

# The role of herbal plant essential oils in the treatment of acne vulgaris

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## ABSTRACT

Acne vulgaris (AV) is a disease of the pilosebaceous unit that often occurs at the age of 15 to 40 years. Various factors can influence this disease such as abnormal keratinization, microbial colonization, increased sebum production and complex inflammatory mechanisms. Essential oils can be used as an alternative therapy for AV. Various kinds of essential oils which are natural aromatic compounds from herbal plants, have long been known to help cure AV. This is because of the various beneficial compounds contained in each essential oils. The effects are varied such as anti-inflammatory, antioxidant and antimicrobial which will affect the healing mechanism of AV. This literature review discusses the role of essential oils from kaffir lime (*Citrus hystrix*), cinnamon (*Cinnamomum*), tea tree (*Melaleuca alternifolia*), lemongrass (*Cymbopogon citratus* (DC) Stapf. and *Cymbopogon flexuosus*), oregano (*Origanum vulgare*) and lavender (*Lavandula angustifolia*) against AV treatment.

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## INTRODUCTION

Acne vulgaris (AV) is a chronic disease of the pilosebaceous unit and is one of the most common diseases in individuals aged 15 to 40 years (Masterson, 2018). This disease is characterized by non-inflammatory (comedones) and inflammatory (papules, pustules, nodules, and cysts) skin lesions, which mainly occurs in areas rich in sebum (face, back, and chest) (Ghovvati et al., 2019). Epidemiologically, this disease ranks as the eighth most common disease worldwide, affecting 9.4% of the world's population (Tan & Bhate, 2015). Pharmacological treatment of AV has been widely used, studied, but there are still many factors that reduce its effectiveness such as lack of patient compliance, lack of knowledge about how to use drugs, fear of side effects that can occur, and the number of costs incurred (Tuchayi et al., 2016). Therefore, alternative treatment is needed that supports pharmacological treatment, one of which is by using essential oils. However, there are still few studies that focus on the use of essential oils for the treatment of this disease (Lambrechts et al., 2017).

Essential oils are generally known as complex and volatile natural aromatic compounds from plants, which are characterized by two or three main components with fairly high levels (20-70%) compared to other components that are present in small amounts (Majeed et al., 2015). With various chemical components contained in it, this oil has many benefits in the health sector, especially in the treatment of skin diseases, such as acne vulgaris. Several types of essential oils have been proven to be useful in the treatment of acne vulgaris (Tisserand & Young, 2014). In addition, this oil certainly has advantages such as affordable, inexpensive manufacturing materials and minimal side effects, so that it becomes an added value in its use (Dilla Dertyasasa & Anindito Sri Tunjung, 2017). Therefore, this review aims to determine the role of various essential oils from herbal plants in the treatment of acne vulgaris.

## METHOD

The purpose of this literature review is to determine the role of various types of essential oils in the treatment of acne vulgaris. A total of 28 articles on 7 types of essential oils against acne vulgaris were used in this literature review and were taken from databases such as PUBMED, Science Direct, and Google Scholar. The unpatterned search terms used included keywords such as "Acne Vulgaris", "Herbal Plants", "Essential Oils", and "Aromatic compounds".

## RESULT AND DISCUSSION

### Acne Vulgaris

Acne vulgaris (AV) is a disease of the pilosebaceous unit of hair follicles on the skin associated with oil glands and usually affects individuals aged 15-40 years (Masterson, 2018; Williams et al., 2012). AV is characterized by the presence of non-inflammatory lesions such as open or closed comedones (black and white comedones) and inflammatory lesions such as papules, pustules, nodules, or cysts. The main pathogenic factors that play an important role in the development of AV are abnormal keratinization of the pilosebaceous follicular tract, microbial colonization (*Propionibacterium acnes*, *Staphylococcus aureus*, and *Staphylococcus epidermidis* being the most common), increased sebum production and complex inflammatory mechanisms involving innate and acquired immunity (Mazzarello et al., 2018; Zaenglein et al., 2016).

The lesions begin when the keratinocytes lining the hair follicles desquamate, creating micro comedones. At puberty, increased sebum production creates an environment that can sustain *P. acnes* colonization. As *P. acnes* proliferates, inflammatory and chemotactic mediators are produced, which promote further inflammation (Tan & Bhate, 2015). *P. acnes* plays an important role in the initiation and duration of inflammation. In infected sebaceous follicles, *P. acnes* releases lipases, proteases, and hyaluronidase that damage skin tissue (Kumar et al., 2016). Furthermore, *P. acnes* induces monocytes through activation of toll-like receptors 2 (TLRs 2) to secrete pro-inflammatory cytokines, such as tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), interleukin (IL)-1 and IL-8. Excessive secretion of pro-inflammatory cytokines is associated with AV severity (Chuang et al., 2018).

