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TEA TREE OIL –AN OVERVIEW

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Abstract

Herbal medicines are gaining popularity in recent decades. To validate their use as therapeutic agent, in vitro and in vivo scrutinization is done. Tea tree oil (TTO), is one such product under scutiny.Tea tree oil is the volatile essential oil derived from the Australian native plant *Melaleuca alternifolia*. It is used for its antimicrobial and anti-inflammatory effects. Many topical formulations use tea tree oil as the active ingredient to treat cutaneous infections. It is marketed as a remedy for various ailments in countries like Australia, Europe, and North America. Also, Tea tree oil is used as antimicrobial agent in pharmaceutics and cosmetic products like hand and face washes, shampoos and skin care products. This review discusses the properties of tea tree oil and its applications.

Keywords: Tea tree oil, antimicrobial, Antimicrobial anti-inflammatory, anti-inflammatory

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INTRODUCTION

Herbal medicines are gaining popularity in recent decades. To validate their use as therapeutic agent, in vitro and in vivo scrutinization is done. Tea tree oil (TTO), is one such product under scrutiny.Tea tree oil is the volatile essential oil derived from the Australian native plant *Melaleucaalternifolia*. It is used for its antimicrobial and anti-inflammatory effects. Many topical formulations use tea tree oil as the active ingredient to treat cutaneous infections. It is marketed as a remedy for various ailments in countries like Australia, Europe, and North America. Also, Tea tree oil is used as antimicrobial agent in pharmaceutics and cosmetic products like hand and face washes, shampoos and skin care products[1].

Habitat and Cultivation

Melaleuca is an Australian native plant. In sub-tropical climates, it can be grown in broad range of soil types; moist soil in full sun is the preferred. Tea trees are drought-tolerant, can bear flooding and fire, intolerant to extreme low temperature[2].They can also tolerate brackish and saline waters, waterlogged low lands, and other flooded areas especially in swamps. Melaleuca tends to grow under pH conditions higher than 7, while in Melaleuca's native habitat, Australia, the soil pH is usually 6 or less. Melaleuca species are tall shrubs and small trees having height up to 7 m with a bushy crown and papery bark. The leaves have prominent glands enriched with aromatic oil. At the time of harvest, whole plant is eradicated within 6–18 months to collect essential oil.

Composition and Chemistry

TTO is composed of terpene hydrocarbons, mainly monoterpenes, sesquiterpenes, and their associated alcohols. Terpenes are volatile, aromatic hydrocarbons and may be considered polymers of isoprene, which has the formula C5H8 (Table I)[3].

TABLE I: Composition of *M. alternifolia*(tea tree oil)

COMPONENT	TYPICAL COMPOSITION
Terpinen-4-ol	40.1
µ-Terpinene	23.0
a-Terpinene	10.4
1,8-Cineole	5.1
Terpinolene	3.1
p-Cymene	2.9
a-Pinene	2.6
a-Terpineol	2.4
Aromadendrene	1.5
6-Cadinene	1.3
Limonene	1.0
Sabinene	0.2

Globulol	0.2
Viridiflorol	0.1

TTO has a relative density of 0.885 to 0.906 , is only sparingly soluble in water, and is miscible with nonpolar solvents..Terpinen-4-ol is considered to be the principal active component and it constitutes up to about 40% of some tea tree oils with non-oxygenated terpenoid hydrocarbons accounting for approximately 50%.

Six varieties, or chemotypes, of M. alternifolia have been described, each producing oil with a distinct chemical composition. These include a terpinen-4-ol chemotype, a terpinolenechemotype, and four 1,8-cineole chemotypes .The terpinen-4-ol chemotype typically contains levels of terpinen-4-ol of between 30 to 40% and is the chemotype used in commercial TTO production[4].Despite the inherent variability of commercial TTO, no obvious differences in its bioactivity either in vitro or in vivo have been noted so far. The composition of TTO may change considerably during storage, with cymene levels increasing and terpinene levels declining[5].Light, heat, exposure to air, and moisture all affect oil stability, and TTO should be stored in dark, cool, dry conditions, preferably in a vessel that contains little air.

