Chapter 09

Fungitoxic Properties of Essential Oils to Treat Tinea

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ABSTRACT

Dermatophytes responsible for causing various skin diseases confined to keratinous tissues in humans are divided into three genera, i.e. Trichophyton, Microsporum, and Epidermophyton. Pathologic clinical manifestations caused by these microbes are divided into tinea pedis, tinea corporis, tinea cruris, tinea capitis (head), tinea faciei (face), tinea barbae (beard), tinea corporis (body), tinea manus (hand), tinea cruris (groin), tinea pedis (foot), and tinea unguium (nail), depending on the affected place. Essential oils, characterized as concentrated, volatile, fragrant, hydrophobic, oily liquids with diverse functional groups, exhibit potential as treatments for tinea owing to their absence of side effects and the escalating antifungal resistance. Monoterpenes and sesquiterpenes (alcohols, ethers, phenols, polysaccharides, aldehydes, and ketones) and terpenes (phenolic compounds) are responsible for the antimicrobial activity of essential oils. Essential oils of *Melaleuca alternifolia* (tea tree oil), *Azadirachta indica* (neem), *Eucalyptus citriodora*, *Cymbopogon martini* (palmarosa), *Foeniculum vulgare* (fennel seed oil), and *Citrus bergamia* (bergamot) individually and in various essential oil combinations have demonstrated their high efficacy in dermatophytosis therapy.

KEYWORDS
Essential Oils, Dermatophytosis, Antifungal Resistance, Natural Remedies, Synergistic Effects, Clinical Trials

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INTRODUCTION

The growing prevalence of serious human pathogenic infections caused by dermatophytes, particularly among low-immunity persons, has prompted significant attention and calls for proactive measures in recent decades (Arif et al., 2009). Trichophyton, Microsporum, and Epidermophyton are the only known genera of dermatophytes responsible for causing various skin diseases in humans, such as athlete's foot, ringworm, and jock itch. The human body's hair, skin cells, and nails are significant components rich in keratin. Dermatophytosis, a condition caused by dermatophytes, is confined to areas of the human body containing one or more of these keratinous tissues (Saxena, 2021).

Tinea pedis, tinea corporis, tinea cruris, and other pathologic clinical manifestations are caused by these microbes that metabolize keratin (Sahoo and Mahajan, 2016). They are clinically classified into various types of tinea, comprising tinea capitis, tinea faciei, tinea barbae, tinea corporis, tinea manus, tinea cruris, tinea pedis, and tinea unguium, depending on the specific location of the infection. Majocchi granuloma, tinea imbricata, and tinea pseudoimbricata are other clinical variations. The most common of these is tinea pedis, or athlete's foot, which causes discomfort in the afflicted areas. Firstly Pellizari characterized it in 1882 (Pellizzari, 1888). While tinea pedis is not a fatal illness, it can significantly affect lifestyle of those affected. It is imperative to recognize that when the immune system is weakened by illnesses or certain treatments like AIDS and immunosuppressive medications, tinea pedis can progress into more dangerous secondary infections (Houghton et al., 2006). Adults are often less susceptible to tinea pedis due to their increased ability to defend against fungal infections of triglycerides in the sebum produced after puberty. However, postmenopausal women are more susceptible to developing tinea pedis due to their lower levels of triglycerides compared to other people (Gupta and Summerbell, 2000). Human feet are common sites for tinea pedis infections, which can spread from soil, animals, and humans. These infections play a significant role in causing superficial mycoses, often leading to frequent relapses and proving resistant to therapy (Gupta, and Cooper, 2008).

The escalation of resistance to antifungal agents as a consequence of pharmacological pressure represents a mounting global concern (Revie et al., 2018). Antimicrobial resistance fosters the survival and propagation of pathogens by conferring the ability to withstand antibiotic eradication (Nainu et al., 2021). This resistance has engendered heightened complexity in the treatment of fungal maladies, resulting in protracted morbidity and mortality. Prolonged administration of antifungal therapeutics may elicit substantive deleterious effects on human tissues (Gnat et al., 2020).

