

**Melaleuca alternifolia** Australian Tea Tree oil as an effective antifungal agent topically for *Tinea unguium* (onychomycosis)

Wendy M Welder

**ABSTRACT**

The evolution of modern medical advances is often underestimated and that as little as a hundred years ago, none of the formulated antibiotics currently available existed. The germ theory was only substantiated because bacteria had been identified with the refining of microscopic technology and organisms that did not exist in context or conjunction to human disease. The connection between what appeared through the lens of a microscope slowly became the basis of the medical theories of human health and illness. This included the causative agents within all states of human wellness. Humans started using plants and their essences long before they were able to re-order it. The scientific renaissance started the medical movement towards concrete concepts and reproducible results all bound by the scientific methods. This left little room for combinations of chemicals or plant constituents and compartmentalized human health into systems that worked best under strict control negating the concept of synergy. Human medicine is now moving out of the realm of being solely dependent on synthetic chemical formulations. Alternative and modern medical healers alike are starting to understand that both paths to human healing are needed to care for the many microbial assaults caused by bacteria, viruses, and fungi. Combing herbal folk-lure with modern chemistry is not a compromise but a middle way for better human health and illustrated with the use of *Melaleuca alternifolia* (Australian Tea Tree Oil) and modern antifungal agents used in conjunction to definitively cure the fungal infection starting with the causative fungi *Tinea unguium* and the condition of onychomycosis as an example.

**Keywords:** *Tinea unguium*, Onychomycosis, *Melaleuca alternifolia*, Australian tea tree oil.

**INTRODUCTION**

Accounting for half of all nail and integumentary infections, *Tinea unguium* dermatophyte onychomycosis (TUDO) is a fungal infection of the nail bed most often appearing first on the great toe and more prevalent in men and those over the age of 60 [1]. This toenail infection is not only socially embarrassing to patients but potentially deadly for the medically fragile population. It can invade and infect the body systemically and especially dangerous to those that are already immunocompromised or diabetic. Characterized by yellow or white discoloration with flaking, cracked, or crumbling on the nail unit, this fungal infection accounts for 50 percent of all nail diseases [2]. The incidence of TUDO is reported as a percentage of between two to fourteen percent of the American population. Other risk factors include *Tinea pedis* (athletes’ foot) or preexisting nail disease or psoriasis, HIV positive, or has a history of peripheral vascular disease [3].

The social and economic impact of TUDO infections crosses the line between cosmetic versus medically indicated. Allopathic treatment modalities are costly [4]. Allopathic treatments for the condition range in expense. Home or folk medicine and remedies that are from easily accessible ingredients cost little to nothing but with variable results. Laser and light therapy with or without oral medication range upwards of 406 dollars a nail [5], is more definitively reliable, and performed by a dermatologist or podiatrist at their offices or outpatient treatment facilities.

*Melaleuca alternifolia* Australian TTO was officially discovered during the Cook expedition (1768-71) [6] with further research carried out by Joseph Banks, a botanist sailing with Cook on the HMS Endeavor. Captain Cook was the one to name the plant after he watched the continents’ native population make a tea from the leaves for use medicinally for upper respiratory infections [7]. Native to Australia and chemically similar to species in the native to New Zealand and used for similar benefits and mechanisms of action. This investigation is further work on the overall question regarding the efficacy of use and to study whether *Melaleuca alternifolia* Australian Tea Tree oil is a potential antifungal agent topically for *Tinea unguium* (onychomycosis).
RESULTS

Melaleuca alternifolia

Australian Tea Tree oil (TTO) as a historical intervention for cutaneous fungal infections has been used by the Australian aborigines for millennia, mostly for its antiseptic actions. Historically indigenous to what is now New South Wales and Queensland Australia it was used traditionally by native inhabitants for cuts, abrasions, skin infections, oral sores, and dental caries, as well as a tea for upper respiratory illnesses or complaints [7]. Scientific research exploring TTO constituents has increasing credence to folk medicine use and benefits.

Fungal genre found most prevalent in Tinea infections

The most common causative dermatophyte in TUDO with worldwide prevalence is *Trichophyton rubrum*, with around 65% global occurrence and 82% of those found in the United States [8]. These numbers are slightly skewed since diagnosis and medical treatment with pharmaceutical intervention are more likely in first-world medical systems. At the same time, home remedies and herbal folk medicine make up the lion’s share of phytopharmaceutical intervention and includes usage for 80% of the global population [9].

