Medicinal Plants and their Constituents in the Treatment of Acne vulgaris

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Abstract: Acne is a chronic inflammatory skin disorder that involves the pilosebaceous unit. It is a common universal disease affecting about 85% of teenagers. The disfiguring dermatosis of acne can destroy self-confidence, causing significant emotional distress. Topical and systemic therapies are available as a conventional acne treatment, including comedolytic agents, antibiotics, and various anti-inflammatory drugs. Interest in medicinal herbs has been progressively increasing due to antibiotic resistance in acne-causing bacteria, side effects, and sometimes high cost of conventional treatment. This review provides up-to-date evidence on medicinal plants and the phytoconstituents used in acne treatment. The data presented in this review were gathered from several databases, including Pubmed, Wiley Online Library, Elsevier, and Web of Science, using keywords such as; Acne vulgaris, Cutibacterium acnes (formerly Propionibacterium acnes), skin diseases, medicinal plants, active constituents, complementary and alternative medicines. The present manuscript provides an updated review of the most reported active constituents with anti-acne properties. Among these classes were the phenolic compounds, exemplified by anthraquinones, flavonoids, tannins, alkaloids, certain terpenes and oxygenated terpenes present in the essential oils of many medicinal plants.

Keywords: Acne vulgaris; Cutibacterium acnes; Propionibacterium acnes; Staphylococcus epidermidis; skin diseases; medicinal plants; essential oils; antimicrobial activity; antibiotic resistance.

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1. Introduction

Acne vulgaris is a disfiguring prolonged inflammatory disorder of the pilosebaceous units. The psychological impacts of acne include loss of self-confidence, depression, anxiety, and interpersonal and work-related difficulties. The clinical presentation of acne comprises black and whiteheads (comedones), pinheads (papules), pustules, nodules, and pitted or hypertrophic scars [1]. The face, shoulders, upper chest, and back may be affected [2].

Acne vulgaris is mainly attributed to the increased production of androgens present in males and females during puberty. Accordingly, the pilosebaceous units produce more sebum, followed by follicular hyperkeratinization and plugging of the hair follicles. Thus, sebum cannot reach the skin surface, which encourages anaerobic bacteria, including Cutibacterium acnes (formerly Propionibacterium acnes), to grow in the plugged follicle. These bacteria trigger an inflammatory response in the skin, manifested as heat, swelling, redness, and pus [3].
The Global Burden of Disease (GBD) reported in 2010 that *Acne vulgaris* was the eighth most common skin disease, with an estimated global prevalence (for all ages) of 9.38% [4]. It affects more than 85% of teenagers, and boys most frequently have severe forms of the disease [5]. More than 100 million US dollars are spent on over-the-counter acne products [6]. Acne is a multifactorial disease affected by interacting factors, and the main risk factors are summarized in figure 1 [7].

![Figure 1. Predisposing factors of Acne vulgaris.](https://biointerfaceresearch.com/)

Acne treatment aims to control existing lesions, prevent permanent scarring as far as possible, limit the duration of the disorder, minimize morbidity and guard against the formation of new acne lesions. Anti-acne drugs may act by normalization of follicular keratinization, thus suppressing sebum production. Others exert antibacterial action against *Cutibacterium acnes*, alleviating inflammation and, through the antioxidant effect, reducing oxidation of sebum, which favors the growth of *C. acnes*. Conventional acne treatment involves topical alone or in combination with systemic therapies in severe cases. Topically used agents include comedolytic agents, antibiotics, and various anti-inflammatory drugs. Systemically used agents include retinoids, antibiotics, zinc, and hormones [8]. Topical treatment is the standard for most patients with comedo-papular acne; however, local and systemic treatments are needed for pustulocystic scarring acne [9]. Drawbacks of conventional therapy include increased antibiotic resistance in acne-causing bacteria (*C. acnes* and *S. epidermidis*) [9]. Moreover, the increased incidence of pregnant women exposed to oral tretinoin, a known teratogen [10], and the poor safety profile of systemic retinoid therapy [9,11].

Herbal therapy of acne has been encouraged due to the advantages of better patient tolerance, long history of use, fewer side effects, and being relatively more cost-effective. Many herbs with a history of use in traditional cultures have entered the growing ‘cosmeceuticals’ market. The efficacy of herbs used in acne treatment is due to their
antibacterial activity and their influence on sebum activity, inflammation, and hyperkeratinization associated with acne. This review aspires to provide up-to-date evidence on medicinal plants and the phytoconstituents used in acne treatment.

2. Materials and Methods

The data presented in this review were assembled from several databases, including PubMed, Wiley Online Library, Elsevier and Web of Science Core Collection, and digital search platforms. The search terms were *Acne vulgaris*, acne, anti-acne, *C. acnes*, skin diseases, medicinal plants, herbal medicines, phytotherapy, Ayurveda, Unani, and Chinese traditional medicine. Additionally, the reference lists of articles were reviewed for additional relevant studies.

3. Results and Discussion

Many efforts have been made to study medicinal herbs' anti-acne activity and investigate the phytoconstituents responsible for that activity. The following part compiles the medicinal plants used in acne treatment, classified according to the class of their active constituents.