Commercial Production

The hand cut plant material was distilled on the spot. This fashion continued for several decades. With the development of effective antibiotics demand for the oil declined. Owing to recent interest in natural products, tea tree oil gain importance. TTO is produced by steam distillation of the leaves and terminal branches of *M. alternifolia*. Once condensed, the clear to pale yellow oil is separated from the aqueous distillate. The yield of oil is typically 1 to 2% of wet plant material weight. Microwave technology as alternative extraction methods have been considered, but not utilized on a commercial scale[3].

Antimicrobial Activity

The antimicrobial activity of tea tree oil has received the most attention. Crushed leaves of tea tree were inhaled to treat coughs and colds or were sprinkled on wounds, after which a poultice was applied. In addition, tea tree leaves were soaked to make an infusion to treat sore throats or skin ailments[6].

The broad spectrum activity of TTO includes antibacterial, antifungal, antiviral, and antiprotozoal activities. Sparing solubility of TTO in water has impeded the evaluation of the antimicrobial activity of TTO. Addition of surfactants to broth and agar test media, addition of dyes as visual indicators are the strategies used to counteract this problem[7]. A broad range of bacteria have now been

tested for their susceptibilities to TTO. While most bacteria are susceptible to TTO at concentrations of 1.0% or less, MICs in excess of 2% have been reported for Organisms. (Table II).

TABLE II: Susceptibility data for bacteria tested against *M. Alternifolia* oil

Bacterial species	MIC
Actinomycesviscosus	0.6
*Actinomyces*spp.	1
Bacillus cereus	0.3
*Bacteroides*spp.	0.06–0.5
*Corynebacterium*sp.	0.2–2
Enterococcusfaecalis	0.5–>8
Fusobacteriumnucleatum	0.6–>0.6
Klebsiellapneumoniae	0.25–0.3
*Lactobacillus*spp.	1–2
Micrococcusluteus	0.06–0.5
*Prevotella*spp.	0.03–0.25
Prevotellaintermedia	0.003–0.1
Propionibacteriumacnes	0.05–0.63
Proteus vulgaris	0.08–2
Pseudomonasaeruginosa	1–8
Staphylococcusaureus	0.5–1.25

TTO is for the most part bactericidal in nature, although it may be bacteriostatic at lower concentrations. Lipophilicity based of its hydrocarbon structure was the earlier assumptions about its mechanism of action[8].Model liposomal systems were permeabilized by TTO supporting this data. Treatment of *S. aureus*with TTO resulted in the leakage of potassium ions and 260-nm-light-absorbing materials and inhibited respiration[9].Treatment with TTO also sensitized *S. aureus*cells to sodium chloride and produced morphological changes apparent under electron microscopy. However, no significant lysis of whole cells was observed spectrophotometrically or by electron microscopy. Furthermore, no cytoplasmic membrane damage could be detected using the lactate dehydrogenase release assay[10],and only modest uptake of

propidium iodide was observed after treatment with TTO.

The loss of viability, inhibition of glucose-dependent respiration, and induction of lysis seen after TTO treatment all occur to a greater degree with organisms in the exponential rather than the stationary phase of growth[11].The loss of intracellular material, inability to maintain homeostasis, and inhibition of respiration after treatment with TTO and/or components is consistent with a mechanism of action involving the loss of membrane integrity and function.

Antifungal

TTO is susceptible to range of yeasts, dermatophytes, and other filamentous fungi. MICs range between 0.03 and 0.5%, and fungicidal concentrations 0.12 to 2% (Table III).

