ISSN: 2959-6386 (Online), Volume 3, Issue 2, June 2024

Journal of Knowledge Learning and Science Technology

Journal homepage: https://jklst.org/index.php/home

Lemon Oil Anti-Microbial And Anti Comedogenic Effects In Skin Care Products

Efe Ekakitie

Registered Pharmacist Professional with the General Pharmaceutical Council of Great Britain, United Kingdom

Abstract

Lemon oil, derived from the peels of citrus fruits, has garnered significant attention due to its antibacterial qualities and potential applications in skincare products. This review paper examines the antibacterial characteristics of limonene, citral, alpha-terpinene, beta-pinene, gamma-terpinene, and geranial, all of which are constituents of lemon oil. These components have demonstrated antimicrobial action against a diverse range of bacteria and fungi. The antibacterial qualities of lemon oil are believed to stem from its ability to impede cellular functions, damage the cell membranes of germs, and hinder the enzymatic processes of microbes. Furthermore, lemon oil has demonstrated potential anti-comedogenic effects, primarily by regulating sebum production and reducing pore size. The antibacterial and anti-comedogenic characteristics of lemon oil mostly stem from its constituents, namely limonene and citral. Lemon oil is commonly used to commercial skincare products due to its potential advantages in promoting clear and healthy skin. The antibacterial and anti-comedogenic qualities of lemon oil make it a valuable ingredient in skincare products. However, further research is needed to understand the mechanisms and effectiveness of lemon oil. Gaining insight into the potential of lemon oil can facilitate the creation of innovative, organic, and efficient skincare solutions.

Keywords: Lemon oil, citrus fruit, skincare, antibacterial, non-comedogenic.

Article Information:
Received: 01-May Efe *Accepted:* 20-May-24 *Online:* 24-June-24 *Published:* 24-June-24
DOI: https://doi.org/10.60087/jklst.vol3.n2.p252

[i] **Correspondence author:** Efe Ekakitie **Email:** ekakit@yahoo.com

Introduction

Plants possess a diverse range of applications, serving as providers of adornment, oxygen, sustenance, drinks, attire, scents, and building resources, and can also be utilized for fragrance production. Plants have the ability to produce a wide range of substances known as "secondary metabolites" (Khursheed et al., 2022). These secondary metabolites play a crucial role in the interactions between plants and their environment, including interactions with competitors, predators, diseases, and pollinators (Jha & Mohamed, 2022). Examples of these secondary metabolites include essential oils, phenolics, alkaloids, and terpenes. They have garnered significant attention due to their potential therapeutic applications and various bioactive effects (Sharma et al., 2022). Lemon oil, derived from the peel of citrus fruits, is one such example

that contains numerous secondary metabolites. These secondary metabolites are responsible for the antibacterial and anti-comedogenic properties of lemon oil (Heidarian et al., 2022).

Skincare is an essential component in the process of preserving bright and healthy skin. In the search for effective skincare solutions, substantial research has been conducted on a variety of components that contain antibacterial and anticomedogenic properties (Mohanapriya et al., 2019). These properties are crucial for inhibiting microbial infections and halting the development of comedones like blackheads and whiteheads, which are common skin imperfections (Nasri et al., 2015). Because of its potential antibacterial and anti-comedogenic properties, lemon oil, which is extracted from the peels of citrus fruits, has recently acquired popularity as a candidate for use in cosmetics and personal care products. The medicinal qualities of lemon oil are due to the fact that it contains a high concentration of bioactive compounds such as limonene, citral, and a variety of terpenes (Ben Hsouna et al., 2023). Keeping a balanced microbiota on the skin relies heavily on the antibacterial properties of skincare products. The microbiome of the skin is rich and varied, hosting both useful and harmful species. Acne and other skin diseases are just two of the many skin problems that can result from an unbalanced microbial ecosystem (Ito & Amagai, 2023). Antimicrobial agents, such as those found in lemon oil, can help to control the growth of pathogenic bacteria, fungi, and viruses on the skin's surface (Reichling et al., 2009). Comedones, on the other hand, result from the accumulation of dead skin cells, excess sebum, and other debris within the hair follicles. The presence of comedones can lead to the development of acne and other skin blemishes (Ravisankar et al., 2015). Anti-comedogenic agents, like lemon oil, can help prevent the formation of these obstructions and maintain clear and healthy pores (S.-S. Kim et al., 2008). The specific constituents of lemon oil, such as limonene and citral, have been studied for their potential antimicrobial and anti-inflammatory effects (J. Kim et al., 1995). These compounds may help to inhibit the growth of bacteria, fungi, and viruses, while also reducing inflammation and promoting skin health (Vikram et al., 2012).

