

SYSTEMATIC REVIEW

The Effectiveness Of Tea Tree Oil In The Treatment Of Skin Diseases: A Systematic Review

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ABSTRACT

Introduction: Tea tree oil (TTO) is an essential oil well-known for its therapeutic effects. Its antimicrobial, anti-inflammatory, and antioxidant properties help treat various skin diseases. Despite its popularity and uses in skincare products, its mechanism of action in treating various skin diseases is still not highlighted. This research aims to investigate TTO's effectiveness in treating skin diseases by determining the antimicrobial properties of the TTO and evaluating the anti-inflammatory and antioxidant properties of TTO. **Methodology:** A systematic review is conducted to prove that tea tree oil effectively treats skin diseases. The information related to this research has been collected from PubMed and Google Scholar. **Results:** The effectiveness of TTO has been investigated in five aspects of healing properties. **Discussion:** The components and actions of TTO's antibacterial, antifungal, antiparasitic, anti-inflammatory, and antioxidant properties show potential for effective treatment of skin diseases. **Conclusion:** TTO is proven to be effective in treating different types of skin diseases due to its various healing properties.

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INTRODUCTION

Tea tree oil (TTO), extracted from the *Melaleuca alternifolia* plant, and contains over 100 compounds, with terpinene-4-ol being the main component [1]. It has healing properties that are effective against bacteria, fungi, parasites, inflammation, and oxidative agents [1]. Due to its healing properties, TTO is widely utilized in cosmetic, pharmaceutical, healthcare, and aromatherapy products [1]. In recent decades, complementary and alternative therapies like tea tree (melaleuca) oil have grown in popularity. Although this essential oil has been used for than a century in Australia, it is currently sold all over the world as both pure oil and an active ingredient in a variety of goods. Tea tree oil's antibacterial and anti-inflammatory properties have historically been its main application [2].

Terpene hydrocarbons, primarily monoterpenes, sesquiterpenes, and their corresponding alcohols, make up TTO. Terpenes are aromatic hydrocarbons that are volatile and can be thought of as polymers of isoprene, which has the formula C₅H₈. Components were described in early reports on the composition of

TTO. The advantages of tea tree oil, which may have antimicrobial and anti-inflammatory properties, have been discovered as a result of recent advancements in our knowledge of the oil's and its constituents' antimicrobial and anti-inflammatory properties as well as clinical efficacy [2].

Skin diseases are caused by various factors, such as pathogenic infections, genetics, immune system disorders, and environmental factors [3]. Examples of skin diseases are psoriasis, albinism, and rosacea [3]. Understanding these different types of skin diseases can help effectively treat and manage skin conditions.

This systematic review aims to fill the knowledge gap regarding the effectiveness of TTO as a treatment for dermatological conditions [3]. The objective is to investigate TTO's effectiveness, antimicrobial properties, and anti-inflammatory and antioxidant effects to determine whether TTO is a viable alternative treatment for skin diseases.

In addition, an increasing amount of research indicates that aromatherapy can help osteoarthritis patients with their pain and functional impairments. These encouraging findings thus support the necessity for more investigation to fully comprehend the impact of TTO use in a range of medical disorders [4].

METHODOLOGY

This systematic review encompasses all studies on how effective TTO is in treating skin diseases. A meta-analysis approach is utilized to merge and evaluate data from various studies to evaluate the efficacy of TTO. The English-written journal articles released between 2014 and 2024 that assess the use of TTO for treating skin diseases will be included, and they will encompass randomized control trials, clinical trials, review articles and observational studies. Only studies involving humans and in-vitro will be considered. Articles that do not focus on the effectiveness of TTO for skin diseases, are not in English, including animal studies, or were released before 2014 will be disregarded. Google Scholar and PubMed were utilized to find suitable articles, beginning on 22 March 2024. The terms used included 'tea tree oil', '*Melaleuca alternifolia*', 'skin diseases', 'bacterial infections', 'fungal diseases', 'efficacy', 'effectiveness', 'clinical trial', and 'RCT'. The process of selecting articles involves three steps. Article screening was conducted based on the titles and abstracts. Data was

