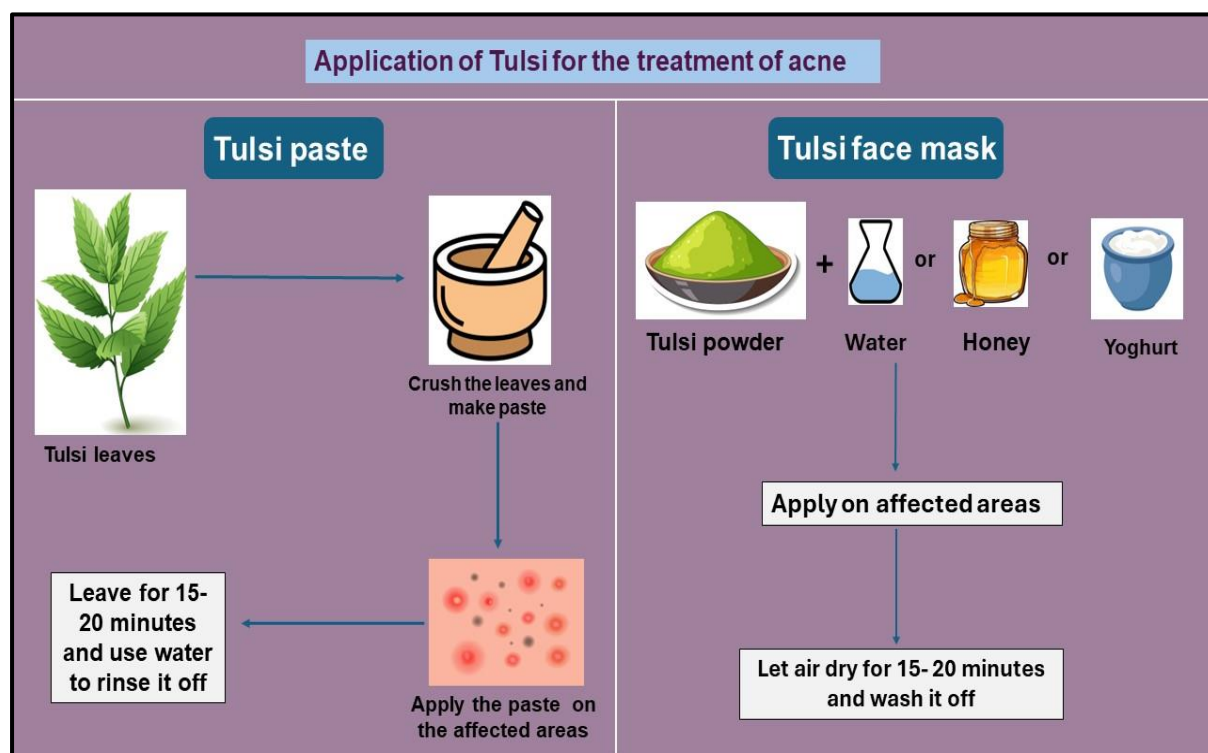


Figure 5: Demonstrates the ways in which Tulsi can be used

***Curcuma longa* (Haldi):** Its English name is Turmeric, and people of India call it Haldi. Table 1 mentions its botanical classification (Indiresht et al., 1990). Turmeric has a non-woody stem, and this plant can live for more than 2 years. The stem of this plant is a rhizome, a horizontally growing subterranean stem that is commonly used in food and medicine. Also, its root has been used as a therapeutic agent in many medicines. Overall, this plant can be used as a spice and a conventional medicine as well. Its common therapeutic activities are antibacterial and anti-inflammatory, which can help in preventing the growth of *Propionibacterium acnes*, saving the skin from oxidative stress, cell regeneration, reduction of hyperpigmentation, and exfoliation. Table 2 comprises some of the chemicals found in turmeric (Indiresht et al., 1990; Niranjana & Prakash, 2008; Kapoor & Lata, 2011; Kim & Lio, 2020).

Usage: Turmeric and Coconut Oil: For soothing and effective acne treatment, mix turmeric powder with coconut oil and form a paste. Then, this mixture should be applied to acne-prone areas and left on for 10-15 minutes. Rinse thoroughly with water afterwards. This remedy can be used multiple times a week to help manage acne and nourish the skin. Turmeric Paste: To create a turmeric paste, combine turmeric powder with water or other beneficial ingredients such as honey, yoghurt, or aloe vera. Apply this paste directly to areas affected by acne. Allow it to remain on the skin for approximately 15-20 minutes before rinsing it off with water. This treatment can be repeated a few times a week to help reduce acne and improve skin health (Kim & Lio, 2020).

