



## Review

# Treatment of acne with tea tree oil (melaleuca) products: A review of efficacy, tolerability and potential modes of action



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## ABSTRACT

Over-the-counter acne treatments containing tea tree oil from the plant *Melaleuca alternifolia* are widely available, and evidence indicates that they are a common choice amongst those self-treating their acne. The aims of this review were to collate and evaluate the clinical evidence on the use of tea tree oil products for treating acne, to review safety and tolerability and to discuss the underlying modes of therapeutic action.

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## 1. Introduction

Acne is viewed as a chronic inflammatory skin disorder caused by a combination of factors, including excessive sebum production, abnormal desquamation of the follicular epithelium, inflammation and the presence of the bacterium *Propionibacterium acnes* [1,2]. Acne affects primarily adolescents and young adults, with up to 90% of adolescents affected by acne at some stage [3]. In addition, ca. 5% of adults suffer from persistent or late-onset acne [4,5]. Aside from physical effects such as discomfort and potential scarring, acne can cause emotional and psychological stress to sufferers [6].

Despite the prevalence of acne, studies show that <20% of adolescents with acne seek help from medical professionals [7,8]. Instead, individuals either do not treat their acne or self-treat with over-the-counter (OTC) products [7,9]. Since acne treatments containing tea tree oil are available without a prescription, it is difficult to gauge their level of use, and very few studies have quantified this. One recent publication, which used an online crowdsourcing data collection technique, found tea tree oil to be the second most commonly used topical treatment, closely following the most commonly used product of 2.5% benzoyl peroxide [10]. This indicates that tea tree oil products are a relatively common choice for those self-treating their acne. Therefore, the aim of this review was to examine the efficacy, safety and tolerability of tea tree oil products for treating acne and to discuss potential modes of therapeutic action.

## 2. Tea tree oil

Tea tree oil, also known as melaleuca oil, is a monoterpenic-rich, lipophilic, essential oil derived by steam distillation from the Australian native plant *Melaleuca alternifolia* (Myrtaceae). The oil contains ca. 100 components, with the most abundant component (terpinen-4-ol) typically comprising ca. 40% of the oil. Tea tree oil has broad-spectrum antimicrobial activity, and non-specific cell membrane damage is a major mechanism of antibacterial action [11]. Clinical studies with tea tree oil products have shown efficacy for a number of superficial diseases including acne, oral candidiasis, tinea, onychomycosis and molluscum contagiosum [12,13]. Further details of the chemical characteristics, toxicity profile, bioactivity and clinical efficacy of the oil have been provided in previous reviews [12,14].

Tea tree oil is an ingredient in many OTC products, including those specifically targeted at treating acne. These products include face and body washes/cleansers, soaps, toners, treatment gels or lotions, spot or blemish sticks, and masks. Tea tree oil may be included as the active therapeutic agent or at lower levels that are unlikely to have therapeutic benefit but instead serve to increase the appeal or marketability of the product. In addition, OTC topical combination products containing tea tree oil with another acne treatment agent such as benzoyl peroxide, salicylic acid, glycolic acid or azelaic acid are available.

## 3. Clinical efficacy of tea tree oil products

An extensive literature search found seven publications [15–21] that have systematically evaluated the efficacy of products

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containing tea tree oil for treating acne (Table 1). Of these, six [15–18,20,21] were comparative, of which three [16,17,21] were double-blinded, with an additional study investigator-blinded [15]. Six studies have been published in full (five in English) and the remaining study was published as an abstract only [15]. An eighth publication mentions the treatment of eight patients with mild facial and back acne with a 5% tea tree oil cream [22]. However, few study details were provided and it was simply reported that patients were either cured or remarkably improved after treatment.