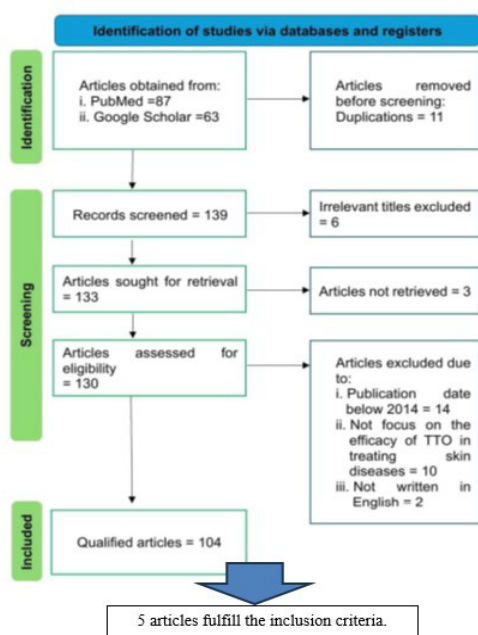


Fig. 1: The PRISMA flowchart for identifying studies based on the predefined inclusion and exclusion criteria.

extracted from chosen articles and sorted according to research design, results, and findings as shown in Table I as out of 104 articles, only 5 were included in the study as they fulfill all the inclusion criteria for the study. This systematic review adhered to the guidelines established by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA).

DISCUSSION

Anti-bacterial

The study by Ossa-Tabares et al. (2020) provides compelling evidence of the antibacterial efficacy of tea tree oil (TTO) against *Cutibacterium acnes*, a bacterium

commonly associated with *acne vulgaris*. The study determined the minimum inhibitory concentration (MIC) of TTO to be 0.25% v/v, indicating that even low concentrations of TTO can effectively inhibit the growth of *C. acnes* [4]. This is supported by a study conducted in 2015 by Wyszowska-Kolatko et al., who stated that TTO exhibits bactericidal activity against 32 strains of *C. acnes* obtained from acne lesions at a concentration of 1 to 5 mg/mL. A low concentration of TTO is sufficient enough to prevent the proliferation of *C. acnes* and decrease inflammation induced by acne [6].

By preventing the growth of *P. acnes* and *S. aureus*, two bacteria linked to acne, and lowering inflammation brought on by acne, tea tree oil dramatically reduced the development of acne. Furthermore, the main active ingredient in TTO-L's antibacterial efficacy was terpinen-4-ol, while Tea Tree Oil's lesser ingredients also had an impact [5].

Anti-fungal

TTO's potential as an antifungal agent against several fungal strains was demonstrated in vitro, which also offered information on its effectiveness and mechanisms. TTO is effective in inhibiting the growth of the main causative agents of onychomycosis, *T. rubrum*, and *T. mentagrophytes*, and may be a safe alternative treatment [8]. TTO also has been found able to penetrate the cell and cytoplasmic membrane of *C. albicans* and *A. niger*, confirming TTO's antifungal effects [8]. Moreover, TTO and its bioactive component terpinen-4-ol demonstrated a positive influence when combined with fluconazole, enhancing the treatment of fluconazole-resistant yeast infections [9].

Using the synergy of the therapeutic agents, monotherapy or polytherapy is the basis for treating fungal skin infections. Because of its antifungal and anti-inflammatory properties, tea tree oil (TTO) could be a useful supplement to conventional antifungal medications. An imidazole antifungal medication called ketoconazole (KTZ) is frequently used to treat fungal infections of the skin. According to a study, the inclusion of TTO enhanced KTZ's penetration and retention across the artificial skin membrane; this effect was especially noticeable in hydrogel formulation [10].