The severity of AV can vary widely from mild, to moderate, and severe (including isotretinoin-induced fulminant AV) with the involvement of systemic symptoms, such as fever, arthralgia, and bone lytic lesions. This division of severity serves to determine the specificity of the type of treatment given (Zaenglein et al., 2016). In addition to pharmacological treatment, of course, there are many other alternative treatments as a complement to support AV healing, one of which is essential oils.

### Essential Oils in the Treatment of Acne Vulgaris

Essential oils are complex and volatile natural aromatic compounds from plants, which usually have two or three main components with fairly high levels (20-70%) compared to other components that are present in smaller amounts (Majeed et al., 2015). However, some studies divide its components into three, which are the main (20-95%), secondary (1-20%), and residual components (less than 1%).

This oil is popular in complementary medicine and is often used to treat dermatological conditions like AVs. For example, *Melaleuca alternifolia* Cheel. (tea tree), known worldwide for its essential oil having anti-infective effects and is used in many commercial AV products (Orchard et al., 2019).

Essential oils are rarely used purely when applied directly to the skin because they can cause skin irritation. This is the reason why the vehicle is used as a medium for the oil to be applied to the skin. The combination of essential oil and vehicle (cream, gel, or carrier oil (vegetable oil or fixed oil)) is believed to reduce the toxicity of essential oils to the skin, slow the evaporation rate and increase the absorption of essential oils. Essential oils are mainly composed of lipophilic molecules, small and non-polar so they are easy to penetrate the skin and cause the effects of the active substances they contain. In addition, vehicles containing essential oils do not need to add additional chemicals as preservatives, because of their antimicrobial and antifungal effects (Orchard et al., 2019; Sarkic & Stappen, 2018).

### Effects of Several Types of Essential Oils on Acne Vulgaris

#### a. Kaffir Lime Essential Oil

The kaffir lime plant or commonly known by the Latin name *Citrus hystrix*, has been scientifically proven to be an alternative AV treatment. The essential oils of this plant has a role as antimicrobial and anti-inflammatory against AV. This is inseparable from the content of chemical compounds in it. Several compounds have been shown to help treat AV (Abirami et al., 2014; Wijayadi & Rusliati, 2020).

Several terpenoid compounds have been proven as antimicrobial agents, namely linalool and seychellene, because they can damage cell membranes of *P. acnes*. This is also supported by research showing the effect of concentration of *C. hystrix* essential oil on the diameter of the inhibition area of *P. acnes*, namely the greater the concentration, the greater the diameter of the inhibition area of *P. acnes*. Other compounds such as linoleic acid work as anti-inflammatory (Wijayadi & Rusliati, 2020). Therefore, this oil can help treat AV and prevent the formation of scar tissue that can occur (Dilla Dertyasasa & Anindito Sri Tunjung, 2017). This is in line with research which found that the D-limonene compound of this oil can inhibits *P. acnes*, reduces inflammation, reduces scar tissue formation and helps relieve the severity of AV (Abirami et al., 2014). Traditionally, lime/lime essential oil is usually applied topically directly to the skin. However, this causes discomfort and its stability is reduced, so it needs to be stabilized, one of which is by using nanocapsules when the topical application is applied (Wijayadi & Rusliati, 2020).

#### b. Cinnamon Essential Oil

Cinnamon essential oil or commonly known by the Latin name *Cinnamomum* has been proven in several studies to be useful in the treatment of AV. There are various species of this plant that are often used as essential oils. According to the research of Ghovvati et al. (2019), this oil can reduce the size and quantity of inflammatory and non-inflammatory lesions of AV. Regarding its anti-inflammatory effect, some studies found that the compounds lincomolide A, secosubamolide and cinnamtannin B1 contained in the stalk of *C. validinerve*, have the potential for inhibition of superoxide anion generation and elastase release from human neutrophils (C. Yang et al., 2020).

In the essential oil of another species, *C. zeylanicum*, eugenol was found as the main component, which has antimicrobial and antioxidant effects (Orchard et al., 2018; Thombare & Mukundan, 2012). However, from the study of Orchard et al. (2018), it was stated that there is a compound that has a stronger antimicrobial effect, namely cinnamaldehyde, which is contained in *C. burmannii*, especially against *Staphylococcus epidermidis*. The difference in the dominance of this compound depends on the sample used in the preparation. Compounds from cinnamon bark primarily contain cinnamaldehyde that is different from that found in cinnamon leaf (eugenol) and cinnamon root bark (camphor). Regarding its antimicrobial effect, in the study of Raihan et al. (2016), it was found that this oil was shown to have zones of inhibition at concentrations of 25%, 50%, and 100%, respectively, of 16.7, 26.7, and 31.3 mm, against *S. epidermidis*, respectively, compared to the

zone of inhibition of vancomycin. which is 17 mm. While in the study of Aminuddin et al. (2018) that discussed its effect on *P. acnes*, an inhibition zone of 13.9 mm was obtained.