3.1. Phenolic compounds.

Phenolic and polyphenolic constituents contribute to vital processes of plant physiology. Phenolic compounds demonstrate activity against *C. acnes* via their antimicrobial, antioxidant, and anti-inflammatory properties, thus exhibiting an anti-acne effect. Table 1 summarizes studies on herbs containing anti-acne phenolic compounds and their mode of anti-acne action.

| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|--------------|-----------|------------------|-------------------------------|---------------------|------|
| *Aloe barbadensis* Miller | Aloe vera | Leaf gel | Applied topically to treat skin ailments, seborrheic dermatitis, psoriasis, *Vulgaris*, genital herpes, skin burns, and *Acne vulgaris* | Antioxidant, Anti-inflammatory, Antimicrobial, Anti-acne effect in vivo | Aloin and emodin | [12-17] |
| *Aloe ferox* Mill. | Bitter aloe | Leaves and roots | Applied topically or ingested to treat eczema, dermatitis, and acne | Antioxidant, Anti-inflammatory, Antimicrobial | Aloe-emodin, aloin A, Aloesin | [18-20] |
| *Arctium lappa* L. | Edible burdock | Root, seed | Topical remedy for skin problems such as eczema, acne, and psoriasis | Antioxidant, Anti-inflammatory, Antimicrobial | Lappool F, and diarctigenin | [21-23] |
| *Artocarpus hirsutus* Lam. | Wild jack | Stem bark | Skin diseases including hydrocele, pimple, heat sores, cracks in the skin | Antimicrobial | Pyranocycloartobiloxa-nthone A, and artonine E | [24] |
| *Artocarpus integer* (Thunb.) Merr. | Cempedak | Root | Skin diseases as antimicrobial | Antimicrobial | Artocarpin, cudraflavone C and artocarpanone | [25] |
| *Berberis vulgaris* L. | Barberry | Root, fruit | Eliminate inflammation orally and topically. It's used to treat skin diseases | Anti-inflammatory, Anti-acne (in vivo) | Anthocyanins,Flavonoid | [26-30] |
| *Caesalpinia sappan* L. | Brazil or sappan wood | Heartwood | Skin diseases Anti-acne | Antioxidant, Anti-inflammatory, Anti-acne | Brazilin, sappanchalcone, protosappanin a, protosappanin c, protosappanin d, protosappanin e, sappanone b | [31,32] |
| *Camellia sinensis* L. | Green Tea | Leaves | Protection and moisturization of the skin and hair | Antimicrobial, Anti-inflammatory, Anti-acne in vivo, Antioxidant, 5 a-reductase inhibitory | Epigallocatechin-3-gallate EGCG, EC, GCG, ECG, EGC, and GA. | [33-39] |
| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|--------------|-----------|------------------|------------------------------|-------------------|------|
| Carthamus tinctorius L. | Safflower | Flower | Used to heal old wounds, Moisturer in skin crèmes and lotions | Anti-acne in vivo, Antioxidant | Flavonoids | [40-42] |
| Casuarina equisetifolia L. | Ironwood | Bark | Astringent, lotion for swelling | Anti-acne In vivo, Antioxidant activity | Catechin, ellagic acid, gallic acid, quercetin and lupeol, coumaroyl triterpenes, d-gallacetich and tannins | [43-45] |
| Curcuma longa L. | Turmeric | Rhizome | Alleviating skin inflammation, used as a paste for skin eruptions and infections | Anti-acne In vivo, Anti-infectious, Antimicrobial, Antioxidant | Curcumin, demethoxycurcumin, bisdemethoxycurcumin | [14,31,46-48] |
| Eisenia bicyclis (Kjellman) Setchell | Sea oak | - | - | Anti-inflammator, Antimicrobial | Phlorotannin: fucofuroeckol-A | [49,50] |
| Embelia ribes Burm F. | Vidanga | Fruit | Dyeing hairs, good pimple remover, treating Acne, treating carbuncle infections, treating vitiligo and leucoderma | Antimicrobial, Anti-inflammator, Antioxidant, Antilipase | Tanninspara-benzoquinone: embelin | [51-54] |
| Emblica officinalis L. | Amla or indian gooseberry | Fruit | Acne and other skin disorders | Anti-acne In vivo, Anti-inflammatory, Antioxidant | Gallic acid, methylgallate, corilagin, furosin, and geranin | [55-59] |
| Epimedium brevicornum Maxim | Horny goat weed | Herb | - | Antimicrobial | Icarin (flavonol) | [60] |
| Eucalyptus maculata Hook. | Eucalyptus | Leaf | Wounds, ulcers of the skin | Antimicrobial, Antioxidant | 2', 6'-dihydroxy-3'-methyl-4'-methoxy-dihydrochalcone, eucalyptin and 8-desmethylyl-eucalyptin. | [61,62] |
| Excoecaria cochinchinensis | Chinese Croton, jungle fire | Leaf | - | Antimicrobial | Phenolic compounds, gallic acid | [63] |
| Greyia flanaganii H. Bolus | Kei bottlebrush | Leaf | - | Antimicrobial, Antioxidant | (3S)-4-hydroxyphenethyl 3-hydroxy-5-phenylpentanoate, 2',4'-6' trihydroxydihydrochalcone, 2',6',4-trihydroxy-4'-methoxydihydrochalcone, eucalyptin and 8-desmethylyl-eucalyptin. | [64] |
| Garcinia mangostana L. | Mangosteen | Fruit rind | Eczema, hyperkeratosis, and other skin disorders such as psoriasis and wounds | Antimicrobial, Anti-acne In vivo | Alpha-mangostin | [65,66] |
| Intsia palebanica Miq. | Merbau | Wood | Skin whitening activity | Anti-lipase | Fustin, amelpopin & 4'-dehydroxyrobidanol | [67] |
| Iris ensata, Thunb. | Ira Ira | Root | Cosmetic preparations for skin roughness and aging | Anti-acne effect In vivo, Antioxidant | Flavonoids and phenolics | [15,68-70] |