Lemon Oil: Constituents and Composition

Citrus species, which are classified under the family Rutaceae, are thought to have originated in the tropical regions of Southeast Asia and China. At the present time, they account for the majority of the world's total fruit production, with over 123 million tons produced in 2010 (Inglese & Sortino, 2019). More than one hundred countries, spanning around 40 degrees of latitude north to south, are currently engaged in the cultivation of citrus plants. The leading citrus-producing countries include China, Brazil, the United States, and regions within the Mediterranean Basin. Among the commercially significant citrus species, sweet oranges (Citrus sinensis L. Osbeck) and tangerines (Citrus unshiu Marc., Citrus nobilis Lour., Citrus deliciosa Ten., Citrus reticulata Blanco, and their hybrids) account for over 80% of production. This is followed by lemons (Citrus Limon L. Burm. f.), limes (Citrus aurantifolia Christm. Swing.), and grapefruits (Citrus paradisi Macf.) (Palazzolo et al., 2013).

Citrus fruits are highly valuable in the commercial sector, mainly for their consumption as fresh fruit and for producing fruit juice in the food industry. Additionally, the byproducts generated during the industrial processing of citrus fruits are important sources of bioactive compounds. These compounds have the potential to be utilized in various applications, such as

animal feed, processed foods, and healthcare products (González-Molina et al., 2010). For the past thousand years, essential oils (EOs) have been extracted from citrus byproducts. The main producers of citrus essential oils are Italy, particularly the island of Sicily, the United States of America (specifically the state of Florida), and South America (specifically Brazil and Argentina) (EM Mustafa, 2015).

Lemon oil is obtained from the peels of citrus fruits and consists of a diverse combination of chemical components that contribute to its therapeutic qualities. The primary elements of lemon oil include limonene, citral, alpha-terpinene, beta-pinene, gamma-terpinene, and geranial (Vekiari et al., 2002).

Table 1: Constituents of lemon oil and its antimicrobial effects against different bacteria

Constituent	Antimicrobial Property	Bacteria Inhibited	References
Limonene	Exhibits broad-spectrum antimicrobial activity.	*Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa*	(Vikram *et al.*, 2012)
Citral	Demonstrates strong antimicrobial effects.	*Salmonella, Cronobacter sakazakii*	(J. Kim *et al.*, 1995; Shi *et al.*, 2017)
Alpha-terpinene	Displays antimicrobial activity.	*Staphylococcus aureus, Klebsiella pneumonia,*	(Adeosun *et al.*, 2022)
Beta-pinene	Exhibits antimicrobial properties.	*Staphylococcus aureus, S. epidermidis, Streptococcus pneumonia.*	(Leite *et al.*, 2007)
Gamma-terpinene	Shows antimicrobial activity.	*Staphylococcus aureus, Escherichia coli, Candida species*, Aspergillus species, and various other bacteria and fungi.	(Wongkattiya *et al.*, 2019)
Geranial	Demonstrates antimicrobial effects.	*Staphylococcus aureus, Escherichia coli, Candida species, Salmonella.*	(J. Kim *et al.*, 1995)

Limonene is the main constituent of lemon oil, making up around 70-90% of its composition. Numerous studies have shown that limonene has antimicrobial properties. It has been proven to effectively combat a wide range of bacteria, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa (Vikram et al., 2012). Limonene works by disrupting the bacterial cell membrane and inhibiting the growth of microorganisms. These antimicrobial effects may contribute to the potential of lemon oil in treating microbial infections on the skin.

