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## Innovative Application of Juniperus Communis Wood Oil in Acne Skincare: Analyzing Its Antimicrobial Properties

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### Abstract

*This review study explores the potential of Juniperus communis wood oil in cosmetics, namely its efficacy in treating acne diseases and its antibacterial qualities. Acne is a common skin ailment characterized by inflammation and the presence of several forms of acne lesions. Traditional acne treatments sometimes involve medications that may have possible side effects, which has sparked a growing interest in natural alternatives with antibacterial properties. Juniperus communis, commonly referred to as juniper, is extensively utilized in traditional medicine for its firmly established therapeutic advantages. This article consolidates the current scientific literature on the use of Juniperus communis wood oil for acne treatment, encompassing its mechanisms of action and its capacity to attack acne-causing bacteria by means of its antimicrobial properties. The review analyzes the anti-inflammatory, antioxidant, sebum-regulating, and anti-comedogenic properties of Juniperus communis wood oil. The paper also evaluates the efficacy of the treatment by analyzing its influence on many indicators, such as the decrease in the number of lesions, inflammation, and sebum production, as evidenced in clinical investigations. The text explores several aspects related to safety factors and formulation considerations, including extraction processes, synergistic effects, and appropriate administration systems. The paper presents a comprehensive analysis of the potential benefits of utilizing Juniperus communis wood oil as a treatment for acne, its potential implications for future acne therapies, and the need for further research in this area.*

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

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### Introduction

Acne is a common dermatological condition that impacts a significant portion of the population, particularly throughout the teenage years and early adulthood. Acne is characterized by the presence of comedones, papules, pustules, or nodules on the skin, often accompanied by inflammation. Acne can exert a substantial influence on an individual's physical appearance and overall state of being, hence impacting their quality of life (Lynn et al., 2016). The primary approaches for controlling acne often entail the utilization of topical and oral medications. These therapies primarily target the underlying causes of acne, such as the overproduction of sebum, bacterial proliferation, inflammation, and abnormal keratinization of hair follicles (Vilar et al., 2015). While these therapies have demonstrated efficacy in many cases, they do possess inherent limitations. Some individuals may experience

adverse reactions to some medications, such as skin dryness, irritation, or increased susceptibility to sunlight. Moreover, the prolonged utilization of specific medications can lead to the development of antibiotic resistance (Snyder et al., 2014). As a result, there is a growing interest among researchers, skincare professionals, and consumers to explore natural remedies for the treatment of acne (Yarnell & Abascal, 2006). Plant extracts and essential oils, being natural substances, have garnered considerable attention due to their perceived safety and possible medicinal properties. These methods offer the chance for effective acne treatment with potentially decreased negative consequences (Winkelman, 2018).

*Juniperus communis* wood oil is a notable example of a natural product that is of interest. *Juniperus communis*, commonly known as juniper, holds great historical importance in traditional medicine, where it has been used to address many health issues (Bais et al., 2014). *Juniperus communis* wood oil is derived from the wood and branches of the juniper tree and contains a varied mixture of bioactive constituents. Tufail et al. (2023) propose that *Juniperus communis* possesses notable anti-inflammatory, antioxidant, and antibacterial properties, all of which are crucial in the management of acne.

This review study aims to consolidate the current scientific knowledge on the use of *Juniperus communis* wood oil in skincare, particularly for the treatment of acne diseases. This review aims to improve our understanding of the efficacy and safety of the chemical by examining its probable mechanisms of action and antibacterial activities. Furthermore, the growing interest in natural alternatives in the field of cosmetics highlights the need of researching plant extracts like *Juniperus communis* wood oil for the development of groundbreaking acne treatments. The study on the efficacy of *Juniperus communis* wood oil in treating acne aligns with the overall trend of utilizing natural alternatives in skincare (Han & Parker, 2017). By understanding the potential benefits and limitations, we can expand our options for treating acne and contribute to the development of innovative and long-lasting skincare treatments.