| Koenigia pandurata (Roxb.) | Fingerroot Chinese ginger | Rhizome | - | Antimicrobial | Panduratin A and isopanduratin A | [71] |
| Lavandula stoechas L. | French lavender | Flower | Various inflammatory diseases | Antimicrobial, Anti-inflammatory, Antioxidant | Calfic acid, quercetin, lutelin, rosmarinic acid | [72-76] |
| Lens culinaris Medik. | Lentil | Seed | Topically applied for the treatment of skin infections and burns as traditional medicine | Anti-acne In vivo, Anti-inflammatory Antioxidant | Flavonoids and condensed tannins | [77-79] |
| Magnolia sp. | Stem bark | - | - | Antimicrobial, Antioxidant | Honokiol and magnolol, tannins | [80] |
| Mangifera indica L. | Mango | Seed Kernel | Decoction of the kernel has been used to treat infectious wounds, ulcers | Antimicrobial, Antioxidant | Gallic acid | [81] |
| Morus alba L. | white mulberry | Cortex | - | Antimicrobial, Antioxidant, Antimicrobial | Polyphenols | [82-85] |
|  |  | Stem | - | Antimicrobial, Antioxidant, Antimicrobial | Polyphenols | [82-85] |
|  |  |  | - | Antimicrobial, Antioxidant | Tannin, flavonoids | [86] |
| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|--------------|-----------|------------------|-------------------------------|---------------------|------|
| *Myristica fragrans* (Houtt.) | Nutmeg | Seed | - | Antimicrobial, Anti-inflammatory | (+)- Erythro-Δ5-7,8,8R-dihydroxy-3,3',5'-trimethoxy-8-O-4'-neolignan, (+)-Erythro-Δ5-7-hydroxy-3,4,3',5'-tetramethoxy-8-O-4'-neolignan | [87] |
| *Olea europaea L.* | Common Olive | Leave | Gentle care and treatment of the skin | Anti-acne effect In vivo, Anti-inflammatory, Antioxidant, Anti-inflammatory | Flavonoids including luteolin and apigenin derivatives. | [15,88-90] |
| *Plumbago indica L.* | Scarlet | Root | It is used for wound healing, tinea versicolor, and ringworm | Antimicrobial | Plumbagin, 3,3'-biplumbagin and elliptinone. | [91] |
| *Polygonum cuspidatum Sieb. et Zucc.* | Japanese knotweed | Rhizome | - | Antimicrobial, Anti-acne effect In vivo | Resveratrol | [60,92] |
| *Podium guajava L.* | Guava | Leaf | Oral antibacterial drugs to manage surgical, skin, and soft tissue infections | Antimicrobial, Antioxidant | Quercetine, quercetin-3-O-glucopyranoside | [93-95] |
| *Punica granatum L.* | Pomegranate | Fruit peel | Inflammation-related diseases | Anti-bacterial, Anti-lipase, Anti-inflammatory | Punicalagin, punicalin, strictinin a, granatin b | [17,96] |
| *Pulsatilla koreana* (Yabe ex Nakai) Nakai ex T. Mori | Korean Pasque Flower | Root | Skin-whitening effect | Antimicrobial | Pulsauquinone, hydropulsauquinone, and structurally related 1, 4-quinone derivatives | [97] |
| *Quercus acutissima Carr.* | Sawtooth oak | Cortex | Skin disorders | 5α-reductase inhibitor | Tetragalloyl glucose, pentagalloyl glucose, ugenin, 1-desgalloyl ugenin, casuarinin, castalagin, stemphenyllin C, (-)-epicatechin gallate, and (--) epigallocatechin gallate | [98] |
| *Rheum ribes L.* | Rhubarb | Root | Strong astringent in China to treat inflammation-related | Anti-inflammatory, Antimicrobial | Rhein, emodin, chrysophanol | [99-101] |
| *Rhinacontus nasatus L.* | Snake jasmine | Leaf | Treatment of Tinea versicolor, ringworm, pruritic rash, abscess pain, and skin diseases | Antimicrobial | Rhinacanthins-rich extract | [102] |
| *Rubia cordifolia L.* | Common Madder | Root | Skin diseases associated with edema and oozing | Anti-acne In vivo antimicrobial activity | Anthraquinone | [77,103] |
| *Rosmarinus officinalis L.* | Rosemary | Herb | Reduce swelling and puffiness of the skin. Burns | Anti-inflammatory, Antioxidant, Antimicrobial | Rosmarinic acid | [104-106] |
| *Schisandra chinensis* Turz. (Baill.) | Magnolia-Vine | Fruits | Skin diseases, such as atopic dermatitis, photo-aging, and hair loss | Anti-inflammatory, Antimicrobial | Lignans: schisandrin A, schisandrin B, and schisandrin C | [107] |
| *Scutellaria baicalensis Georgi.* | Asian skullcap, | Root | Skin disorders | Anti-oxidant, Anti-inflammatory, Anti-acne in vivo | Baicalein, oroxylin A, wogonin, 7-O-methylwogonin, skullcapflavone II, 5,7,4'-trihydroxy-8 methoxyflavone, viscidulin II, and ganhuangenin | [108-112] |
| *Terminalia chebula Retz.* | Chebulic myrobolan | Fruit | Skin disease, wound healer | Antimicrobial, Anti-lipase, Antioxidant, Anti-inflammatory, Anti-acne effect in vivo | Chebulagic acid | [14,53,113-115] |
| *Terminalia arjuna* (Roxb.) Wight & Arn. | Arjun | Stem bark | Wound healing, acne | Antimicrobial, Antioxidant, Anti-inflammatory, anti-acne effect in vivo | Flavonoids | [14,116-118] |
| *Terminalia laxiflora* (Engl. &Diels) | Heartwood | Wood | Alleviate rheumatic pain, moisturize skin and cause general body relaxation in addition to other cosmetic and medicinal uses | Antimicrobial, Anti-lipase, Antioxidant | Ellagic acid, flavogallonic acid, dilactone, terchebulin and gallic acid | [119] |
3.2. Terpenoids and steroids