***Allium sativum* (Garlic):** *Allium sativum* (Figure 6) is a bulbous plant that belongs to the Alliaceae family, classification provided in Table 1. In English, it is called garlic and lahsun in Urdu (Belemkar et al., 2013). It has clove-like bulbs and flat leaves. Garlic is distinguishable from other family members in that it has clove-shaped bulbs and flat leaves. The plants can be herbaceous, biennial vegetables, perennial bulbs, or treated as annuals, and they typically have a mild odour. Most common garlic kinds are considered annuals, although, in particular areas, some are permanent and can grow to be 2 feet or higher (Devi et al., 2014). Its main components include flavonoids, volatile oils comprising sulfur, ajoene, allyl propyl disulfide, diallyl disulfide, and allicin (Mikail, 2010; Chekki et al., 2014). Garlic has

been used as medicine for a very long time now. It exhibits therapeutic activities such as antimicrobial, antioxidant, antiviral, and immunomodulatory activities. Due to the presence of antioxidants, it helps in fighting acne and keeps the skin rejuvenating (Rehman & Riaz, 2019).



Figure 6: Bulbs of *Allium sativum*

**Citrus limon (lemon):** The fruit of *Citrus limon* is known as lemon. Both lemon peels and juice contain a high amount of citric acid. Its astringent nature helps in getting rid of excessive sebum and promotes healthy skin (Klimek-Szczykutowicz et al., 2020). It has antibacterial activity, which destroys acne-causing bacteria. The anti-inflammatory activities of lemon are due to the presence of linalool, limonene, alpha-pinene, linalylate, etc. Table 2 includes information about the phytochemical constituents of lemon and their therapeutic activities.



Usage: Lemons with vitamin C have been demonstrated to be effective for acne sufferers. Being an alkaline fruit, lemons also eliminate a variety of microorganisms that cause acne. For those with more severe acne, the easiest method to take advantage of these restorative properties is to drink citrus juice and water every morning. Applying a mixture of one part lemon juice and one part rose or melon water to acne-prone areas of the skin is effective. After applying the solution to the skin for 30 minutes, rinse it off with water. This should be followed twice a week. In the affected areas, fresh citrus juice should be administered immediately using a cotton ball and left overnight. In the morning, wash the solution. The least diluted solution is prone to burning but is considered the most effective (Al-Qudah et al., 2018).

***Calendula officinalis* (Marigold):** *Calendula officinalis*, known in India as Genda, is an annual plant recognized for its aromatic, lance-shaped leaves. Typically, the leaves are stemless, while the plant itself can grow up to 60 cm with branching tips. The flowers of Calendula are yellow to orange and measure about 3-5 cm in diameter (El-Sahhar et al., 2001). This plant possesses various medicinal properties, including antimicrobial and anti-inflammatory activities, soothing irritated skin, and retaining moisture. These benefits are due to compounds such as linoleic and oleic acid, triterpenoids (like faradiol esters and calendulosides), flavonoids, carotenoids, saponins, and essential oils (Sharma & Kumari, 2021; Vora et al., 2018).

Usage: Creams and ointments of Marigold are commonly used for treating skin irritations, wounds, and rashes. Tinctures used for internal and external applications (Vora et al., 2018). Key compounds in calendula include linoleic acid, oleic acid, faradiol esters, calendulosides, saponins, flavonoids, and carotenoids. Calendula's wide-ranging applications and rich medicinal properties underscore its value in herbal medicine, making it an essential component in promoting skin health and healing (Sharma & Kumari, 2021; Vora et al., 2018; Figure 7).