#### c. Tea Tree Essential Oil

Tea tree essential oil or commonly known by the Latin name *Melaleuca alternifolia*, has long been known to have enormous potential in the treatment of dermatological disorders, especially mild to moderate AV, due to its potential against a broad spectrum of microorganisms. This oil is known to be the second treatment of choice after benzoyl peroxide in the treatment of AV because of its antimicrobial and anti-inflammatory activity (Yadav et al., 2016).

As an AV therapy, of course, antibiotics are one of the regimens used, but the increasing resistance to them raises concerns about their use so various other alternatives have emerged, one of which is tea tree oil (Pazyar et al., 2012). The goal of conventional AV treatment is antimicrobial effects (benzoyl peroxide and antibiotics), anti-inflammatory effects (retinoids), normalization of follicular keratinization (retinoids), reduction of sebum secretion (retinoids), and keratolytic activity (salicylic acid). Of these several purposes, tea tree oil fulfills the first and second purposes (Hammer, 2014).

This oil contains 80-90% cyclic monoterpene compounds, consisting of 50% oxygenated and the other 50% in the form of hydrocarbons, namely terpinene-4-ol, p-cymene,  $\alpha$ -terpinene, limonene 1,8-cineol,  $\alpha$ -terpineol, terpinolene, 1,8-cineol, sabinene dan  $\alpha$ -pinene (Ahmad & Popli, 2019; A. C. De Groot & Schmidt, 2016). Related to its anti-inflammatory activity, the compound terpinene-4-ol is known to reduce the production of IL-1, IL-8, IL-10, prostaglandin E2, and TNF. These compounds can also modulate vasodilation and plasma extravasation. In addition, this compound together with -terpineol compounds, suppresses the production of superoxide by monocytes (Ahmad & Popli, 2019).

Apart from being anti-inflammatory, its antimicrobial activity has also been proven in various AV studies. This activity has been demonstrated in three laboratory studies of this oil against *P. acnes*, which reported minimum inhibitory concentrations (MIC) of this oil of 0.31-0.62% and 0.5% against one variant of *P. acnes*, and minimum bactericidal concentrations of 0.25-0.5%. for 32 variants of *P. acnes* (Hammer, 2014).

In AV treatment, it was found that this oil was found to be effective in the topical form of 5% in gel form against mild to moderate AV (Pazyar et al., 2012). In the study of Malhi et al. (2016), it was found that topical treatment with 5% tea tree oil for 12 weeks reduced AV lesions by 54%. However, The European Cosmetic Association recommends the use of no more than 1% tea tree oil in cosmetic preparations (Ahmad & Popli, 2019).

#### d. Lemongrass Essential Oil

Lemongrass essential oil or commonly known by the Latin name *Cymbopogon citratus* (DC) Stapf. and *Cymbopogon flexuosus* grows in most tropical and subtropical countries. This plant comes from India and Indonesia, and was then introduced and cultivated in most tropical countries, including Africa (Algeria, Egypt, Morocco), South America, and Indochina. This plant has long been used to treat various diseases, including AV. To obtain the essential oil from this plant, the leaves are taken and processed by steam distillation technique. This oil has various biological activities such as anticancer, antioxidant, anti-inflammatory, antimicrobial, and antifungal (A. De Groot & Schmidt, 2016; Lambrechts et al., 2017).

The antimicrobial activity of this oil has long been shown to be beneficial in the treatment of AV. From the study of Bunrathep et al. (2020), it was found that citral compounds (geranial and neral) which are the major components in this oil, provide high efficacy against pathogens such as *P. acnes* and *S. epidermidis* with MIC 0.125-0.25 mg/ml, and an inhibition zone of  $21.47 \pm 0.81$  mm for *P. acnes* and  $17.80 \pm 1.13$  mm for *S. epidermidis*. In addition, citral plays a major role in the anti-inflammatory effect of this oil. While from the study of Song et al. (2016) showed that this compound can inhibit TNF-, IL-8, vascular cell adhesion molecule 1 (VCAM-1), and intercellular adhesion

molecule 1 (ICAM-1) in human umbilical vein endothelial cells. In animal studies, citral significantly inhibits oxidative stress, apoptosis, and activation of macrophages as well as Nuclear factor kappa B (NF- $\kappa$ B), so it plays a role in antioxidant and anti-inflammatory activity (S. M. Yang et al., 2013).