Terpenoids represent the largest and most diverse group of naturally occurring plant secondary metabolites. The role of terpenoids in acne may be due to their antibacterial activity against *Cutibacterium acnes*, anti-oxidant or anti-inflammatory activity. Table 2 summarizes herbs containing anti-acne terpenoids, steroids, and their reported mode of action.

| Herb                  | Common names | Part used | Traditional uses                        | Reported biological activities          | Active constituents                                                                 | Ref.            |
|-----------------------|--------------|-----------|-----------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------|-----------------|
| *Zingiber officinale*| Ginger       | Rhizome   | Dermatitis                              | Antioxidant, Anti-acne in vivo, Anti-inflammatory | Gingerols and shogaols                                                               | [48,56,120-124] |
| *Momordica betche*)* | Bitter melon | Fruit     | Applied locally in case of chronic skin diseases and to treat burns, boils, and rashes | Anti-inflammatory                         | Phytochemicals from fruit (Phyllol)                                                   |                 |
| *Eucalyptus globulus*| Blue Eucalyptus| Leaf   | Wounds, ulcers of the skin              | Antimicrobial, Anti-inflammatory, Anti-lipogenic | 1,8-Cineole, 1-terpinene, p-pinene, p-cymene                                          |                 |
| *Glycyrrhiza glabra*| Liquorice     | Rhizome   | Depurative and toxic that is used to treat patients with chronic skin disease | Antimicrobial, Anti-inflammatory, Antioxidant | Glycyrrhizin, anti-inflammatory and lipogenic                                          | [10,17,33,105,142-144] |
| *Camphora mukul*     | Guggul       | Oleo-gum resin of the stem bark         | Anti-inflammatory, Anti-inflammatory, Antioxidant, Anti-inflammatory | Triterpenes: ursoic acid, oleanolic acid, sexol, corosolic acid, pomolic acid, tormentic acid, euscaphic acid | [134-136] |
| *Eriobotrya japonica*| Loquat        | Leaf     | Inflammatory disorders                  | Antioxidant, Anti-inflammatory            | Triterpenoids: ursoic acid, oleanolic acid, ε-terpinol, ε-terpinol, ε-pinene          | [105,137,138] |
| *Lavandula stoechas* | French lavender| Flower | Various inflammatory diseases.           | Anti-inflammatory, Antioxidant, Antioxidant, Anti-inflammatory | Camphor, fenchone                                                                      |                 |
| *Matricaria chamomilla* | Chamomile | Leaf, flower head | Anti-inflammatory and antiseptic | Anti-inflammatory, Anti-androgen, Anti-inflammatory | Bis-acetal oxode A, camazulenine, o-cimene, γ-farnesene, spathulenol                  | [98,149,150] |
| *Melinaceae alternifolia* (Maiden & Betcher) | Tea tree | Leaf | Topical treatment to treat bruises, insect bites, and skin infections | Anti-acne in vivo, Anti-inflammatory, Anti-inflammatory, Antioxidant | Terpenes: ε-1, ε-3, ε-4, γ-terpinol, ε-pinene                                        | [151-156] |
| *Momordica charantia* | Bitter melon | Fruit leaf | Applied locally in case of chronic skin diseases and to treat burns, boils, and rashes | Anti-inflammatory                         | Phytochemicals from fruit (Phyllol)                                                   | [157,158] |
| *Nostoc commune*     | Star jelly    | -         | -                                       | Antimicrobial, Anti-inflammatory          | Nostociolone, nostociolone derivative                                                  | [159] |
| *Ocimum basilicum*   | Sweet Basil   | Leaf      | Wounds, acne, and vitiligo              | Anti-inflammatory, Anti-inflammatory, Anti-inflammation | Neral, citral, γ-humulene, β-caryophyllene, linalool, and germacrene-d                | [160-163] |
| *Olea europaea*      | Common Olive  | Leaf      | Gentle care and treatment of the skin   | Anti-inflammatory, Antioxidant, Antimicrobial | Indolide monoterpenes including oleuropine, oleruroside, triterpenes; oleic acid and oleic acid | [15,88-90] |

Table 2. Herbs containing anti-acne terpenoid constituents.
3.3. Alkaloids.