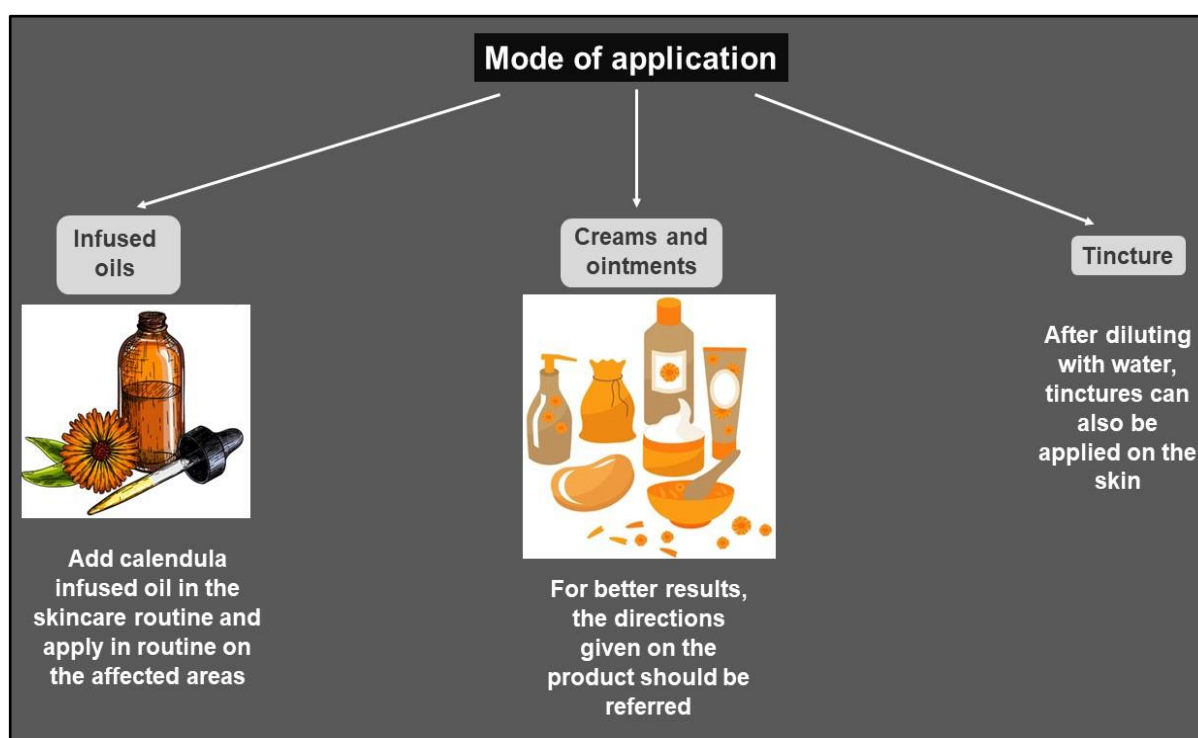


Figure 7: Demonstrates the ways in which calendula can be used to treat the skin affected by acne

**Zingiber officinale (Ginger):** *Zingiber officinale*, commonly known as ginger, is an integral part of South Asian cuisine and belongs to the Zingiberaceae family. This plant is famous for its extensive therapeutic properties, which include the inhibition and treatment of common ailments such as arthritis, gastrointestinal disorders, and inflammatory diseases. In traditional medicine, ginger root has been used for treating various skin conditions, ulcers, and cancers of the colon and prostate. As individuals age, their health inevitably declines a process that can be accelerated by conditions such as diabetes mellitus and hypertension. While topical steroids are known to inhibit collagen production, ginger extracts offer a natural alternative by improving skin structure and condition, thus enhancing the wound healing process. Gingerol, an active compound in ginger, promotes the healing of skin damage by stimulating the formation of new blood vessels at injury sites. This not only aids in the regeneration of damaged skin cells without irritating them but also alleviates pain associated with infections, thereby increasing patient compliance. Ginger's efficacy is further enhanced when used in combination with curcumin, as demonstrated in experimental studies with rats, where it significantly promoted wound healing. Moreover, ginger extract exhibits potent anti-inflammatory properties. In studies involving mice with Croton oil-induced ear oedema, ginger was found to suppress the production of nitric oxide and cytokinin cyclooxygenase, key contributors to inflammation. These findings suggest that ginger can effectively regenerate damaged skin cells and facilitate wound-healing processes in humans. Additionally, ginger's role in promoting skin health is supported by its ability to reduce the risk of wound-related complications and enhance overall skin resilience. Such activities are due to the presence of phytochemicals such as gingerol, steroids, tannins, saponins, carbohydrates, and flavonoids. Overall, *Zingiber officinale* is a multifaceted herbal remedy with significant potential in modern medicine, particularly for skin health and wound healing. Its wide range of therapeutic effects, minimal side effects, and the ability to enhance patient compliance make it a valuable alternative to synthetic drugs in the treatment of various ailments. As research continues to uncover its benefits, ginger is poised to become an even more integral component of natural and holistic healthcare practices (Galor et al., 2011; Mao et al., 2019; Effiom & Abaye, 2020).