Antiparasitic

TTO is a widely used treatment against the Demodex mite, which is a common ectoparasite of the human skin. Most clinical trials studying TTO as an antiparasitic medication are aimed at treating blepharitis caused by demodicosis, or infestation of Demodex mites, around the eyelid area. The effectiveness of TTO against Demodex can be attributed to the killing effect of TTO's terpinen-4-ol component against Demodex mites, as well as terpinen-4-ol's ability to reduce inflammation caused by parasite infestations on the skin [11]. This observation is supported by a clinical trial where a

Table 1: Comparison of different studies and findings using Tea Tree Oil

No	Aspect	Author & Publication Year	Types of Study	Aims	Findings	References
1.	Antibacterial	Ossa-Tabares et al. (2020)	In vitro (Concentration range)	To evaluate the composition, features, and antimicrobial effect of TTO at 2% v/v, and its minimal inhibitor concentration against <i>Cutibacterium acnes</i> .	TTO has 30% to 40% of terpinen-4-ol. The MIC obtained against <i>C. acnes</i> 0.25% v/v.	Ossa-Tabares, J. C., Llanos, C. J., Garcia, A. M. (2020). Evaluation Of Tea Tree Oil Physicochemical Features And Its Antimicrobial Activity Against Cutibacterium Acnes (Propionibacterium Acnes) ATCC 6919. Biomedica. 40(4). 693-701. doi: 10.7705/biomedica.5122.
2.	Anti-fungal	Marcos-Tejedor et al. (2021)	In vitro (Real-Time PCR assay)	To assess the in vitro effectiveness of tea tree essential oil (less harmful) against the main causative agents of these infections.	Tea tree essential oil inhibits the in vitro growth of the fungus and may be a less harmful alternative to the onychomycosis treatment.	Marcos-Tejedor, F., González-García, P., & Mayordomo, R. (2021). Solubilization In Vitro Of Tea Tree Oil And First Results Of Antifungal Effect In Onychomycosis. Enfermedades Infecciosas Y Microbiología Clínica, 39(8), 395–398. doi: 10.1016/j.eimce.2021.07.001.
3.	Antiparasitic	Karakurt & Zeytun (2018)	Clinical trial (eyelash shampoo)	To examine the efficacy of 7.5% TTO eyelash shampoo on Demodex density and ocular symptoms in patients with demodectic blepharitis.	Demodex mite count was completely reduced in 36% of patients treated with 7.5% TTO eyelash shampoo with a significant reduction of ocular demodectic blepharitis symptoms	Karakurt, Y., & Zeytun, E. (2018). Evaluation of the Efficacy of Tea Tree Oil On the Density of Demodex Mites (Acari: Demodicidae) and Ocular Symptoms In Patients With Demodectic Blepharitis. The Journal of Parasitology, 104(5), 473–478. doi: 10.1645/18-46.
4.	Anti-inflammatory	Hammer et al., 2015	Clinical trial	To evaluate the clinical evidence on the use of tea tree oil products for treating acne.	The anti-inflammatory activity of TTO is a critical factor in the pathogenesis of acne, and it has proven to be a conventional therapy for acne.	Hammer, K. A. (2015c). Treatment Of Acne With Tea Tree Oil (Melaleuca) Products: A Review Of Efficacy, Tolerability And Potential Modes Of Action. International Journal of Antimicrobial Agents, 45(2), 106–110. doi:10.1016/j.ijantimicag.2014.10.011
5.	Antioxidant	Malik et al., 2022.	In vitro (free radical scavenging activity)	The investigation aims to study the half-maximum inhibitory concentration, sun protection factor value, and oxidative potential of tea tree and rosemary essential oils.	TTO is frequently used as the main ingredient in topical treatment of cutaneous infections. In addition to its moisturizing effect, its antioxidant properties can shield cells from damage caused by free radicals, delaying signs of aging.	P., & Upadhyay, P. (2022, October 31). GC-MS Chemical Profile, Antioxidant Activity, and Sun Protection Factor of Essential Oil of Tea Tree (Melaleuca alternifolia) and Rosemary (Rosmarinus officinalis L.). Oriental Journal of Chemistry, 38(5), 1266-1275. doi: 10.13005/ojc/380524.

greater percentage of a group of patients that used eyelash shampoo containing TTO reported reduction in Demodex mite count and blepharitis symptoms, compared to another group that used TTO-free eyelash shampoo [12]. Additionally, TTO has shown potential as a long-term treatment for demodicosis [13].

Pathogens known as ectoparasites can infect the skin and result in severe pain, discomfort, and illness. Insecticides are usually used to control them. However, new and alternative ways of control are necessary due to the rapid emergence of antimicrobial resistance, the slow rate of development of novel bioactives, and health and environmental concerns about the continuous use of neurotoxic pesticides. Recent research has demonstrated the amazing potential of tea tree oil (TTO) as an alternative agent against ectoparasites [14]. The use of TTO in the pharmacotherapy of ectoparasitic infections is supported by the encouraging results seen in clinical trials [15].