### **A Brief Overview of *Juniperus communis***

*Juniperus communis*, also known as juniper, is a plant that belongs to the Cupressaceae family. It exhibits a wide geographic distribution, encompassing Europe, North America, Asia, and select regions of Africa. *Juniperus communis* is well-known for its strong ability to thrive in various settings, including cold temperate climates, deserts, and mountainous areas (Tahir et al., 2016).

#### ***Historical uses in conventional medicine***

*Juniperus communis* has been widely utilized in traditional therapeutic practices throughout history. Diverse cultures have utilized distinct plant constituents for medicinal purposes. *Juniperus communis* has been employed for the treatment of several health conditions through the use of its berries, leaves, wood, and essential oil. The conventional uses of this drug include treating digestive disorders, respiratory conditions, arthritis, urinary tract infections, and skin issues (Prakash, 2015).

## *Architecture*

The essential oil derived from the wood of *Juniperus communis* is a highly valuable component of the plant. The material is composed of a complex mixture of bioactive compounds, including monoterpenes, sesquiterpenes, and other volatile molecules (Koukos & Papadopoulou, 1997). The main chemical constituents included in *Juniperus communis* wood oil are  $\alpha$ -pinene,  $\beta$ -pinene, myrcene, limonene, terpinene, and cedrol. The compounds identified in the study conducted by Zeraib et al. (2014) are accountable for the distinct aroma and potential therapeutic properties of the oil.

Alpha-pinene possesses anti-inflammatory properties that have the potential to alleviate the erythema and edema frequently observed in acne-related inflammation. As a result, it improves the skin's overall calmness and clarity (Him et al., 2008).

Beta-pinene, also referred to as  $\beta$ -pinene, exhibits anti-inflammatory properties and has been observed to possess antibacterial properties. According to Salehi et al. (2019), it possesses the capability to combat acne-causing bacteria and aid in reducing acne symptoms.

Myrcene demonstrates anti-inflammatory properties and has the potential to help decrease acne-related inflammation. Moreover, it has been suggested that it exhibits antioxidant characteristics, which protect the skin from oxidative stress (Kılıç et al., 2019).

Limonene exhibits both anti-inflammatory and antibacterial effects. It exhibits anti-inflammatory qualities and antibacterial activities against bacteria that cause acne, hence assisting in the overall management of acne (Nurzyńska-Wierdak et al., 2022).

Terpinene exhibits antibacterial characteristics and effectively inhibits the growth of microorganisms linked to acne. By directly targeting the microbiological aspect of acne, it aids in reducing the prevalence of these bacteria on the skin (Taleb et al., 2018).

**Cedrol:** Cedrol is widely recognized for its exceptional sedative and soothing properties. Higley (1998) suggests that the utilization of this product may potentially diminish skin irritation and redness resulting from acne, hence enhancing the overall health and appearance of the skin.

Geographical location, climate conditions, and extraction procedures can all impact the chemical composition of *Juniperus communis* wood oil. Scientists have conducted comprehensive analyses of the composition and pharmacological impacts of the oil in order to gain a better understanding of its potential advantages and the underlying processes by which it works (Esteban et al., 2023). The oil possesses a diverse array of bioactive constituents that confer upon it antibacterial, anti-inflammatory, and antioxidant properties. Therefore, it has the potential to be used in skincare, particularly for the treatment of acne (Gonçalves et al., 2022).

By examining the botanical traits, geographic range, historical usage, and chemical composition of *Juniperus communis*, we can get insights into its long-standing history and understand its potential medical advantages. These findings establish a foundation for studying the use of *Juniperus communis* wood oil in cosmetics and its specific effects on acne issues and antibacterial characteristics.

### **Mechanisms of action for treating acne**

Acne is a multifaceted skin condition that is affected by various variables. Understanding the fundamental mechanisms is crucial for developing effective medicines (Kanlayavattanakul & Lourith, 2011). The potential mechanisms of action of *Juniperus communis* wood oil in the treatment of acne have been investigated and can be summarized as follows:

#### *Properties that reduce inflammation:*

Inflammation plays a crucial role in both the initiation and progression of acne. *Juniperus communis* wood oil possesses anti-inflammatory qualities that can mitigate erythema, edema, and overall discomfort resulting from acne lesions. The oil includes bioactive compounds that have the ability to hinder pro-inflammatory molecules and pathways, resulting in a decrease in the skin's inflammatory response (Han & Parker, 2017).