TABLE III. Susceptibility data for fungi tested against *M. Alternifolia* oil

Fungal species	MIC
*Alternaria*spp.	0.016
Aspergillusflavus	0.31–0.7
Candidaalbicans	0.06–8
C.glabrata	0.03–8
C.parapsilosis	0.03–0.5
C.tropicalis	0.12–2
*Cladosporium*spp.	0.008–0.12
Cryptococcus	0.015–0.06
*Fusarium*spp.	0.008–0.25
Malasseziafurfur	0.03–0.12
M.sympodialis	0.016–0.12
Microsporumcanis	0.03–0.5
M.gypseum	0.016–0.25
*Penicillium*spp.	0.03–0.06
Rhodotorularubra	0.06

TTO vapors inhibit fungal growth and affect sporulation. Permeability of *C. albicans*cells also is altered. Inhibition of respiration in C.albicans is observed in dose dependent manner along with alteration in membrane properties[12].TTO also inhibits glucose-induced medium acidification by *C. albicans*, *C. glabrata*, and *Saccharomycescerevisiae.* Medium acidification occurs largely by the expulsion of

protons by the plasma membrane ATPase, which is fuelled by ATP derived from the mitochondria. The terpeneeugenol inhibits mitochondrial respiration and energy production. TTO inhibits the formation of germ tubes, or mycelial conversion, in *C. albicans*indicating that TTO causes a postantifungal effect[13].

Antiviral activity

The antiviral activity of TTO was first shown using tobacco mosaic virus and tobacco plants. Various concentrations of TTO were investigated by incubating viruses to see the effect and then these treated viruses were used to infect cell monolayers. TTO reduced HSV-1 titers by 98.2% and HSV-2 titers by 93.0%. Action of TTO was seen on both enveloped and nonenveloped viruses[14].TTO effects on the range of viruses are yet to be tested.

Antiprotozoal activity

TTO has antiprotozoal activity. 50% growth reduction of *Leishmania major* and *Trypanosomabrucei*were observed[15].Terpinen-4-ol contributed significantly to this activity. Anecdotal in vivo evidence on effect of TTO in treating *Trichomonasvaginalis*infections is available.

Resistance to TTO

TTO has been used as medicinal oil ever since 1920s and no clinical resistance has been reported. Cross-resistance with resistance to conventional antibiotics also not been demonstrated. It is likely that the multicomponent nature of TTO may reduce the potential for resistance to occur spontaneously, since multiple simultaneous mutations may be required to overcome all of the antimicrobial actions of each of the components[16].Furthermore, since TTO is known to affect cell membranes, it presumably affects multiple properties and functions associated with the cell membrane, similar to the case for membrane-active biocides. This means that numerous targets would have to adapt to overcome the effects of the oil.

Anti-inflammatory activity

TTO affects a range of immune responses, both in vitro and in vivo. the water-soluble components of TTO can inhibit the lipopolysaccharide-induced production of the inflammatory mediators tumor necrosis factor alpha (TNF), interleukin-1 (IL), and IL 10 by human peripheral blood monocytes by approximately 50% and that of prostaglandin E2 by about 30% after 40 h. Terpinen-4-olwas able to diminish the production of TNF, IL-1, IL-8,IL-10, and prostaglandin E2 by lipopolysaccharide-activatedmonocytes[17].The water-soluble fraction of TTO, terpinen-4-ol,and -terpineol also suppressed superoxide production byagonist-stimulated monocytes but not neutrophils .TTO decreases the

production of reactive oxygen species by both stimulated neutrophils and monocytes and that it also stimulates the production of reactive oxygen species by nonprimed neutrophils and monocytes.

The majority antioxidant activity in TTO was attributed to the three terpenic compounds, i.e., R-terpinene, R-terpinolene, and *ç*-terpinene, rather than the chemical terpinen-4-ol[18]. In addition, it was found that the potency of TTO antioxidant activity was comparable to that of the common synthetic antioxidant BHT. This suggests that TTO might become a useful antioxidant relevant to the maintenance of oxidative stability of food matrix.

Clinical studies in dentistry

A clinical and microbiological study was done to evaluate the effects of tea tree oil in chronic periodontitis patients as a local drug delivery agent. Results showed that there was significant reduction in probing pocket depth and clinical attachment level in tea tree oil group and concluded that tea tree oil can be used as an adjunctive therapy[19].