Alkaloids are a major class of phytoconstituents and have been well studied for acne treatment (Table 3). Berberine has been reported to exhibit antimicrobial activity against *Cutibacterium acnes*, *Staphylococcus* spp., and decrease lipogenesis by sebaceous glands in hamsters [195].

| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|--------------|-----------|------------------|------------------------------|---------------------|------|
| Origanum vulgare L. | Oregano | Leaf | - | Antimicrobial, Anti-inflammatory | Thymol | [164,165] |
| Picrorhiza kurroa Roy ex Benth. | Kutki | Rhizome | Acne vulgaris and acne rosacea associated with acniform postulation | Anti-inflammatory, Antioxidant | Picroside-I and picroside-II | [166-168] |
| Pinus densiflora (Sieb. Et Zucc) | Japanese red pine | Cones | Cosmetic formulation With anti-inflammatory, antioxidant, and anti-proliferative-effects on cancer cells | Antimicrobial | 9 Labdane-type diterpenes | [169] |
| Prunus domestica L. | Chellean plum yew | Stem bark | - | Antimicrobial | Abietane diterpene, 2-acetoxyferruginol | [170] |
| Psidium guajava L. | Guava | Leaf | Oral antibacterial drugs to manage surgical, skin, and soft tissue infections | Antimicrobial, Antioxidant | α-pinene | [93,94] |
| Psoralea corylifolia L. | Buguchi | Fruit | The inflammatory diseases, mucomembranous disorders, dermatitis, and edematous conditions of the skin | Antimicrobial, Anti-inflammatory, Antioxidant | Bakuchiol, α meroterpenes | [171-173] |
| Rabdosia rosthornii (Diels) Hara | Isodon | Leaves | Pyrexia, edema and abdominal distention | Antimicrobial | Ent-kaurene diterpenoids, namely, rosthornins A–D | [174] |
| Rosa damascena Mill. | Damask rose | Flower | Toner for oily skin, prone to acne | Antimicrobial, Anti-inflammatory, Antioxidant | Geranols, β-citronellol nonadecane nerol | [72,175-177] |
| Rosmarinus officinalis L. | Rosemary | Herb | Reduce swelling and puffiness of the skin, burns | Anti-inflammatory, Antioxidant, Antimicrobial | Carnosol, carnosic acid, and rosmarinic acid | [104-106] |
| Salvia miltiorrhiza Bunge | Danshen | Root | Acne, psoriasis, eczema, and other skin conditions | Anti-inflammatory, Antioxidant, Antimicrobial | Diterpene quinone (tanshinone) cryptotanshinone | [40,178-180] |
| Sapindus mukorossi Gaertn | Indian soapberry | Fruit pericarp | Whitening and freckle-removing ability when used as a face wash | Antimicrobial Lipase and tyrosinase inhibitor | Four oleanane-type triterpenoid saponin. Sapindoside A and B | [181,182] |
| Solanum melongena L. | Eggplant | Fruit | Suppress lipogenesis, Follicular dyskeratosis normalization, Anti-inflammatory | Lupeol | | [183] |
| Sophora flavescens Ait. | Shrubby sophora | Radix | Eczema, inflammatory disorders, ulcers and skin burns | Antimicrobial, 5 α reductase inhibition | Lupeol | [184,185] |
| Syzygium aromaticum L. | Clove | Flower buds | Antimicrobial | Anti-inflammatory | Eugenol, eugenyl acetate, β-caryophyllene | [186] |
| Syzygium jambos L. | Rose apple | Leaf | Acne | Antimicrobial, Anti-inflammatory, Antioxidant | Anacardic acid analogue, ursolic acid | [187] |
| Vetiveria zizanoides L. | Vetiver grass | Root | Sense of heat and dermatoses | Anti-inflammatory, Antioxidant | Valereno, valerenal β-Cadinene | [188-191] |
| Withania somnifera L. | Ashwagandha | Root | Skin diseases | Antimicrobial, Anti-inflammatory, Antioxidant | Glycosidol monolides identified as stoinosides VII-X and withaferin A | [14,192-194] |
3.4. Fatty acids.

Sebum secretion is one of the main factors of acne pathogenesis. Quantitative and qualitative alterations have been observed in sebum from acne patients. The C16 : 0/C16 : 1 ratio in the skin surface triglycerides and wax esters is higher in acne patients. It has been suggested that the desaturation of fatty acids may play a major role in sebogenesis and acne onset. It has been reported that linoleic acid is effective in acne treatment. In a double-blind placebo-controlled randomized cross-over study, topically applied linoleic acid significantly affected the size of follicular casts and microcomedones [207,208]. Therefore, plants containing linoleic acid may be used in acne treatment. Table 4 summarizes herbs containing fatty acids and their reported mode of action.

| Herb                          | Common names       | Part used | Traditional uses                                                                 | Reported biological activities                                                                 | Active constituents                                                                 | Ref.                  |
|-------------------------------|--------------------|-----------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------|
| *Achillea millefolium* L.     | Yarrow             | Flowering tops | Acute eczema, burn, bruise, wounds, ulcerations, varicose ulcers, cracks, breast fissing, abcess, impetigo, tinea, leucorrhea | Antioxidant, Anti-inflammatory, Antimicrobial                                                   | An Alkamide: N-(21-hydroxy-21-(piperidin-1-yl)-henicosa-17, 19-diyl-1-y) acetamide. | [10,196,197]          |
| *Berberis vulgaris* L.        | Barberry           | Root, fruit | Topically used for skin diseases                                                  | Anti-inflammatory, Anti-acne in vivo                                                            | Berberine                                                                           | [26-30]               |
| *Coptis chinensis* HuangLian  | Chinese goldthread | Root       | Severe skin and inflammation-related diseases                                     | Anti-lipogenic, Anti-inflammatory, Antimicrobial, Antioxidant                                   | Berberine                                                                           | [142,198-200]         |
| *Hydrastis canadensis* L.     | Goldenseal         | Root       | Wounds, and local inflammation                                                    | Anti-inflammatory, Antioxidant, Antimicrobial                                                    | Berberine                                                                           | [201-203]             |
| *Mahonia aquifolium* (Pursh) Nutt. | Oregon grape     | Root       | Various skin inflammatory conditions, psoriasis                                   | Antimicrobial, Antioxidant, Anti-inflammatory                                                   | Protobberine, berberine and jatrohazine                                              | [204-206]             |