#### *Effects associated with the inhibition of oxidation:*

Oxidative stress, resulting from an imbalance between free radicals and antioxidants, is recognized as a contributing factor to the development of acne. *Juniperus communis* wood oil exhibits antioxidant properties that can neutralize free radicals and alleviate oxidative stress. The management of acne may potentially be improved by this (Elmastaş et al., 2006). The oil's antioxidant components, including as terpenes and cedrol, has the capacity to eradicate reactive oxygen species and protect the skin from damage. Consequently, they enhance skin health and have the potential to aid in the management of acne (Höferl et al., 2014).

### **Control of sebum secretion:**

Excessive production of sebaceous glands is a major contributing factor in the development of acne. *Juniperus communis* wood oil has potential in regulating sebum production. Individual components of the oil, such as  $\alpha$ -pinene and limonene, possess the capacity to control the activity of sebaceous glands, leading to a reduction in sebum production (Abate et al., 2021). According to Abelan et al. (2022), *Juniperus communis* wood oil has the ability to control the production of sebum, which can help avoid clogged pores and the formation of acne lesions.

#### *Properties that inhibit the development of comedones (blackheads and whiteheads).*

Comedones, including whiteheads and blackheads, are a specific feature of acne. *Juniperus communis* wood oil has anti-comedogenic properties, which means it can prevent the formation of acne lesions (Maddheshiya et al., 2022). The oil has the potential to inhibit the obstruction of hair follicles and the formation of comedones by reducing the overproduction of sebum, regulating abnormal follicular keratinization, and promoting the exfoliation of dead skin cells (Abate et al., 2021).

Acquiring knowledge about these mechanisms of action provides useful insights into how *Juniperus communis* wood oil can effectively help to the treatment of acne. The oil offers a complete approach to addressing the underlying factors that contribute to acne, such as inflammation, oxidative stress, excessive sebum production, and the creation of comedones (Kalaba et al., 2020).

### **Impact of Antimicrobial Agents**

Acne is often associated with the fast proliferation of microorganisms on the skin, namely *Propionibacterium acnes* (*P. acnes*) and *Staphylococcus epidermidis* (*S. epidermidis*). The bacteria reside in the pilosebaceous units and have a part in the formation of acne lesions, which are accompanied by inflammation. Therefore, it is crucial to examine the antibacterial characteristics of *Juniperus communis* wood oil in order to understand its potential effectiveness in the treatment of acne (Wang et al., 2014).

Scientists conducted laboratory studies to investigate the antimicrobial properties of *Juniperus communis* wood oil against acne-causing bacteria. This research involves conducting studies to assess the effectiveness of the oil against *P. acnes* and *S. Epidermidis* is frequently examined in laboratory environments, as evidenced by the studies conducted by Orchard et al. (2018) and Popescu et al. (2023). The test results yield crucial data regarding the oil's ability to impede the proliferation and viability of these bacteria. The antibacterial activities of *Juniperus communis* wood oil can be ascribed to its chemical composition, namely the presence of bioactive compounds such as  $\alpha$ -pinene,  $\beta$ -pinene, and terpinen-4-ol (Glišić et al., 2007). Multiple researchers have found that these compounds exhibit potent antibacterial properties that effectively target a broad spectrum of bacteria, including *P. acnes* and *S. Epidermidis*.

Additionally, other research have compared the efficacy of *Juniperus communis* wood oil with that of conventional antibacterial therapies (Albrecht & Madisch, 2022). The objective of these research is to assess the effectiveness of the oil in relation to established antibacterial treatments. Conventional antimicrobial agents, such as antibiotics and topical antiseptics, are frequently used to treat acne. Nevertheless, because of worries about antibiotic resistance and negative consequences, there has been an increasing curiosity in investigating natural substitutes, such as *Juniperus communis* wood oil. Assessing the oil's antibacterial efficacy relative to conventional therapies helps determine its potential as a viable alternative or adjunct therapy for acne (Zhao et al., 2020). Scientists can assess the efficacy of *Juniperus communis* wood oil in combating acne-causing bacteria by examining its antimicrobial characteristics and comparing them to established antimicrobial therapies. These findings improve our understanding of the mechanism of action of the oil and its ability to precisely target the microbiological component of acne. This provides important insights into its potential function in acne treatment. Further research, including clinical trials, is required to ascertain the efficacy, optimal concentration, and long-term safety of *Juniperus communis* wood oil as an antibacterial agent for treating acne (Rezvani et al., 2009).