Table 1: Botanical classification of Anti-acne plants

Scientific name	Kingdom	Phylum	Class	Order	Family	Genus	Species
<i>Aloe barbadensis</i>	Plantae	Angiosperms	Monocots	Asparagales	Asphodelaceae	Aloe	barbadensis
<i>Azadirachta indica</i>	Plantae	Angiosperms	Eudicots	Sapindales	Meliaceae	Azadirachta	indica
<i>Ocimum sanctum</i>	Plantae	Magnoliophyta	Magnoliopsida	Lamiales	Lamiaceae	Ocimum	sanctum
<i>Curcuma longa</i>	Plantae	Magnoliophyta	Liliopsida	Zingiberales	Zingiberaceae	Curcuma	longa
<i>Allium sativum</i>	Plantae	Magnoliophyta	Liliopsida	Asparagales	Amaryllidaceae	Allium	sativum
<i>Citrus limon</i>	Plantae	Angiosperms	Eudicots	Sapindales	Rutaceae	Citrus	limon
<i>Calendula officinalis</i>	Plantae	Magnoliophyta	Magnoliopsida	Asterales	Asteraceae	Calendula	officinalis
<i>Zingiber officinale</i>	Plantae	Lythraceae	Monocots	Zingiberales	Zingiberaceae	Zingiber	officinale

Table 2: Chemical constituents of plants and their functions (Source: Online literature)

Plant	Constituents	Functions
<i>Aloe barbadensis</i>	Enzymes, sterols, saponins, polysaccharides, lignin, minerals, glycoproteins, anthraquinones,	Reduce inflammation, support skin regeneration and wounds healing, antibacterial, alleviate pain, promote cell renewal, aids healing process, soothes the skin promotes healthy skin and skin renewal, support cleansing of skin and possess, improve gel absorption

<i>Azadirachta indica</i>	Fatty acids, nimboline, Quercetin, vitamins and minerals, nimbdin, nimbidin	Hydrate the skin and control the oil production, prevent the growth of bacteria, reduce inflammation, irritation, redness, oxidative stress
<i>Ocimum sanctum</i>	Ocimene, linalool, apigenin, Ursula acid, eugenol	Antibacterial, reduces redness and inflammation
<i>Curcuma longa</i>	Curcumin, zingiberene, flavonoids, turmerones	Anti-inflammatory, antibacterial, preserve skin from oxidative stress
<i>Allium sativum</i>	flavonoids, volatile oil comprising sulphur, ajoene, allyl propyl disulfide, diallyl disulfide, allicin	Antimicrobial, antioxidant, antiviral, and immunomodulatory activities
<i>Citrus limon</i>	Terpenes, flavonoids, limonene, vitamin C, carotenoids, polyphenols, linalool, linalylate, limonene, alpha-pinene	Reduces oxidative stress, promotes youthful skin, antibacterial, anti-inflammatory, lessens the sebum production
<i>Calendula officinalis</i>	Oleic acid, linoleic acid, calendulosides, faradiol, carotenoids, saponins, essential oils.	Maintain the moisture of skin, reduction of inflammation, promote healthy skin, antibacterial (slight)
<i>Zingiber officinale</i>	Gingerol, steroids, tannins, saponins, carbohydrates, flavonoids	Anti-inflammatory, antibacterial, wound-healing

## Conclusion

Natural remedies for acne, such as Aloe vera and Neem, offer significant anti-inflammatory and antimicrobial benefits. These treatments, when combined with lifestyle and dietary changes, provide a holistic approach to managing acne, promoting healthier skin compared to synthetic drugs. Medicinal plants have been pivotal in drug discovery and remain a reliable source for new acne treatments. Herbal remedies are favoured for their minimal adverse effects, making them a viable alternative. Continued research and technological advancements aim to incorporate these botanicals into modern skincare, enhancing their efficacy and safety, and inspiring further innovation in acne treatment.

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