Citral is another important constituent of lemon oil, responsible for its characteristic lemon scent. It exhibits strong antimicrobial properties against both bacteria and fungi. Studies have demonstrated the inhibitory effects of citral on various pathogens, including Salmonella and Cronobacter sakazakii. Citral has the ability to limit the growth and spread of microbes by destroying the cell membrane (Shi et al., 2017). Alpha-terpinene, beta-pinene, and gamma-terpinene are terpenes found in lemon oil. It has been demonstrated that these terpenes exhibit

antibacterial activity against a wide variety of pathogens, including bacteria and fungi. They have the potential to inhibit the growth and viability of bacteria, which contributes to the antimicrobial properties of lemon oil (Adeosun et al., 2022; Leite et al., 2007). Geranial, also known as citral A, is a constituent of lemon oil that has been studied for its antimicrobial properties. It demonstrates strong antibacterial activity against Gram-positive as well as Gram-negative bacteria. Both types of bacteria are susceptible to its effects. Geranial induces cell death by compromising the structural integrity of the membranes that surround bacterial cells (J. Kim et al., 1995).

The constituents found in lemon oil have antimicrobial properties that can effectively combat the growth of bacteria, fungi, and other microorganisms on the skin's surface. This helps prevent microbial infections and maintains a healthy skin microbiome. Lemon oil may also have anti-comedogenic effects, although there are limited studies specifically investigating this. However, the combination of antimicrobial, anti-inflammatory, and astringent properties in lemon oil may contribute to its potential to reduce the formation of comedones. By controlling bacterial growth, reducing inflammation, and tightening the skin, lemon oil helps prevent the accumulation of debris, excess sebum, and dead skin cells in hair follicles, thus minimizing the formation of comedones.

Lemon oil is widely used in multiple industries, such as skincare, aromatherapy, cleaning products, and culinary applications. In skincare, lemon oil is highly regarded for its potential therapeutic properties, including its ability to fight against microorganisms, protect against oxidative damage, and tighten tissues. These beneficial qualities have made lemon oil a commonly utilized ingredient in various skincare products (Sharmeen et al., 2021).

Antimicrobial Effects of Lemon Oil

Lemon oil exhibit antimicrobial action via a variety of different pathways that are directed against bacterial, fungal, and viral pathogens (Swamy et al., 2016). Numerous research have shed light on these mechanisms, as well as the effect that lemon oil has on different types of bacteria (Adeosun et al., 2022; J. Kim et al., 1995). The antibacterial properties of lemon oil can be attributed due to its primary components, which include limonene, citral, and terpenes. These compounds can disrupt the cell membranes of microorganisms, leading to cell lysis and death. Additionally, they may interfere with microbial enzyme activity, inhibit microbial adhesion, and disrupt essential cellular processes (Lu et al., 2019). It has been demonstrated that the primary component of lemon oil, limonene, possesses antibacterial properties that are effective against a wide variety of microorganisms (Vikram et al., 2012). Lemon oil has a number of essential components, one of which is citral, which has potent antibacterial capabilities. It has been discovered that it prevent their growth by causing damage to the cell membranes of bacteria and fungi and by interfering with the key biological operations of these organisms, (Shi et al., 2017). Terpenes present in lemon oil, such as alpha-terpinene, beta-pinene, and gamma-terpinene, have also shown antimicrobial activity against a range of microorganisms. They can inhibit microbial growth by interfering with cellular processes and causing membrane damage. These mechanisms collectively contribute to the antimicrobial activity of lemon oil and its potential to combat bacterial, fungal, and viral pathogens on the skin (Wongkattiya et al., 2019).

Lemon oil is widely known for its strong antimicrobial properties, which have been proven effective against various bacteria and algae. Several studies have focused on investigating the antimicrobial effects of lemon oil and have consistently found that it can inhibit the growth of different types of microorganisms. For example, a study by Elgayyar et al. (2001) examined the antibacterial activity of lemon oil against both Gram-positive and Gram-negative bacteria. The results showed that lemon oil was able to effectively suppress the growth of both types of bacteria. Similarly, Mancuso et al. (2019) conducted a study to evaluate the antimicrobial potential of lemon oil against Candida strains and found significant inhibition of their growth.