### **Empirical facts and clinical efficacy**

Clinical experiments have been done to test the efficacy of *Juniperus communis* wood oil in treating acne and to create scientific data supporting its potential therapeutic benefits. The findings of this research significantly augment our comprehension of the efficacy of oil in the treatment of acne. These clinical trials commonly examine various effectiveness metrics to assess the impact of *Juniperus communis* wood oil on acne. The measures include the following:

Lesion count reduction refers to the process of quantifying acne lesions, which include comedones, papules, pustules, or nodules. This method is often employed to evaluate the effectiveness of a treatment. Kanlayavattanakul and Lourith (2011) state that a decrease in the quantity of lesions indicates an amelioration in the severity of acne.

Acne is often associated with inflammation, and hence has anti-inflammatory properties. Evaluating inflammatory markers, such as erythema (redness) and swelling, helps determine the effectiveness of *Juniperus communis* wood oil in lowering inflammation and improving acne symptoms (Darwish et al., 2020).

**Sebum production regulation:** The excessive production of sebum plays a crucial role in the development of acne. Clinical trials may assess the impact of the oil on sebum production levels to determine its effectiveness in regulating sebum release and preventing clogged pores.

The clinical investigations provide useful insights into the potential benefits and effectiveness of *Juniperus communis* wood oil in the treatment of acne (Kanlayavattanakul & Lourith, 2011).

Various factors must be considered when developing a product. When assessing the efficacy of *Juniperus communis* wood oil in skincare products for acne treatment, it is crucial to consider many elements pertaining to the formulation. The considerations include the methods employed to extract and refine the oil, the potential synergistic effects with additional essential oils or substances, and the appropriate formulation and delivery systems for efficient skincare applications (Kozłowska et al., 2017).

### **Methods for isolating and refining substances:**

The extraction and purification procedures used can affect both the composition and therapeutic properties of *Juniperus communis* wood oil. Different extraction techniques, such as steam distillation or solvent extraction, might yield oils with distinct chemical compositions. It is essential to select extraction methods that preserve the required bioactive elements and ensure the oil's purity and quality (Bogolitsyn et al., 2019).

There is a possibility of experiencing synergistic effects when combining this essential oil with other oils or substances.

The effectiveness of *Juniperus communis* wood oil may be enhanced when combined with other essential oils or chemicals (Tariq et al., 2019). Tea tree oil and lavender oil possess antibacterial and anti-inflammatory properties, which have the potential to enhance the advantages of *Juniperus communis* wood oil. The combination of these essential oils may have a synergistic impact, working together to effectively treat symptoms of acne (Williams et al., 1998). The convergence of multiple variables can lead to increased efficacy or a broader spectrum of antimicrobial activity. The careful selection and blending of compatible substances can enhance the overall effectiveness of skincare formulations (Moussaoui & Alaoui, 2016).

#### *Techniques and systems for producing and disseminating goods:*

Effective skincare applications require appropriate formulation and delivery methods to ensure stability, skin penetration, and accurate results. When developing skincare products, it is crucial to use suitable carriers, emulsifiers, or solvents in order to efficiently include

*Juniperus communis* wood oil (Kouassi et al., 2022). The choice of formulation and delivery method, such as creams, gels, serums, or lotions, will depend on the intended purpose and specific needs of the targeted skin condition. Enhancing the formulation and delivery techniques of *Juniperus communis* wood oil can enhance its skin absorption capability and efficacy (Eskens & Amin, 2021; Patravale & Mandawgade, 2008).