The other potential fungal infections causing onychomycosis include the fungi *Epidermophyton* and most often seen first in *Tinea pedis* and more prevalent in male adolescents into early adulthood. These fungi may be the source of resistant cases of *Trichophyton pedis*, and treatment failures warrant higher levels of diagnostic testing [8]. The other is *Microsporum* and one of only three species with *M. canis* having the most common transmission and effect seen from animals to humans and the cause of ringworm [10]. This infestation is not common with *Tinea* infections. If there is a culture done with sensitivities due to what appears to be a resistant fungal strain with treatment failure, *Microsporum* is sometimes the culprit and most likely a secondary infection from a previous ringworm infestation. Fungal infections are becoming more familiar with a disturbing trend towards drug-resistant colonization. Quoted by one article to now be 40% of cases [11] the infestation has the potential to become a systematically catastrophic fungal sepsis and, on the rise [12]. It is considered by infectious disease professionals potentially be the next new microbial infectious disease with allopathic pharmaceutical failure on the horizon.

Tea Tree Oil (TTO) constituents

A.R. Penfold first explored Australian TTO's significant constituencies in the early part of the twentieth century [13]. Terpinene 4-ol is an alcohol constituent with the most active antifungal properties against *Cryptococcus neoformans*, *Malassezia spp.*, *Rhodotorula spp.*, *Trichosporon spp.*, *Aspergillus spp.*, *Penicillium spp* and dermatophytes [14]. Specific studies are rare regarding TTOs antifungal capability against TUDO citing efficacy against fungi more with *Candida* and *Tinea pedis* than onychomycosis [15]. There appears to be a synergistic dependence of Terpinene 4-ol and the other principal constituent of tea tree oil since Terpinen 4-ol has little to no biological activity by itself against fungal infections. The constituent 1,8-cineole [7] and other critical chemical constituents in TTO include cymenol, thujanol, globulol, and viridiflora, gamma-terpinene, cymene, alphapinene, beta-pinene, myrcene, and limonene [13]. These chemical constituents attest to TTO's antimicrobial activity with its overall high monoterpenes and sesquiterpene chemical profiles. This also explains some of TTO's therapeutic mechanisms of action and includes antimicrobial and antifungal effects [16]. Monoterpenes are more biologically active against dermatophytes than other phytochemical constituents [17, 18].

TTO mechanism of action

Cell wall degradation and cellular electrolyte and respiratory effects of TTO appear to be a combination between the significant constituents in TTO and successfully demonstrated. One study investigated and convincingly alluded to significant fungal membrane degradation [14]. This effect is primarily attributed to Terpinen 4-ol, though, as already mentioned, as a single constituency appears to be only weakly active. Microbial inhibitor concentrations are increased and enhanced by the synergistic chemical makeup of TTO rather than the action of a single constituency [13]. One study by Hammer et al. explored the question of minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) specifically in and as a result of TTO introduction to *in vitro* human nail samples and found all constituents except one had an inhibitory or eradication effect on fungal membranes. The singular constituency that showed no biochemical activity was b-mycene. The major constituencies with a greater than 0.25% MIC/MFC after terpinen-4-ol include a-terpineol, linalool, a-pinene and b-pinene [19].

DISCUSSION

Research evidence of tea tree oil effectiveness for fungal infections

Since the 1994 Dietary Supplement Health and Education Act (DSHEA), the commercial market for whole crude herb has exploded to a trillion-dollar business worldwide ("Dietary Supplement Health and Education Act (DSHEA) | The Alliance for Natural Health", 2020). What started as a fringe pseudo-science is now a quickly evolving field of genetics and refined herbal constituencies isolated with the potential to be the next frontier in pharmacological manipulation of human health and wellness. It is estimated that globally alternative healthcare and herbal medicine are used by 80 percent of the world’s population, preferentially utilizing herbal medicine in all of its forms, including volatile essential oils [9]. Essential oils do not fall under the DSHE act. Instead, they are under the purview of the U.S. Food and Drug Administration (FDA) and with the caveat that aromatherapy and E.O.s are regulated as cosmetics. It is not written law that the FDA first approve all cosmetics before going on the market. However, they monitor the advertising claims of cosmetics, and if they cross into the medicinal or pharmacological realm with health claims, the FDA will inspect and take necessary actions. The FDA highlights the most proper labeling of products in the interest and safety in terms of scientifically unsupported claims [20].