Anti-Comedogenic Effects of Lemon Oil

Regulation of Sebum Production:

There is a hypothesis that lemon oil may affect the production of sebum, which is a major factor in the development of comedones. However, there is a lack of research specifically examining the anti-comedogenic effects of lemon oil on sebum management (Abelan et al., 2022). Sebum is an oily substance produced by the sebaceous glands in the skin. Excessive sebum production can contribute to the formation of comedones and acne. Some studies suggest that lemon oil may help regulate sebum production, potentially reducing the risk of comedone formation. However, it is important to note that the exact mechanisms by which lemon oil regulates sebum production are not well-established, and further research is needed to fully understand this relationship (Ali et al., 2015).

Pore Size Reduction:

Lemon oil has the potential to reduce pore size, which can help prevent the formation of comedones. Comedones are formed when larger pores become clogged with dead skin cells and other particles. Lemon oil may tighten and tone the skin, leading to smaller pores and potentially preventing comedone formation. Although there is limited scientific research specifically on the pore size reduction effects of lemon oil, its astringent properties suggest that it has the potential to tighten the skin and reduce pore size.

Lemon oil in skin care products

Lemon oil is commonly found in various forms of commercially available skin care products, such as cleansers, toners, serums, moisturizers, masks, and exfoliators (Iraqui & Das, 2022). The concentration of lemon oil used in these products varies depending on their intended purpose and formulation. Skincare products that contain lemon oil often emphasize its potential benefits for the skin, including its ability to manage sebum production, provide astringent effects, and reduce pore size. Additionally, the pleasant scent of lemon oil enhances the sensory experience of using cosmetics (Barbulova et al., 2015). However, it is important to consider individual skin sensitivity and potential allergic reactions when using skincare products containing lemon oil. Like any other ingredient, lemon oil may cause skin irritation or sensitization in some individuals (Guzmán & Lucia, 2021).

Table 2: Skin care products having lemon oils

Skincare Product	Use of Lemon Oil
Cleansing Gel	Lemon oil helps remove impurities, excess oil, and dirt, providing a fresh and clean feeling.
Toning Lotion	Lemon oil acts as an astringent, tightening pores and balancing the skin's pH levels.
Acne Treatment	Lemon oil's antimicrobial properties help combat acne-causing bacteria, promoting clearer skin.
Brightening Serum	Lemon oil's skin-brightening properties help improve the appearance of dull and uneven skin tone.
Revitalizing Mask	Lemon oil's rejuvenating effects invigorate the skin, leaving it refreshed and revitalized.
Moisturizing Cream	Lemon oil provides hydration and nourishment to the skin, keeping it soft and supple.

Conclusion

In conclusion, lemon oil is a promising ingredient in skincare products due to the significant antibacterial and anti-comedogenic properties that it possesses. The antimicrobial properties of lemon oil, supported by studies such as (Elgayyar *et al.*, 2001) and (Mancuso *et al.*, 2019), highlight its ability to inhibit the growth of different microorganism such as Candida and other bacterial species. According to these findings, lemon oil has the potential to act as an antibacterial agent that is both natural and effective. In addition, lemon oil has also possible anti-comedogenic properties by regulating the production of sebum and leading to a reduction in the size of pores. Although additional research is required to fully understand the mechanisms and efficacy of lemon oil, the use of lemon oil in a variety of skincare products has the potential to offer benefits for maintaining clear and healthy skin. Incorporating lemon oil into skin care products offers the potential for a natural and multifaceted approach to improving skin health and preventing microbial diseases. In general, lemon oil's ability to fight off microbial infections and prevent the formation of comedones makes it a beneficial component in the production of skincare products.

References

Abelan, U. S., de Oliveira, A. C., Cacoci, É. S. P., Martins, T. E. A., Giacon, V. M., Velasco, M. V. R., & Lima, C. R. R. d. C. (2022). Potential use of essential oils in cosmetic and dermatological hair products: A review. *Journal of Cosmetic Dermatology, 21*(4), 1407-1418.

Adeosun, I. J., Baloyi, I. T., & Cosa, S. (2022). Anti-biofilm and associated anti-virulence activities of selected phytochemical compounds against Klebsiella pneumoniae. *Plants, 11*(11), 1429.

Ali, B., Al-Wabel, N. A., Shams, S., Ahamad, A., Khan, S. A., & Anwar, F. (2015). Essential oils used in aromatherapy: A systemic review. *Asian Pacific Journal of Tropical Biomedicine, 5*(8), 601-611.