In order to develop effective and user-friendly skincare solutions that can fully harness the potential benefits of *Juniperus communis* wood oil for treating acne, it is crucial to consider certain formulation parameters. Moreover, adhering strictly to impeccable production techniques and quality control protocols ensures the consistency, safety, and efficacy of the final skincare products. Considering these formulation considerations, the utilization of *Juniperus communis* wood oil in skincare products can enhance its curative attributes and provide a convenient, organic alternative for individuals seeking remedies to control acne.

### Conclusion

In summary, the current understanding of *Juniperus communis* wood oil in skincare for acne suggests that it has the potential to be a successful natural alternative for treating acne. The oil comprises significant chemical constituents, such as  $\alpha$ -pinene,  $\beta$ -pinene, myrcene, limonene, terpinene, and cedrol, which contribute to its anti-inflammatory, antibacterial, and antioxidant properties. *Juniperus communis* wood oil exhibits properties that render it a highly auspicious contender for efficiently combating the diverse elements that contribute to acne, including inflammation, bacterial proliferation, and oxidative stress.

According to current studies, *Juniperus communis* wood oil has shown potential in reducing acne lesions, irritation, and sebum production. This oil offers a comprehensive approach to addressing acne. Furthermore, the oil's antibacterial characteristics specifically target the bacteria that cause acne, providing an additional benefit in addressing the microbiological component of acne. Nevertheless, further clinical trials are required to ascertain its efficacy, optimal dosage, and long-term safety. The future prospects of utilizing *Juniperus communis* wood oil in acne treatments and cosmetic products are extremely promising. Due to its natural origin, possible therapeutic powers, and observed tolerance, this chemical is an attractive option for individuals seeking alternative or supplementary treatments for acne. By incorporating *Juniperus communis* wood oil into skincare products, an effective and eco-friendly approach to acne management may be achieved, which is especially beneficial considering the increasing preference for natural alternatives in skincare.

### References

- Abate, L., Bachheti, A., Bachheti, R. K., Husen, A., Getachew, M., & Pandey, D. (2021). Potential role of forest-based plants in essential oil production: an approach to cosmetic and personal health care applications. *Non-Timber Forest Products: Food, Healthcare, and Industrial Applications*, 1-18.
- 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.

Albrecht, U. W., & Madisch, A. (2022). Therapeutic potentials associated with biological properties of Juniper berry oil (*Juniperus communis* L.) and its therapeutic use in several diseases—A Review. *Bioactive Compounds in Health and Disease*, 5(9), 174-185.

Bais, S., Gill, N. S., Rana, N., & Shandil, S. (2014). A phytopharmacological review on a medicinal plant: *Juniperus communis*. *International scholarly research notices*, 2014.

Bogolitsyn, K., Krasikova, A., Gusakova, M., Ivakhnov, A., & Gravitis, J. (2019). Selective extraction of terpenoid compounds of *Juniperus communis* L. wood in the medium of a binary solvent (supercritical CO<sub>2</sub> with modifier). *Phytochemical analysis*, 30(6), 609-616.

Darwish, R. S., Hammoda, H. M., Ghareeb, D. A., Abdelhamid, A. S., Harraz, F. M., & Shawky, E. (2020). Efficacy-directed discrimination of the essential oils of three *Juniperus* species based on their in-vitro antimicrobial and anti-inflammatory activities. *Journal of ethnopharmacology*, 259, 112971.

Elmastaş, M., Gülçin, I., Beydemir, Ş., İrfan Küfrevioğlu, Ö., & Aboul-Enein, H. Y. (2006). A study on the in vitro antioxidant activity of juniper (*Juniperus communis* L.) fruit extracts. *Analytical letters*, 39(1), 47-65.

Eskens, O., & Amin, S. (2021). Challenges and effective routes for formulating and delivery of epidermal growth factors in skin care. *International journal of cosmetic science*, 43(2), 123-130.

Esteban, L. S., Mediavilla, I., Xavier, V., Amaral, J. S., Pires, T. C., Calhelha, R. C., López, C., & Barros, L. (2023). Yield, Chemical Composition and Bioactivity of Essential Oils from Common Juniper (*Juniperus communis* L.) from Different Spanish Origins. *Molecules*, 28(11), 4448.