The earliest of the comparative studies [16] was a double-blinded study comparing the efficacy of a 5% tea tree oil water-based gel and a 5% benzoyl peroxide water-based lotion in patients with mild-to-moderate acne (Table 1). Products were applied twice daily for 8 weeks and patients were assessed at baseline and at 1, 2 and 3 months. At 3 months, both treatments resulted in significant reductions in lesion counts from baseline. However, for inflamed lesions, benzoyl peroxide performed significantly better than tea tree oil at 1, 2 and 3 months. For tea tree oil, the mean number of inflamed lesions was reduced by ca. 49% after 3 months compared with ca. 68% for benzoyl peroxide. There was no significant difference between treatments for non-inflamed lesions, with a mean reduction of ca. 28% in the tea tree oil group and 35%

in the benzoyl peroxide group. Skin oiliness differed significantly between groups at 1, 2 and 3 months, with less oiliness experienced in the benzoyl peroxide group. Adverse events such as dryness, stinging and burning were reported significantly more in the benzoyl peroxide group (79% of patients) than in the tea tree oil group (44% of patients).

Darabi et al. (2005) conducted a single-blinded comparative study of 5% tea tree oil gel and 2% erythromycin gel in a total of 60 patients with mild-to-moderate acne [15]. Patients applied product twice daily for 6 weeks, after which time the mean reduction in acne lesion numbers was ca. 55% for the tea tree oil group and 40% for the erythromycin group. Lesion numbers were reduced by more than 50% from baseline for 87.5% of patients in the tea tree oil group and 53.8% of patients in the erythromycin group. Frequencies of side effects did not differ significantly between groups, however there were significantly more withdrawals due to adverse events in the erythromycin group.

Enshaieh et al. (2007) conducted a double-blinded placebo-controlled trial of the efficacy of 5% tea tree oil gel in patients (30 per group) with mild-to-moderate acne [17]. The placebo consisted of vehicle (carbomer) gel only. Product was applied twice daily for 6 weeks (45 days) by leaving on for 20 min then washing off.

**Table 1**  
Summary of clinical studies evaluating tea tree oil (TTO) products for the treatment of acne.

Treatment group	Trial design	Product application	Efficacy (mean reduction in total lesion count <sup>a</sup> ) (%)	Tolerability (frequency of adverse events)	Outcomes	Reference
(1) TTO 5% gel (n = 58) (2) BP 5% (n = 61)	Double-blind <sup>b</sup>	Twice daily (left on) for 8 weeks	(1) 29.3 (2) 45.9	(1) 44% (2) 79%	Both treatments significantly reduced inflamed lesions, although BP better than TTO. Treatments equivalent for reducing non-inflamed lesions and erythema	[16]
(1) TTO 5% gel (n = 30) (2) Erythromycin 2% gel (n = 30)	Investigator-blind	Twice daily (left on) for 6 weeks	(1) 55 (2) 40	Rates not stated; rates for groups not significantly different	TTO significantly better than 2% erythromycin at reducing lesion numbers	[15]
(1) TTO 5% gel (n = 30) (2) Placebo (n = 30)	Double-blind	Twice daily (washed off) for 6 weeks	(1) 43.6 (2) 12.0	(1) 10% (2) 6.7%	TTO significantly better than placebo at reducing lesion numbers. Significant decrease in total lesion count and acne severity index after TTO treatment but not placebo	[17]
(1) TTO 5% gel (n = 46) (2) TTO 5% gel + Perfact tablet (n = 46) (3) Perfact tablet alone (n = 48)	Open-label	Gel applied once daily; tablets taken twice daily for 4 weeks	(1) 62.1 (2) 73.7 (3) 73.0	No serious adverse events reported	All treatments significantly reduced lesion number compared with baseline. No statistics performed comparing all groups	[18]
(1) TTO 5% extract (n = 34) (2) LFCO 5% extract (n = 34)	Double-blind	Twice daily for 8 weeks	(1) 38.2 <sup>c</sup> (2) 65.3	(1) 31.3% (2) 12.6%	Inflammatory lesions significantly reduced by both treatments; LFCO better than TTO. LFCO also reduced non-inflammatory lesions	[21]
(1) Baseline + mixture of TTO 3% and lavender oil 2% (n = 27) (2) Baseline only (n = 27)	Not stated	Oils applied twice daily (washed off) for 4 weeks. Baseline not stated	(1) 9.2 (2) 4.8	(1) 3.7% (2) 0%	Numbers of inflammatory lesions significantly reduced compared with baseline	[20]
TTO 0.1% + <i>Ramulus mori</i> extract 0.01% (n = 20)	Case-controlled	4 Weeks	28.7	Not stated in English abstract	Numbers of inflammatory lesions significantly reduced compared with baseline	[19]

BP, benzoyl peroxide; LFCO, *Lactobacillus fermented Chamaecyparis obtusa*.