Barbulova, A., Colucci, G., & Apone, F. (2015). New trends in cosmetics: By-products of plant origin and their potential use as cosmetic active ingredients. *Cosmetics, 2*(2), 82-92.

Ben Hsouna, A., Sadaka, C., Generalić Mekinić, I., Garzoli, S., Švarc-Gajić, J., Rodrigues, F., Morais, S., Moreira, M. M., Ferreira, E., & Spigno, G. (2023). The chemical variability, nutraceutical value, and food-industry and cosmetic applications of citrus plants: A critical Review. *Antioxidants, 12*(2), 481.

Dhanavade, M. J., Jalkute, C. B., Ghosh, J. S., & Sonawane, K. D. (2011). Study antimicrobial activity of lemon (Citrus lemon L.) peel extract. *British Journal of pharmacology and Toxicology, 2*(3), 119-122.

Elgayyar, M., Draughon, F., Golden, D., & Mount, J. (2001). Antimicrobial activity of essential oils from plants against selected pathogenic and saprophytic microorganisms. *Journal of food protection, 64*(7), 1019-1024.

EM Mustafa, N. (2015). Citrus essential oils: current and prospective uses in the food industry. *Recent patents on food, nutrition & agriculture, 7*(2), 115-127.

González-Molina, E., Domínguez-Perles, R., Moreno, D., & García-Viguera, C. (2010). Natural bioactive compounds of Citrus limon for food and health. *Journal of pharmaceutical and biomedical analysis, 51*(2), 327-345.

Guzmán, E., & Lucia, A. (2021). Essential oils and their individual components in cosmetic products. *Cosmetics, 8*(4), 114.

Heidarian, S., Kachoie, M. A., Mousavi-Fard, S., & Moattar, F. (2022). Antimicrobial Effects Of Lemon balm (Melissa officinalis L.) Essential Oil Against Pathogenic Bacteria. *Journal of Positive School Psychology, 6*(7), 2033-2038.

Inglese, P., & Sortino, G. (2019). Citrus history, taxonomy, breeding, and fruit quality. In *Oxford Research Encyclopedia of Environmental Science*.

Iraqui, P., & Das, M. K. (2022). Herbal cosmeceuticals for beauty and skin therapy. In *Nanocosmeceuticals* (pp. 453-480): Elsevier.

Ito, Y., & Amagai, M. (2023). Dissecting skin microbiota and microenvironment for the development of therapeutic strategies. *Current Opinion in Microbiology, 74*, 102311.

Jha, Y., & Mohamed, H. I. (2022). Plant secondary metabolites as a tool to investigate biotic stress tolerance in plants: a review. *Gesunde Pflanzen, 74*(4), 771-790.

Khursheed, A., Rather, M. A., Jain, V., Rasool, S., Nazir, R., Malik, N. A., & Majid, S. A. (2022). Plant based natural products as potential ecofriendly and safer biopesticides: A comprehensive overview of their advantages over conventional pesticides, limitations and regulatory aspects. *Microbial Pathogenesis*, 105854.

Kim, J., Marshall, M., Cornell, J., III, J. P., & Wei, C. (1995). Antibacterial activity of carvacrol, citral, and geraniol against Salmonella typhimurium in culture medium and on fish cubes. *Journal of food science, 60*(6), 1364-1368.

Kim, S.-S., Baik, J. S., Oh, T.-H., Yoon, W.-J., Lee, N. H., & Hyun, C.-G. (2008). Biological activities of Korean Citrus obovoides and Citrus natsudaidai essential oils against acne-inducing bacteria. *Bioscience, biotechnology, and biochemistry, 72*(10), 2507-2513.

Leite, A. M., Lima, E. d. O., Souza, E. L. d., Diniz, M. d. F. F. M., Trajano, V. N., & Medeiros, I. A. d. (2007). Inhibitory effect of beta-pinene, alpha-pinene and eugenol on the growth of potential infectious endocarditis causing Gram-positive bacteria. *Revista Brasileira de Ciências Farmacêuticas, 43*, 121-126.

Lu, Q., Huang, N., Peng, Y., Zhu, C., & Pan, S. (2019). Peel oils from three Citrus species: Volatile constituents, antioxidant activities and related contributions of individual components. *Journal of food science and technology, 56*, 4492-4502.