Glišić, S., Milojević, S., Dimitrijević, S., Orlović, A., & Skala, D. (2007). Antimicrobial activity of the essential oil and different fractions of *Juniperus communis* L. and a comparison with some commercial antibiotics. *Journal of the Serbian Chemical Society*, 72(4), 311-320.

Gonçalves, A. C., Flores-Félix, J. D., Coutinho, P., Alves, G., & Silva, L. R. (2022). Zimbro (*Juniperus communis* L.) as a promising source of bioactive compounds and biomedical activities: A review on recent trends. *International Journal of Molecular Sciences*, 23(6), 3197.

Han, X., & Parker, T. L. (2017). Anti-inflammatory activity of Juniper (*Juniperus communis*) berry essential oil in human dermal fibroblasts. *Cogent Medicine*, 4(1), 1306200.

Higley, C. (1998). *Reference guide for essential oils: Abundant Health*.

Him, A., Ozbek, H., Turel, I., & Oner, A. C. (2008). Antinociceptive activity of alpha-pinene and fenchone. *Pharmacologyonline*, 3, 363-369.

Höferl, M., Stoilova, I., Schmidt, E., Wanner, J., Jirovetz, L., Trifonova, D., Krastev, L., & Krastanov, A. (2014). Chemical composition and antioxidant properties of Juniper berry (*Juniperus communis* L.) essential oil. Action of the essential oil on the antioxidant protection of *Saccharomyces cerevisiae* model organism. *Antioxidants*, 3(1), 81-98.

Kalaba, V., Marjanović-Balaban, Ž., Kalaba, D., Lazić, D., & Cvjetković, V. G. (2020). Antibacterial activity of essential oil of *Juniperus communis* L. *QUALITY OF LIFE (BANJA LUKA)-APEIRON*, 18(1-2).

Kanlayavattanakul, M., & Lourith, N. (2011). Therapeutic agents and herbs in topical application for acne treatment. *International journal of cosmetic science*, 33(4), 289-297.



Kılıç, S., Okullu, S. Ö., Kurt, Ö., Sevinç, H., Dündar, C., Altınordu, F., & Türkoğlu, M. (2019). Efficacy of two plant extracts against acne vulgaris: initial results of microbiological tests and cell culture studies. *Journal of cosmetic dermatology*, 18(4), 1061-1065.

Kouassi, M.-C., Grisel, M., & Gore, E. (2022). Multifunctional active ingredient-based delivery systems for skincare formulations: A review. *Colloids and Surfaces B: Biointerfaces*, 112676.

Koukos, P. K., & Papadopoulou, K. I. (1997). Essential oil of *Juniperus communis* L. grown in Northern Greece: Variation of fruit oil yield and composition. *Journal of Essential Oil Research*, 9(1), 35-39.

Kozłowska, J., Kaczmarkiewicz, A., Stachowiak, N., & Sionkowska, A. (2017). Evaluation of sebostatic activity of *Juniperus communis* fruit oil and *Pelargonium graveolens* oil compared to niacinamide. *Cosmetics*, 4(3), 36.

Lynn, D. D., Umari, T., Dunnick, C. A., & Dellavalle, R. P. (2016). The epidemiology of acne vulgaris in late adolescence. *Adolescent health, medicine and therapeutics*, 13-25.

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.

Moussaoui, F., & Alaoui, T. (2016). Evaluation of antibacterial activity and synergistic effect between antibiotic and the essential oils of some medicinal plants. *Asian Pacific journal of tropical biomedicine*, 6(1), 32-37.

Nurzyńska-Wierdak, R., Pietrasik, D., & Walasek-Janusz, M. (2022). Essential oils in the treatment of various types of acne—A review. *Plants*, 12(1), 90.

Orchard, A., Van Vuuren, S., Viljoen, A., & Kamatou, G. (2018). The in vitro antimicrobial evaluation of commercial essential oils and their combinations against acne. *International journal of cosmetic science*, 40(3), 226-243.

Patravale, V., & Mandawgade, S. (2008). Novel cosmetic delivery systems: an application update. *International journal of cosmetic science*, 30(1), 19-33.