Research has been done to evaluate if tea tree oil is able to reduce plaque formation and oral bacteria numbers. In one study, the results showed a 0.2% tea tree oil mouth rinse used once daily for seven days significantly reduced the number of *S.mutans* and the total number of oral bacteria. This effect was consistent up to two weeks after use of the mouth rinse was stopped[20] .However, in comparison to a placebo, there was no difference in plaque accumulation. A 2.5% tea tree oil solution was also studied in orthodontic patients, and did reduce gingival index and papillary bleeding scores, but seemed to confirm other studies in which it was determined that tea tree oil might reduce oral bacteria, but not necessarily plaque formation.

Mouth rinses containing melaleuca have been shown to treat even azole-resistant oral candida infections effectively. In a study of refractory oral candida in patients living with AIDS, a 15mL melaleuca oral solution was swished for 30-60 seconds, four times daily, for two weeks. At a six-month follow-up, 67% of participants oral candida infections had significantly improved, or been cured, without recurrence[21].

A study used gingival crevicular fluid samples to monitor the presence of pentraxin-3 (PTX3), which is an inflammatory molecule, as a marker for periodontitis. It was determined that the 5% tea tree oil gel did help reduce oral bacteria and inflammatory PTX3 molecules for a better treatment outcome than SRP alone[22].

The study evaluated the efficacy of tea tree oil for the treatment of gingivitis.The tea tree oil was administered in the form of

mouthwash and then compared with a mouthwash with chlorhexidine 0.12%. The comparison showed that tea tree oil offered a better improvement in the evaluation of PI, BOP, and PD; furthermore, it did not cause dental dyschromia and taste alteration[23].

CONCLUSION

There are already several nonantibiotic approaches to the treatment and prevention of infection, including probiotics, phages, and phytomedicines. Alternative therapies are viewed

favorably by many patients. In addition, many report, significant improvement while taking complementary and alternative medicines. A wealth of in vitro data now supports the long-held beliefs that TTO has antimicrobial and anti-inflammatory properties. Large randomized clinical trials are now required to cement a place for TTO as a topical medicinal agent.

REFERENCES

1) S.D. Cox, C.M. Mann and J.L. Markham Interactions between components of the essential oil of MelaleucaalternifoliaThe Society for Applied Microbiology, Journal of Applied Microbiology, 91, 492±497,2001

2) JavadSharifi-Rad, BahareSalehi, Elena Maria Varoni, FarukhSharopov, 5880 Plants of the Melaleuca Genus as Antimicrobial Agents: From Farm to Pharmacy, Phytother. Res. (2017)

3) Carson, C. F., Hammer, K. A., & Riley, T. V. (2006). Melaleucaalternifolia (Tea Tree) oil: a review of antimicrobial and other medicinal properties. *Clinical microbiology reviews*, *19*(1), 50-62.

4) Homer, L. E., D. N. Leach, D. Lea, L. S. Lee, R. J. Henry, and P. R. Baverstock. 2000. Natural variation in the essential oil content of *Melaleucaalternifolia*Cheel (Myrtaceae). Biochem. Syst. Ecol. 28:367–382.

5)Brophy, J. J., N. W. Davies, I. A. Southwell, I. A. Stiff, and L. R. Williams.1989. Gas chromatographic quality control for oil of *Melaleuca*terpinen-4-ol type (Australian tea tree). J. Agric. Food Chem. 37:1330–1335.

6)Shemesh, A., and W. L. Mayo. 1991. Australian tea tree oil: a natural antiseptic and fungicidal agent. Aust. J. Pharm. 72:802–803.

7) Carson, C. F., B. D. Cookson, H. D. Farrelly, and T. V. Riley. 1995.Susceptibility of methicillin-resistant *Staphylococcus aureus*to the essential oil of *Melaleucaalternifolia*. J. Antimicrob. Chemother.35:421–424.

8)Sikkema, J., J. A. M. de Bont, and B. Poolman. 1995. Mechanisms of membrane toxicity of hydrocarbons. Microbiol.Rev. 59:201–222.

9) Cox, S. D., C. M. Mann, J. L. Markham, H. C. Bell, J. E. Gustafson, J. R.Warmington, and S. G.Wyllie. 2000. The mode of antimicrobial action ofthe essential oil of *Melaleucaalternifolia*(tea tree oil). J. Appl. Microbiol.88:170–175.