<sup>a</sup> Data are from the end of the stated treatment period.

<sup>b</sup> The authors stated that the study was technically single-blinded as patients were likely to be able to identify which product they had received.

<sup>c</sup> Inflammatory lesions only; reductions in total lesion count not stated.

Evaluation at 6 weeks showed that overall the tea tree oil gel performed significantly better than placebo. Tea tree oil treatment resulted in a mean decrease in total lesion count from baseline of 43.6% compared with 12.0% for placebo. Similarly, the mean reduction in acne severity index was 40.5% for the tea tree oil group compared with 7.0% for placebo. Pruritus was reported as an adverse event both in the tea tree oil (10% of patients) and placebo (6.7%) groups [17].

A study published in 2011 [18] compared three groups in an open-label study: (i) 5% tea tree oil gel; (ii) 5% tea tree oil gel and a polyherbal tablet; and (iii) polyherbal tablet alone [18]. Gel was applied once daily and tablets were taken twice daily for 4 weeks. The tablet contained extracts of neem (*Azadirachta indica*), turmeric (*Curcuma longa*) and black pepper (*Piper nigrum*). The total reduction in lesion count after 4 weeks was 62.1% for the gel group, 73.7% for the gel + tablet group and 73.0% for tablet alone. Each treatment significantly improved acne but analyses were not performed comparing the three treatments to determine whether they differed significantly in effectiveness. No serious adverse events occurred during the study and it is not stated whether any minor adverse events occurred.

Kwon et al. (2014) recently published a double-blind split-face study comparing 5% tea tree oil to 5% *Lactobacillus*-fermented *Chamaecyparis obtusa* (LFCO) extract [21]. A total of 34 participants applied each treatment twice daily to the left or right side of the face for 8 weeks. After 8 weeks, inflammatory and non-inflammatory lesions were reduced by a mean of 65.3% and 52.6%, respectively, for LFCO and by 38.2% and 23.7%, respectively, for tea tree oil. The LFCO extract was significantly more effective at reducing numbers of lesions than the tea tree oil treatment. Sebum excretion, measured with a sebumeter, was decreased by ca. 30% after 8 weeks in the LFCO group and was unchanged in the tea tree oil group.

Lastly, two studies evaluated products containing tea tree oil combined with one or more additional plant extracts. The first of these [20] compared a 'baseline acne intervention programme' in two groups, one of which had an additional essential oil treatment. The baseline programme was not described, whereas the essential oil treatment contained a mixture of 3% tea tree oil and 2% lavender oil in jojoba oil and was applied twice daily for 4 weeks. The treatment was left on for 5 min and then washed off. After 4 weeks, reductions in the number of acne lesions were 4.8% for the control group and 9.2% for the essential oil group. The essential oil group had a mean reduction in sebum excretion, measured using a sebumeter, of 12.3% compared with 1.1% in the control group. No serious adverse events occurred. One participant complained of itch, which resolved without intervention and the participant went on to complete the study. A non-comparative study by Yoo et al. (2003) evaluated a cream containing 0.1% tea tree oil and 0.01% *Ramulus mori* extract (a Chinese medicinal plant) applied for 4 weeks at an unspecified frequency for the treatment of acne in 20 patients [19]. After 4 weeks there was a decrease in the number of lesions of 28.7% compared with baseline.

All studies investigated subjects with mild-to-moderate acne. Only one study followed acne nodules and cysts, with minor improvements after 4 weeks of treatment [18]. There are few data to indicate that topical tea tree oil would be beneficial for severe acne, for which systemic therapy is typically recommended.