Popescu, D. I., Botoran, O. R., Cristea, R., Mihăescu, C., & Şuţan, N. A. (2023). Effects of Geographical Area and Harvest Times on Chemical Composition and Antibacterial Activity of *Juniperus communis* L. Pseudo-Fruits Extracts: A Statistical Approach. *Horticulturae*, 9(3), 325.

Prakash, R. (2015). Medicinal plants used by tribal communities: A study of Uttarakhand Himalayan region. *International Journal of Humanities and Social Science Invention*, 4(2), 55-61.

Rezvani, S., Rezai, M. A., & Mahmoodi, N. (2009). Analysis and antimicrobial activity of the plant *Juniperus communis*. *Rasayan J. Chem*, 2(2), 257-260.

Salehi, B., Upadhyay, S., Erdogan Orhan, I., Kumar Jugran, A., LD Jayaweera, S., A. Dias, D., Sharopov, F., Taheri, Y., Martins, N., & Baghalpour, N. (2019). Therapeutic potential of  $\alpha$ - and  $\beta$ -pinene: A miracle gift of nature. *Biomolecules*, 9(11), 738.

Snyder, S., Crandell, I., Davis, S. A., & Feldman, S. R. (2014). Medical adherence to acne therapy: a systematic review. *American journal of clinical dermatology*, 15, 87-94.

Tahir, A., Jilani, M. I., Khera, R. A., & Nadeem, F. (2016). *Juniperus communis*: Biological activities and therapeutic potentials of a medicinal plant—A comprehensive study. *Int. J. Chem. Biochem. Sci*, *9*, 85-91.

Taleb, M. H., Abdeltawab, N. F., Shamma, R. N., Abdelgayed, S. S., Mohamed, S. S., Farag, M. A., & Ramadan, M. A. (2018). *Origanum vulgare* L. essential oil as a potential anti-acne topical nanoemulsion—In vitro and in vivo study. *Molecules*, *23*(9), 2164.

Tariq, S., Wani, S., Rasool, W., Shafi, K., Bhat, M. A., Prabhakar, A., Shalla, A. H., & Rather, M. A. (2019). A comprehensive review of the antibacterial, antifungal and antiviral potential of essential oils and their chemical constituents against drug-resistant microbial pathogens. *Microbial pathogenesis*, *134*, 103580.

Tufail, T., Ain, H. B. U., Saeed, A., Imran, M., Basharat, S., & Nayik, G. A. (2023). Juniper essential oil: An overview of bioactive compounds and functional aspects. *Essential Oils*, 415-427.

Vilar, G. N., Santos, L. A. d., & Sobral Filho, J. F. (2015). Quality of life, self-esteem and psychosocial factors in adolescents with acne vulgaris. *Anais brasileiros de dermatologia*, *90*, 622-629.

Wang, Y., Kuo, S., Shu, M., Yu, J., Huang, S., Dai, A., Two, A., Gallo, R. L., & Huang, C.-M. (2014). *Staphylococcus epidermidis* in the human skin microbiome mediates fermentation to inhibit the growth of *Propionibacterium acnes*: implications of probiotics in acne vulgaris. *Applied microbiology and biotechnology*, *98*, 411-424.

Williams, L. R., Stockley, J., Yan, W., & Home, V. (1998). Essential oils with high antimicrobial activity for therapeutic use. *International Journal of Aromatherapy*, *8*(4), 30-40.

Winkelman, W. J. (2018). Aromatherapy, botanicals, and essential oils in acne. *Clinics in dermatology*, *36*(3), 299-305.

Yarnell, E., & Abascal, K. (2006). Herbal medicine for acne vulgaris. *Alternative & Complementary Therapies*, *12*(6), 303-309.

Zeraib, A., Ramdani, M., Boudjedjou, L., Chalard, P., & Figuredo, G. (2014). Chemical composition and antibacterial activity of *Juniperus thurifera* L. essential oils. *Journal of BioScience & Biotechnology*, *3*(2).

Zhao, J., Wang, Y., Jiang, L., & Mu, Y. Z. (2020). The application of skin care product in acne treatment. *Dermatologic Therapy*, *33*(6), e14287.