10)Reichling, J., A. Weseler, U. Landvatter, and R. Saller. 2002. Bioactive essential oils used in phytomedicine as antiinfective agents: Australian tea tree oil and manuka oil. ActaPhytotherapeutica1:26–32.

11) D. Cox, J. L. Markham, C. M. Mann, S. G. Wyllie, J. E. Gustafson, and J. R. Warmington, Abstr. 28th Int. Symp. Essential Oils, p. 201–213,1997

12) Hammer, K. A., C. F. Carson, and T. V. Riley. 2004. Antifungal effects of *Melaleucaalternifolia*(tea tree) oil and its components on *Candida albicans*, *Candida*

*glabrata*and *Saccharomyces cerevisiae*. J. Antimicrob. Chemother.53:1081–1085.

13)D'Auria, F. D., L. Laino, V. Strippoli, M. Tecca, G. Salvatore, L. Battinelli and G. Mazzanti. 2001. *In vitro* activity of tea tree oil against *Candidaalbicans*mycelial conversion and other pathogenic fungi. J. Chemother. 13:377–383.

14)Schnitzler, P., K. Scho¨n, and J. Reichling. 2001. Antiviral activity of Australian tea tree oil and eucalyptus oil against herpes simplex virus in cell culture. Pharmazie56:343–347

15)Mikus, J., M. Harkenthal, D. Steverding, and J. Reichling. 2000. *In vitro* effect of essential oils and isolated mono- and sesquiterpenes on *Leishmania major* and *Trypanosomabrucei*. Planta Med. 66:366–368.

16) Vazquez, J. A., M. T. Arganoza, D. Boikov, J. K. Vaishampayan, and R. A. Akins. 2000. *In vitro* susceptibilities of *Candida* and *Aspergillus*species to*Melaleucaalternifolia*(tea tree) oil. Rev. Iberoam. Micol.17:60–63.

17) Hart, P. H., C. Brand, C. F. Carson, T. V. Riley, R. H. Prager, and J. J.Finlay-Jones. 2000. Terpinen-4-ol, the main component of the essential oilof *Melaleucaalternifolia*(tea tree oil), suppresses inflammatory mediatorproduction by activated human monocytes. Inflamm. Res. 49:619–626.

18) C. Brand1,A. Ferrante2, R.H. Prager3et alThe water-soluble components of the essential oil of *Melaleucaalternifolia*(tea tree oil) suppress the production of superoxideby human monocytes, but not neutrophils, activated in vitro.Inflamm. res. 50 (2001) 213–219

19) Kaveri G Siddabasappa, LaxmanVandana. Effect of Tea Tree Oil in Chronic Periodontitis Patients: A Clinical and Microbiological Study. CODS Journal of Dentistry, Volume 11 Issue 2 (July–December 2019)

20) BetulRahman, SausanAlkawas, Elaf A. Al Zubaidi, Omar I. Adel, and NuhaHawas.Comparative antiplaque and antigingivitis effectiveness of tea tree oil mouthwash and a cetylpyridinium chloride mouthwash: A randomized controlled crossover study ContempClin Dent. 2014 Oct-Dec; 5(4): 466–470.

21)Jandourek A, Vaishampayan JK, Vazquez JA. Efficacy of melaleuca oral solution for the treatment of fluconazole refractory oral candidiasis in AIDS patients. AIDS. 1998;12:1033–7.

22) Elgendy, E. A., Ali, S. A., &Zineldeen, D. H. (2013). Effect of local application of tea tree (Melaleucaalternifolia) oil gel on long pentraxin level used as an adjunctive treatment of chronic periodontitis: A randomized controlled clinical study. *Journal of Indian Society of Periodontology*, *17*(4), 444-8.

1. 23) Francesca Ripari, AlessiaCera, Monica Freda et alTea Tree Oil versus Chlorhexidine Mouthwash in Treatment of Gingivitis: A Pilot Randomized, Double Blinded Clinical Trial,Eur J Dent. 2020 Feb; 14(1): 55–62.

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