3.5. Miscellaneous constituents.

Some plants have been studied for their anti-acne activity due to their antimicrobial, anti-inflammatory, anti-androgen, and antioxidant activities. Their constituents belong to different chemical classes; these herbs are summarized in table 5; all these have anti-acne activities due to various constituents.

| Herb                                | Common names      | Part used | Traditional uses                                                                 | Reported biological activities                                                                 | Active constituents                                                                 | Ref.          |
|-------------------------------------|-------------------|-----------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------|
| *Achyranthes aspera* L.             | Prickly chalk flower | Seeds    | *Acne vulgaris*, eruptions of the skin, boils, scabies, and other skin diseases | Antimicrobial, Antioxidant, Anti-androgen                                                        | Oleaneolic acid glycosides, Betaine, achyranthene, hentriacontane, ecodysterone, achyranthes saponias A, B, C, D | [212-215]    |
| *Allium cepa* L.                    | Onion             | Fruit     | Topically for reducing the appearance of scars                                   | Antimicrobial, Antioxidant                                                                      | Thiosulfonates: MeS(O)S 1-propenyl (E,Z); n-PrS(O)S                                   | [216,217]    |
| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|-------------|-----------|------------------|-------------------------------|---------------------|-----|
| Myrtus communis L. | Myrtle | Leaf | Topical disinfectant, astringent, vaginal douche, and mouth gargles | Antimicrobial | 5-Acetoxy-4-hydroxy-4-isoibutyl-2,2,6,6-tetramethylcyclohexan-1,3-dione, β-sitosterol, isomyrtucoummulone, endomperoxide-G,3-hormone, gallic acid, myricetin-3-O- | [47] |
| Impatiens balsamina L. | Rose balsam | Leaf | Warts and snakebite | Antimicrobial | Flavonoids like kaempferol glucoside, furochromones, glycerol, fatty acids, limolic acid, myristic acid, n-octadecanoic acid, starch, saponsins, sesquerpenes, xerophytic acid, terpenoids, polyphenol, and vanillic | [251,252] |
| Glehnia littoralis Fr. Schmidt ex Miq. | Beach silvertop | Root | Healing wounds and skin infections | Antimicrobial, Antioxidant | Coumarins, coumarin glycosides and polyacetylenes | [246-249] |
| Humulus lupulus L. | Hop | Flower | Healing wounds and skin infections | Antimicrobial, Antioxidant | Xanthohumol, lupulones & humulones | [250] |
| Impatiens balsamina L. | Rose balsam | Leaf | Warts and snakebite | Antimicrobial | Flavonoids like kaempferol and quercetin lawsone, lawsone methylether, and methylene-3,30-hydroxycyclohexane | [251,252] |
| Juglans regia L. | Walnut | Walnut seed husk | Externally, the seeds are pulverized into a paste and applied as a poultice to areas of dermatitis and eczema | Antimicrobial, Antioxidant | Hydroxybenzoic tannins and naphthoquinones, naphthalenones, α-tetralones, and α-tetralone dimers, hydroxycinnamic acids, flavonoids, dihydroheptanoids, ceramides, alkanes, steroids, triterpenoids, sesquerpenes, and neolignans | [253-255] |
| Mitchellia repens L. | Partridge berry | Leaf | Astringent skin wash, astringent and mouth gargles | Hormone-balancing herbs | NA | [10] |
| Andrographis paniculata (Burm.f.) Nees | Chiraita | Leaf | Skin infections | Antimicrobial, Antioxidant, Anti-inflammatory, Anti-androgen | Andrographolide (labdane diterpenoid) and echinodulin (polyphehhol) | [214,222-226] |
| Azadirachta indica A.Juss. | Neem | Leaf | Acne, psoriasis, eczema, ringworm, and even stubborn warts | Anti-acne In vivo, Anti-inflammatory, Antimicrobial | Azadirachitin, nimbim, nimbinid, nimboide, and limonoids quercetin and β-sitosterol | [228-231] |
| Calendula officinalis L. | Calendula | Flower heads | Bruised or damaged skin. Also traditionally used for the care of varicose veins. | Antimicrobial, Antioxidant, Anti-fibrotic, Anti-inflammatory, Antioxidant | Triterpenoids, flavonoids, coumarins, quinones, volatile oil, carotenoids | [232-236] |
| Cassia alata L. | Candle bush | Leaf | Skin diseases like eczema, including rough skin, blisters, inflammation, itchiness and bleeding | Antimicrobial, Antioxidant, Anti-acne in vivo | Flavones, flavonoids, flavonoids glycosides, alatinon, alononal and β-sitosterol-β-d-glucoside | [228,237-239] |
| Codonopsis pilosula (Franch.) Nannf. | Dangshen | Root | Tonic | Antimicrobial, Anti-inflammatory | Polyacetylenes, phenylpropanoids, alkaloids triterpenoids | [240-242] |
| Cyperus rotundus L. | Nagarmotha | Rhizome | Dermatitis and other skin disorders. | Anti-acne In vivo, Anti-inflammatory, Antioxidant | Alkaloids, , furochromones, glycerol, fatty oils, limolic acid, myristic acid, n-octadecanoic acid, starch, saponsins, sesquerpenes, xerophytic acid, terpenoids, polyphenol, and vanillic | [243-245] |
| Glehnia littoralis Fr. Schmidt ex Miq. | | Root | - | Antimicrobial, Antioxidant, Anti-inflammatory | Coumarins, coumarin glycosides and polyacetylenes | [246-249] |
| Humulus lupulus L. | Hop | Flower | Healing wounds and skin infections | Antimicrobial, Antioxidant | Xanthohumol, lupulones & humulones | [250] |
| Impatiens balsamina L. | Rose balsam | Leaf | Warts and snakebite | Antimicrobial | Flavonoids like kaempferol and quercetin lawsone, lawsone methylether, and methylene-3,30-hydroxycyclohexane | [251,252] |
| Juglans regia L. | Walnut | Walnut seed husk | Externally, the seeds are pulverized into a paste and applied as a poultice to areas of dermatitis and eczema | Antimicrobial, Antioxidant | Hydroxybenzoic tannins and naphthoquinones, naphthalenones, α-tetralones, and α-tetralone dimers, hydroxycinnamic acids, flavonoids, dihydroheptanoids, ceramides, alkanes, steroids, triterpenoids, sesquerpenes, and neolignans | [253-255] |
| Mitchellia repens L. | Partridge berry | Leaf | Astringent skin wash, astringent and mouth gargles | Hormone-balancing herbs | NA | [10] |