To summarise, five of the studies evaluated products containing 5% tea tree oil and found that lesion numbers were reduced, with reductions ranging from 23.7% to 62.1% after products were applied for 4–8 weeks. Overall, these data suggest that the use of OTC tea tree oil products containing  $\geq 5\%$  tea tree oil and applied twice daily for multiple weeks is likely to reduce numbers of acne lesions. However, this generalisation must be considered within the context of the overall quality of these studies. Trial quality is often acknowledged as a limitation of studies assessing alternative products [23].

Several methods for calculating a score to indicate trial quality have been published [24,25], however scores for most of the acne studies discussed in the current review cannot be generated due to missing information. Randomisation and double-blinding are recognised as major factors influencing study quality [26], and whilst several of the acne trials were randomised, the blinding both of patients and investigators was acknowledged in one of the studies as unrealistic given the characteristic fragrance of tea tree oil [16]. Deception may be one way of improving patient blinding when evaluating tea tree oil products [27], although some patients are still likely to identify the tea tree oil fragrance. Clearly, many of the studies described herein do not meet the current criteria for what defines a rigorous, clinical acne study [28].

### 3.1. Tolerability of tea tree oil products

Adverse events were reported after the application of tea tree oil products in five of the seven studies [15–17,20,21]. An additional study stated that there were no serious adverse events [18]. In the remaining study, no details were provided about adverse events in the English abstract [19]. Stated events were minor pruritus, burning, stinging, scaling, itch, redness and dryness [16,17,20,21]. Only one study suggested that one or more patients withdrew due to an adverse event [15]. Rates of adverse events in the tea tree oil groups were 44% [16], 31.3% [21], 10% [17], 3.7% [20] and not disclosed [15]. For the comparators, rates of adverse events were higher than tea tree oil for benzoyl peroxide (79% vs. 44%) [16] and erythromycin (rate not stated) [15] but were lower than tea tree oil in the placebo comparator group (6.7% vs. 10%) [17] and LFCO extract group (12.6% vs. 31.3%) [21]. The types of adverse events reported for the tea tree oil treatment groups are typical events for topically applied acne treatments [29] and occurred at similar, or lower, rates than the other medicated acne products. These limited data suggest that tea tree oil products are tolerated similarly to other topical acne medications.

Previous patch test studies with human volunteers demonstrated that tea tree oil has both irritant and allergenic potential, although rates for both are low [30,31]. The frequencies of adverse events reported in the tea tree oil acne studies are higher than would be expected from patch test studies and are higher than those reported in most other clinical studies evaluating tea tree oil for non-acne conditions [12]. This may be attributed to the relative sensitivity of facial skin [32] compared with other body sites such as the back, which is the site typically used for patch testing. In addition, the base formulation of the products used in the acne studies may have influenced irritancy. This is supported by results of a patch test study showing that mean irritancy scores for 25% tea tree oil in three different base formulations (including cream, ointment and gel) differed [30].

## 4. Properties of tea tree oil contributing to clinical efficacy

Major modes of action shown for conventional acne therapies include antimicrobial action (benzoyl peroxide and antibiotics), anti-inflammatory activity (retinoids), normalisation of follicular keratinisation (retinoids), reduction in the secretion of sebum (retinoids) and keratolytic activity (salicylic acid). Of these, only the first two properties have been demonstrated thus far for tea tree oil.

The antibacterial activity of tea tree oil against a range of clinically important bacteria is well established, with the majority of organisms inhibited at  $<2\%$  (v/v) [12]. The activity of tea tree oil against *P. acnes* has been shown in three laboratory studies, which report minimum inhibitory concentrations (MICs) of tea tree oil of 0.31–0.62% (v/v) [33] and 0.5% (v/v) [21] for single strains of *P. acnes*, and minimum bactericidal concentrations of 0.25–0.5% for 32 *P.*

*acnes* strains [34]. In addition, MICs for the tea tree oil components terpinen-4-ol and  $\alpha$ -terpineol were 0.16–0.31% and 0.08–0.16%, respectively, against one *P. acnes* strain [33]. These studies were performed with bacterial cells in a free-living or planktonic state, whereas recent evidence suggests that *P. acnes* exists within macrocolonies or a biofilm within skin follicles [35]. In general, bacteria growing within biofilms are more difficult to eradicate than their planktonic counterparts and this may be one of the factors contributing to the relatively long time that it can take to improve acne after commencement of treatment [36]. Whilst no data exist for tea tree oil and *P. acnes* biofilms, the oil has activity against biofilms of other Gram-positive bacteria such as *Staphylococcus aureus* [37], suggesting that in principle it may also affect *P. acnes* biofilm.