Anti-inflammatory and antioxidant

Conventional acne treatments have demonstrated multiple major mechanisms of action, including anti-

inflammatory activity (retinoids). Normalisation of retinoids leads to a reduction in the secretion of sebum. This property has been proven thus far. Research indicates that inflammatory changes occur both before and after *P. acnes* colonies pilosebaceous follicles, which are significant elements in the pathogenesis of acne [15]. In human studies, TTO lessened cutaneous reactions that were brought on by experiments such as contact hypersensitivity brought on by histamine or nickel, which was thought to be the consequences of reductions in microvascular blood flow, plasma extravasation and vasodilation [15]. When tea tree oil products are applied to treat haemorrhoids, ocular demodicosis, and tinea, three clinical investigations without an acne component also show decreased inflammation lesions were reduced more than the number of non-inflammatory lesions, whilst a fourth study showed little difference [12]. This suggests that the anti-inflammatory activity of tea tree oil contributes to clinical efficacy. Applying tea tree oil products has been demonstrated in multiple trials to decrease the number of lesions in individuals with mild-to-moderate acne, which may be attributed to their anti-inflammatory properties.

In addition, TTO potentially has good antioxidant properties. A study done by Zhang et al. in 2018 has evaluated the in vitro antioxidant activity of TTO. DPPH assay shows that TTO has more oxidative effect than α -lipoic acid but no better than quercetin, Vitamin C and Vitamin E. TBARS assay shows that antioxidant power of TTO is better than Vitamin C and α -lipoic acid but lesser antioxidant power than quercetin and Vitamin E while hydroxyl radical scavenging activity shows that TTO has more antioxidant power than Vitamin C and α -lipoic acid but no better than quercetin and Vitamin C [16].

A review paper by Nascimento et al. in 2018 stated many qualities of TTO including inhibiting or delaying the production of free radicals, scavenging free radicals and converting them into less toxic compounds, and delaying or interrupting the formation of secondary toxic active species and inflammatory mediators [17]. This is supported by an in vitro study by Malik et al. (2022) that stated the antioxidant properties of TTO derive from its main component which is terpinen-4-ol. This antioxidant component of TTO can also help to shield the cells from damage caused by free radicals and UV exposure [18].

To support the findings, several human studies that have assessed the effectiveness and safety of using tea tree oil in the treatment of acne are presented, along with a number of characteristics of the oil that make it a potential component. We may conclude that the antibacterial, anti-inflammatory, and antioxidant qualities of tea tree oil lead to a reduction in inflammatory lesions, primarily papules and pustules [17]

In addition, according to a study, terpinen-4-ol, a bioactive component of TTO, could legitimately be added to the list of potential biocides that are effective against *Legionella* when used in conjunction with other chemical compounds or physical treatments to control *Legionella* contamination, particularly in small waterlines or respiratory medical devices [19].

CONCLUSION

In conclusion, the findings of this study suggest that in general tea tree oil has healing properties which are anti-bacterial, anti-inflammatory, anti-parasitic, antioxidant and antifungal. The primary constituents of tea tree oil (TTO), particularly the terpene terpinen-4-ol, which demonstrates strong antimicrobial could give a significant effect by rupturing bacterial cell membranes and suppressing enzyme activity, are largely responsible for the oil's biological activity. These constituents also contribute to the oil's antioxidant, anti-inflammatory, and cytotoxic qualities by scavenging free radicals and modifying cellular stress pathways. Therefore, the general objective of this systematic review was achieved. The tea tree oil's effectiveness in treating skin diseases was

investigated. The alternative hypothesis was accepted. Tea tree oil is effective in treating skin diseases caused by *Cutibacterium acnes*, agents of onychomycosis, Demodectic blepharitis, free radical and UV exposure. The source and quality of tea tree oil utilized in various studies vary greatly, which can influence the results. This includes consistent confirmation of TTO's comical composition used in the clinical trials and in vitro studies. Future research recommendations require standardised TTO formulations to guarantee uniformity of the results.

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