| Myrtus communis L. | Myrtle | Leaf | Topical disinfectant, astringent, vaginal douche, and mouth gargles | Antimicrobial | 5-Acetoxy-4-hydroxy-4-isoibutyl-2,2,6,6-tetramethylcyclohexan-1,3-dione, β-sitosterol, isomyrtucoummulone, endomperoxide-G,3-hormone, gallic acid, myricetin-3-O- | [47] |
| A. Bunge | Chiraita | Leaf | Skin infections | Antimicrobial, Antioxidant, Anti-inflammatory, Anti-androgen | Andrographolide (labdane diterpenoid) and echinodulin (polyphehhol) | [214,222-226] |
| Azadirachta indica | Neem | Leaf | Acne, psoriasis, eczema, ringworm, and even stubborn warts | Anti-acne In vivo, Anti-inflammatory, Antimicrobial | Azadirachitin, nimbim, nimbinid, nimboide, and limonoids quercetin and β-sitosterol | [228-231] |
| Calendula officinalis L. | Calendula | Flower heads | Bruised or damaged skin. Also traditionally used for the care of varicose veins. | Antimicrobial, Antioxidant, Anti-fibrotic, Anti-inflammatory, Antioxidant | Triterpenoids, flavonoids, coumarins, quinones, volatile oil, carotenoids | [232-236] |
| Cassia alata L. | Candle bush | Leaf | Skin diseases like eczema, including rough skin, blisters, inflammation, itchiness and bleeding | Antimicrobial, Antioxidant, Anti-acne in vivo | Flavones, flavonoids, flavonoids glycosides, alatinon, alononal and β-sitosterol-β-d-glucoside | [228,237-239] |
| Codonopsis pilosula (Franch.) Nannf. | Dangshen | Root | Tonic | Antimicrobial, Anti-inflammatory | Polyacetylenes, phenylpropanoids, alkaloids triterpenoids | [240-242] |
| Cyperus rotundus L. | Nagarmotha | Rhizome | Dermatitis and other skin disorders. | Anti-acne In vivo, Anti-inflammatory, Antioxidant | Alkaloids, , furochromones, glycerol, fatty oils, limolic acid, myristic acid, n-octadecanoic acid, starch, saponsins, sesquerpenes, xerophytic acid, terpenoids, polyphenol, and vanillic | [243-245] |
| Glehnia littoralis Fr. Schmidt ex Miq. | | Root | - | Antimicrobial, Antioxidant, Anti-inflammatory | Coumarins, coumarin glycosides and polyacetylenes | [246-249] |
| Humulus lupulus L. | Hop | Flower | Healing wounds and skin infections | Antimicrobial, Antioxidant | Xanthohumol, lupulones & humulones | [250] |
| Impatiens balsamina L. | Rose balsam | Leaf | Warts and snakebite | Antimicrobial | Flavonoids like kaempferol and quercetin lawsone, lawsone methylether, and methylene-3,30-hydroxycyclohexane | [251,252] |
| Juglans regia L. | Walnut | Walnut seed husk | Externally, the seeds are pulverized into a paste and applied as a poultice to areas of dermatitis and eczema | Antimicrobial, Antioxidant | Hydroxybenzoic tannins and naphthoquinones, naphthalenones, α-tetralones, and α-tetralone dimers, hydroxycinnamic acids, flavonoids, dihydroheptanoids, ceramides, alkanes, steroids, triterpenoids, sesquerpenes, and neolignans | [253-255] |
| Mitchellia repens L. | Partridge berry | Leaf | Astringent skin wash, astringent and mouth gargles | Hormone-balancing herbs | NA | [10] |
| Myrtus communis L. | Myrtle | Leaf | Topical disinfectant, astringent, vaginal douche, and mouth gargles | Antimicrobial | 5-Acetoxy-4-hydroxy-4-isoibutyl-2,2,6,6-tetramethylcyclohexan-1,3-dione, β-sitosterol, isomyrtucoummulone, endomperoxide-G,3-hormone, gallic acid, myricetin-3-O- | [47] |
| Herb | Common names | Part used | Traditional uses | Reported biological activities | Active constituents | Ref. |
|------|-------------|-----------|------------------|-----------------------------|-------------------|------|
| **Phellodendron chinense Schneid. or Phellodendron amurense Rupr.** | Cortex Phellodendri | Cortex | Acne | Antimicrobial, Anti-inflammatory, Anti-acne In vivo | Alkaloids (berberine, palmatine, and jatrorrhizine), isoquinoline alkaloid, limonoids, phenolic acid, quinic acid, lignans, and quercetin | [105,256-259] |
| **Rauwolfia serpentina L. Benth. ex Kurz.** | Indian Snakeroot | Root | Acne and skin diseases | Anti-acne activity | Alkaloids (reserpine, ajmaline, serpentine), phenolics, flavonoids | [260,261] |
| **Rhodomyrtus tomentosa (Aiton.)** | Australia Murta | Leaf | Abscesses, skin-whitening, anti-aging and skin beautifying agents. | Antimicrobial, Anti-acne in vivo | Rhodomyrtone | [262,263] |
| **Salmalia malabarica Schott** | Shalmali | Aerial parts | Various skin troubles, especially paste of thorns, work out on *Acne vulgaris* | Antimicrobial, Anti-inflammatory, Antioxidant | β- Sitosterol, β- sitosterol glycoside, hentriacontane, hentriacontanol, quercetin and kaempferol | [264-266] |
| **Sargassum macrocarpum C.Agardh** | Marine brown alga | | | Antimicrobial | Sargafuran | [267] |
| **Saussurea lappa Clarke** | Costus or Kuth root | Root | Inflammatory skin diseases | Antimicrobial, Anti-inflammatory, Anti-acne in vivo | Costunolide, dehydrocostus lactone, cynaropicrin, lappadilactone, germacrenes | [238,268-270] |
| **Serenoa repens (W. Bartram)** | Saw palmetto | Fruit | - | Anti-androgen, Anti-inflammatory, Anti-acne In vivo | Flavonoid, phosphoglycerides plant sterols and fatty acids, mainly lauric acid | [271-273] |
| **Taraxacum officinale (Weber) ex Wigg** | Dandelion | Leaf and root | Boils, blisters | Anti-inflammatory, Antioxidant, Antimicrobial | Butyro lactones, butanoates namely taraxiresoxide A-F | [274-278] |
| **Tinospora cordifolia (Wild.) Hook,f.and Thoms.** | Heartleaf moonseed | Root | Skin diseases | Anti-acne In vivo, Antioxidant | Alkaloids, terpenoids, lignans, steroids | [279,280] |
| **Verbena spp.** | Vervain | Flower top | Inflammatory disorders, skinburns, abrasions | Antimicrobial, Anti-lipase, Antioxidant, Anti-inflammatory | NA | [281-283] |
| **Vitex agnus castus L.** | Chasteberry | Fruit | Mild skin rash; increased acne | Anti-acne | Sabinene, 1, 8-cineole, 9-pinene. flavonoids (casticin, luteolin, apigenin) iridoid glycosides (agugside and aubcin diterpenes (vitexilactone, rotundifuran, vitetinifolin D) diterpene lactam (vitex lactam A), and fatty acids (linoleic and oleic acid) | [5,284,285] |
| **Vitex negundo L.** | Chinese chaste-tree | Leaves | Skin diseases | Anti-acne In vivo, Antimicrobial, Anti-inflammatory, Antioxidant, Anti-androgen | Negundoside, agugside, vitenmoside, 7,8 dimethyl herbacitin 3- rhamnoside, flavonoids, volatile constituents: viridiflorol, β- caryophyllene, sabinene, 4-terpineol, γ-terpinein, caryophyllene oxide, 1- octen-3-ol, globulol | [286-290] |