Australian TTO is historically used for skin and hair commercially, and it falls under the ambiguous designation of a cosmetic when this is not the chemically accurate case. TTO is often labeled of products in the interest and safety in terms of scientifically unsupported claims [20]. TTO is often mixed with other pharmaceuticals or cosmetic preparations and falls under FDA purview with the requirement of being registered if advertised as an antifungal agent. This grey area has seen the larger essential oil producers receive warnings from the FDA regarding medicinal health claims and cures. There have been marketing tweaks by companies to comply with FDA mandates in an attempt to remain within the arena of over-the-counter [21].

There are older studies regarding TTOs constituency profile and use in the treatment of onychomycosis compared to conventional treatment options. Syed et al. explored the treatment of toenail onychomycosis with 2% butenafine and 5% *Melaleuca alternifolia* (tea tree) oil in
cream. The researchers found that 60 adults between 18-80 years treated with a combination of butenafine hydrochloride and *Melaleuca alternifolia* had the most success. When used over six to eighteen months, the chemical combination had a 100 percent cure rate in comparison to placebo and single organic and synthetic chemical treatment modalities [22]. These kinds of studies add empirical credence to the idea that microbial resistance in all of its forms is overcome by using both herbal and allopathic pharmaceutical agents to help end the microbial resistance conundrum once and for all [13,23,24].

There are physical limitations for TTO efficacy in treating nail bed fungal infections. Protected by the outer nail barrier directly determines how much TTO EO is absorbed to fight fungus [25] and make efforts to eradicate the disease difficult. Efficacious treatment is also more likely with the bi-frontal approaches to the issue and more likely with combination treatment. Allopathic pharmaceutical agents have an above-average treatment success, but the cost of potential hepatic injury or the inconvenience of non-tolerability making that sole chemical or singular drug option less than desirable. In contrast, TTO alone has positive though up until recently, scientifically unexplored and inconsistent treatment results [19]. This gives strength to the premise of using both allopathic and volatile essential oil modalities attractive [25].

The inquiry of TTO as an efficacious treatment for onychomycosis has reliable chemical analysis of TTO's constituency profile with the research explaining mode and therapeutic actions. This comes with the negative caveat that only consistent use from the client for a minimum of six months will see positive results with treatment time up to a year and a half. This makes the use of TTO as a sole antifungal agent less likely a definitive treatment modality. The middle way answer was best illustrated in Syed et al.’s study, that TTO in combination with an allopathic pharmaceutical agent. Though not ideal from an OTC availability standpoint this answer still puts onychomycosis treatment out of reach to many of those that suffer from it [22]. This back and forth between TTO essential oil versus allopathic treatments are at somewhat of a stalemate until more is known about essential oil constituency combinations that work as well as their allopathic counterparts in the treatment of onychomycosis.

**CONCLUSION**

The growing incidence of drug-resistant organisms has the modern pharmaceutical industrial approaches at an impasse with no new synthetically developed solutions in sight. Herbal medicine has been used successfully by humans for millennia through sickness and health. There is also a pride in the ingenuity of the human race. The ever-evolving problem-solving skills our species possesses have taken humanity out of the cave. Science is now elucidating the small evolving problem [20].

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The opportunity for human health and wellness is being found in the marriage of synthetic and naturally occurring chemical constituencies. The logical answer of combining not only essential oils, herbs, and chemically synthetic formulations is at this point the next best answer when it comes to infectious diseases that modern medicine has failed to treat and only made the situations worse and evidenced by the number of multi-drug resistant organisms. There is more hope to develop long term cures using both essential oils for cell wall degradation so the older allopathic antimicrobials work again. The investigation regarding tea tree oil for use in onychomycosis illustrates that a consistent treatment plan grounded solely in an essential oil can be efficacious but the length of the treatment is the key to its success. Until this obstacle is overcome the use of tea tree oil can be a powerful aid in the treatment of onychomycosis fungal infections but cannot be recommended as a stand-alone therapeutic modality until more research is done.

**REFERENCES**


HOW TO CITE THIS ARTICLE