#### e. Oregano Essential Oil

The oregano plant or commonly known by the Latin name *Origanum vulgare* is a member of the Labiatae family (Lamiaceae) originating from Europe and North America and cultivated in various parts of the world. The genus *Origanum* currently exists in various regions, especially the Mediterranean region, and includes about 45 species, 6 subspecies, and 3 varieties. In therapy, the most frequently used plant parts are aerial plants (leaves, flowers, and seeds) (Bora et al., 2022; Chuang et al., 2018).

The essential oil of this plant has been widely studied for its benefits. In one study, it was found that the compounds that play a major role in its therapeutic activity are carvacrol or 2-methyl-5-(1-methylethyl)-phenol and thymol or 2-isopropyl-5-methylphenol. These two compounds were synthesized through the aromatization and hydroxylation of p-cymene (Bora et al., 2022). The antimicrobial activity of these two compounds has been proven in various studies. In the study of Spagnoletti et al. (2016), it was found that the essential oil of *Origanum vulgare* subsp. *hirtum* showed an IC<sub>50</sub> value of 0.148 mg/ml in human epidermal keratinocytes (HaCaT). Meanwhile, in a study using the nanoencapsulated form, this oil could inhibit antibiofilm activity against *Escherichia coli* at subcytotoxic concentrations (0.03 mg/ml), while the IC<sub>50</sub> value was low. obtained from pure oregano oil and encapsulated 0.093 and 0.044 mg/ml respectively (Kapustová et al., 2021).

In a study on the benefits of oregano against AV, it was investigated in the form of nanoemulsions in a mouse model with AV and compared with antibiotics. This form was topically applied to the ears of mice infected with *P. acnes* at a dose of 0.672 mg/ml. Meanwhile, another group of rats were given 2% erythromycin epicutaneously as a positive control. This formulation showed stronger inflammation inhibition than antibiotics. Then it was also found that the nanoemulsion reduced the number of bacteria to  $4.3 \times 10$  CFU/ml, indicating a superior bactericidal effect compared to erythromycin ( $3.5 \times 10^3$  CFU/ml) (Bora et al., 2022; Taleb et al., 2018).

In addition, it was also found that the antimicrobial activity of this oil showed a MIC of 0.34 mg/ml and a minimum bactericidal concentration (MBC) of 0.67 mg/ml against *P. acnes*, as well as a MIC of 0.67 mg/ml and an MBC of 1.34 mg/ml against *S. epidermidis*. In addition, oregano also exhibited killing dynamics for 12 and 8 hours against *P. acnes* and *S. epidermidis*, respectively. From these results, it was concluded that oregano showed superior antimicrobial effects compared to antibiotics (Bora et al., 2022; Taleb et al., 2018).

#### f. Lavender Essential Oil

The lavender plant or commonly known by the Latin name *Lavandula angustifolia* is an important member of the Lamiaceae family. This species is widely distributed in the Mediterranean region and is cultivated in Italy, France, and Spain, and is often used for extracting its essential oil. The essential oil is usually obtained from the steam distillation process of the flower heads and leaves of the plant. This oil is often used for skin and beauty problems, especially against AV (Mhmood et al., 2020; Sharma et al., 2019).

The main active compounds of this oil are monoterpenes (linalool, linalyl acetate, lavandulol, geraniol, bornyl acetate, borneol, terpineol, and eucalyptol or lavandulyl acetate), which have different antibacterial, antifungal, and anti-inflammatory activities, depending on their chemical composition. The good antimicrobial properties of lavender essential oil are achieved by its high and nearly equal content of linalool and linalyl acetate (Mhmood et al., 2020).

From the study of Kim and Shin (2013) with 54 participants who were divided into 2 groups (control and test) for 4 weeks using a topical application of a mixture of 3% tea tree essential oil, 2% lavender essential oil and jojoba essential oil on AV, the results showed a significant decrease in inflammatory and non-inflammatory lesions in the test group, whereas in the control group there

was only a significant decrease in non-inflammatory lesions. Meanwhile, in the study of Abdullhusein and Al-Awsi (2018), it was found that this oil showed high efficiency at the lowest concentration (250 mg/ml), which causes a total inhibition of bacteria by 18 mm.

## CONCLUSION

Essential oils have long been known to have various benefits for skin health, especially for AV. Various kinds of essential oils such as essential oils of kaffir lime, cinnamon, tea tree, lemongrass, oregano, and lavender have been scientifically proven to be beneficial for the treatment of AV because they have various beneficial effects, namely as antimicrobial, anti-inflammatory, and antioxidant. However, its use as an alternative AV treatment is still not optimal, so further research is needed.

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