**4. Conclusion**

Conventional treatment of acne has been used for a long time. The extensive use of antibiotics led to the emergence of resistance in acne-related pathogens. Isotretinoin is effective in all stages of acne pathogenesis, yet it demonstrates various adverse effects and is teratogenic. Moreover, the high cost of conventional treatment of acne presents another drawback. Herbal
medicine has been used effectively since ancient times in acne treatment. The efficacy of such herbs is not only due to their anti-bacterial activity but also their influence on androgenicity, increased sebum activity, inflammation, and hyperkeratinization associated with acne.

Based on the above data, it could be deduced that the class of phenolic constituents demonstrated the highest anti-acne potential among the investigated phytoconstituents. The terpenoids followed this class, demonstrating promising activity against acne and acting by different mechanisms. As for the alkaloids, berberine was the most prominent from various plants with an anti-acne effect.

Many herbs with a history of use in traditional cultures have entered the growing ‘cosmeceuticals’ market due to the advantages of better patient tolerance, long history of use, fewer side effects, and being relatively more cost-effective. Herbal extracts may be used alone or as adjuvants. Novel drug delivery systems such as microemulsion, liposomal, and nano-formulations can improve the drug delivery of herbal extracts or oil to reduce their associated side effects. This creates extensive interest in developing such formulations, thus flourishing the pharmaceutical industry.

The present review provides extensive and updated research on the anti-acne properties of medicinal plants and their phytoconstituents. This work provides a useful bibliography for further preclinical and clinical investigations and encourages the pharmaceutical industry to invest in the natural treatment of acne projects.

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Conflicts of Interest

The authors declare no conflict of interest.

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