A second property that is likely to contribute to clinical efficacy is anti-inflammatory activity. Inflammation is a critical factor in the pathogenesis of acne, and research suggests that inflammatory changes occur both before and after *P. acnes* colonises pilosebaceous follicles [38]. Inflammatory changes are present in acne-prone skin even before hyperproliferation or the formation of microcomedones [38]. This inflammation is characterised by the presence of CD4<sup>+</sup> T-helper cells and macrophages at levels higher than those found in skin not prone to acne [38,39]. Acne can also occur in the absence of *P. acnes* [40], which further supports the critical role of inflammation in comedogenesis. After follicle colonisation, *P. acnes* induces a suite of inflammatory changes such as the production of cytokines by host tissues and activation of the innate immune response via Toll-like receptor 2 [39,41]. A number of studies have shown in vitro that tea tree oil or major components suppress inflammation [42]. Cytokine production by human monocytes (but not neutrophils) [43,44] and macrophages [45] is inhibited by tea tree oil and the major component terpinen-4-ol [46]. Also, tea tree oil and terpinen-4-ol both reduce production of interleukin-8 by human oral keratinocyte cells (OKF6–TERT2) [47]. Anti-inflammatory activity has also been shown in animal studies where tea tree oil applied to the skin of mice suppressed curdlan-induced inflammation [48] and reduced histamine-induced ear swelling [49].

In human studies, tea tree oil reduced experimentally induced skin reactions (nickel- or histamine-induced contact hypersensitivity) [50–52], which was suggested to be a result of decreases in vasodilation, microvascular blood flow and plasma extravasation [53]. Three non-acne clinical studies also report reduced inflammation following application of tea tree oil products for treating haemorrhoids [54], ocular demodocosis [55] and tinea [56]. Of the tea tree oil acne studies, four showed that reductions in inflammatory lesion numbers were greater than reductions for non-inflammatory lesions [16,19–21], whilst a fourth study showed little difference [18]. This suggests that the anti-inflammatory activity of tea tree oil contributes to clinical efficacy. Potential mechanisms by which tea tree oil may reduce the inflammation associated with acne are by directly inhibiting the production of pro-inflammatory cytokines by host tissues and indirectly by inhibiting the growth of *P. acnes*, which is a major immunological stimulant.

The location of tea tree oil within the skin after application is another factor that may influence efficacy. Tea tree oil penetrates poorly into and through human skin, with most being lost to evaporation [57]. That said, low levels of some tea tree oil components have been detected within the stratum corneum but not in the deeper skin layers, indicating that the components do not penetrate through the dermis [57]. Work with bovine udder skin has shown that tea tree oil components can be recovered from follicular casts after application of the oil to the skin [58]. The amount of tea tree oil recovered differed according to the formulation applied, with most recovered from a microemulsion and the least from the clay formulation.

In addition to these biological activities, the effectiveness of tea tree oil products for treating acne is likely to be influenced by a number of other product-specific variables, such as the concentration of tea tree oil and base formulation, in addition to the frequency of product application and duration of therapy. These variables have not been investigated; however, since the majority of studies investigated gel products containing 5% tea tree oil and showed moderate efficacy this suggests that this combination is promising.

## 5. Conclusions

Several studies have shown that application of tea tree oil products reduces the number of lesions in those with mild-to-moderate acne. Comparative trials showed that tea tree oil products were better than placebo and were equivalent to comparators including 5% benzoyl peroxide and 2% topical erythromycin. Adverse events were typical of those experienced with other topical treatments and occurred at similar rates. Efficacy may be attributed to the antibacterial and anti-inflammatory activity of the oil. Whilst existing clinical studies provide useful data, further rigorous studies are required to corroborate these findings.

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