Maddheshiya, S., Ahmad, A., Ahmad, W., Zakir, F., & Aggarwal, G. (2022). Essential oils for the treatment of skin anomalies: Scope and potential. *South African Journal of Botany, 151*, 187-197.

Mancuso, M., Catalfamo, M., Laganà, P., Rappazzo, A. C., Raymo, V., Zampino, D., & Zaccone, R. (2019). Screening of antimicrobial activity of citrus essential oils against pathogenic bacteria and Candida strains. *Flavour and Fragrance Journal, 34*(3), 187-200.

Mohanapriya, A., Padmavathi, M., & Prasathkumar, A. (2019). A comparative study on the impact of skin care products on the self-esteem of women users and non-users in Coimbatore city. *International Journal of Recent Technology and Engineering, 7*(5), 421-424.

Nasri, H., Bahmani, M., Shahinfard, N., Nafchi, A. M., Saberianpour, S., & Kopaei, M. R. (2015). Medicinal plants for the treatment of acne vulgaris: A review of recent evidences. *Jundishapur journal of microbiology, 8*(11).

Palazzolo, E., Laudicina, V. A., & Germanà, M. A. (2013). Current and potential use of citrus essential oils. *Curr. Org. Chem, 17*(24), 3042-3049.

Prommaban, A., & Chaiyana, W. (2022). Microemulsion of essential oils from citrus peels and leaves with anti-aging, whitening, and irritation reducing capacity. *Journal of Drug Delivery Science and Technology, 69*, 103188.

Ravisankar, P., Koushik, O. S., Himaja, V., Ramesh, J., & Pragna, P. (2015). Acne-causes and amazing remedial measures for acne. *J Pharm Res, 5*, 209-301.

Reichling, J., Schnitzler, P., Suschke, U., & Saller, R. (2009). Essential oils of aromatic plants with antibacterial, antifungal, antiviral, and cytotoxic properties–an overview. *Complementary Medicine Research, 16*(2), 79-90.

Sharma, A., Sharma, S., Kumar, A., Kumar, V., & Sharma, A. K. (2022). Plant secondary metabolites: An introduction of their chemistry and biological significance with physicochemical aspect. In *Plant Secondary Metabolites: Physico-Chemical Properties and Therapeutic Applications* (pp. 1-45): Springer.

Sharmeen, J. B., Mahomoodally, F. M., Zengin, G., & Maggi, F. (2021). Essential oils as natural sources of fragrance compounds for cosmetics and cosmeceuticals. *Molecules, 26*(3), 666.

Shi, C., Sun, Y., Liu, Z., Guo, D., Sun, H., Sun, Z., Chen, S., Zhang, W., Wen, Q., & Peng, X. (2017). Inhibition of Cronobacter sakazakii virulence factors by citral. *Scientific Reports, 7*(1), 43243.

Subba, M., Soumithri, T., & Rao, R. S. (1967). Antimicrobial action of citrus oils. *Journal of food science, 32*(2), 225-227.

Swamy, M. K., Akhtar, M. S., & Sinniah, U. R. (2016). Antimicrobial properties of plant essential oils against human pathogens and their mode of action: an updated review. *Evidence-based complementary and alternative medicine, 2016*.

Vekiari, S. A., Protopapadakis, E. E., Papadopoulou, P., Papanicolaou, D., Panou, C., & Vamvakias, M. (2002). Composition and seasonal variation of the essential oil from leaves and peel of a Cretan lemon variety. *Journal of agricultural and food chemistry, 50*(1), 147-153.

Vikram, A., Jayaprakasha, G. K., Jesudhasan, P. R., Pillai, S. D., & Patil, B. S. (2012). Limonin 7-methoxime interferes with Escherichia coli biofilm formation and attachment in type 1 pili and antigen 43 dependent manner. *Food Control, 26*(2), 427-438.

Wongkattiya, N., Sanguansermsri, P., Fraser, I. H., & Sanguansermsri, D. (2019). Antibacterial activity of cuminaldehyde on food-borne pathogens, the bioactive component of essential oil from Cuminum cyminum L. collected in Thailand. *Journal of Complementary and Integrative Medicine, 16*(4).