Researchers are increasingly interested in developing novel antimicrobial medications from natural materials due to their diverse chemical properties (Orchard et al., 2019). Essential oils (EO) have shown promising potential in effectively combating both fungal and bacterial pathogens, indicating their potential as a valuable treatment for superficial fungal infections (Orchard et al., 2017). EOs are hydrophobic, concentrated, volatile, fragrant, oily liquids having different functional groups, can be extracted from a variety of plant parts, including flowers, seeds, leaves, branches, bark, fruits, and roots. Crucial terpenoids, often known as volatile oils because of their propensity to readily diffuse into the atmosphere, are typically the molecules that give herbs, spices, and perfumes their distinctive flavour and aroma. Monoterpenes and sesquiterpenes, which include alcohols, ethers, phenols, polysaccharides, aldehydes, and ketones, are the primary components of EOs and are also responsible for their aroma and biological activity. Essential oil's phenolic constituents have also been identified as antibacterial bioactive ingredients (Chanthaphon et al., 2008).

Essential oils derived from medicinal plants have shown potential as alternative agents to combat fungal infections (Khan and Altaf, 2020). Essential oils of *Melaleuca alternifolia*, *Azadirachta indica*, *Eucalyptus citriodora*, *Cymbopogon martini*, *Foeniculum vulgare* and *Citrus bergamia* have been used to treat tinea due to their antimicrobial and antifungal activity. Furthermore, scientific evaluation of various essential oil combinations has demonstrated their high efficacy in dermatophytosis therapy.

Tinea Corporis

Fungi known as dermatophytes infiltrate and proliferate within keratinized tissues, such as the skin, hair, and nails, resulting in infection (Weitzman and Summerbell, 1995). Dermatophyton (causing infections on all keratinous tissues), Epidermophyton (causing infections on skin and nails), and Microsporum (causes skin and hair infection) are the three groups into which dermatophytes can be divided on the basis of genera. These have been divided into three categories: geophilic, zoophilic, and anthropophilic, depending on how they spread. Ultimately, these have been clinically divided into tinea capitis (head), tinea faciei (face), tinea barbae (beard), tinea corporis (body), tinea manus (hand), tinea cruris (groin), tinea pedis (foot), and tinea unguium (nail), depending on the affected place. Majocchi granuloma, tinea imbricata, and tinea pseudoimbricata are other clinical variations.

This field has frequently had little research done in it, despite the fact that cutaneous dermatophytosis is growing increasingly prevalent globally, especially in tropical areas. In reality, the American Academy of Dermatology's recommendations for treating tinea corporis and cruris date back almost two decades (Drake et al., 1996), and in the modern world, they seem, at best, insufficient. With little mention of tinea corporis/cruris, the updated guidelines, which were released by the British Association of Dermatology and the British Medical Journal have mostly concentrated on tinea capitis and tinea unguium (Ameen et al., 2014; Fuller et al., 2014). Updated Cochrane studies on topical treatment for tinea corporis, cruris, and pedis have helped close this knowledge gap, but there aren't many on oral medications. Nonetheless, there are noticeably lacking well-planned studies, national and/or international evidence-based guidelines, and suggestions about the amount and length of time to use systemic antifungals for tinea corporis/cruris (Bell-Syer et al., 2012; El-Gohary et al., 2014). To bring attention to some of the management difficulties that remain unclear, the current review will go over some of the latest developments in the pathophysiology and treatment of tinea corporis, tinea cruris, and tinea pedis.

A superficial dermatophyte infection of the skin, tinea corporis, sometimes referred to as "ringworm," is not the same as tinea manuum, tinea pedis, scalp capitis, bearded areas, face, groin, or nails (onychomycosis or tinea unguium) (Weitzman and Summerbell, 1995). The three genera of dermatophytes that cause tinea corporis—Trichophyton, which infects skin, hair, and nails, Microsporum, which infects skin and hair, and Epidermophyton, which infects skin and nails—are the most common sources of the condition. Dermatophytes are categorized as anthropophilic, zoophilic, or geophilic according on whether their primary source is soil, animals, or people, respectively, this is shown in Fig 1. Doctors need to educate themselves since tinea corporis is a prevalent fungal infection that can mimic many different annular diseases.

Fig 1: Typical annular lesions of ringworm (Source: https://dermnetnz.org/topics/tinea-corporis)

History

Histological observations include modest superficial perivascular infiltration in the upper dermis, hyperkeratosis, parakeratosis, and minor acanthosis. Periodic acid, methenamine silver, or hematoxylin-eosin. The stratum corneum contains yeast, as shown by the "spaghetti and meatballs" pattern revealed by Schiff staining (Hattori et al., 1984). More hyphae and spores are typically found in hyper-pigmented lesions than in hypo-pigmented ones. The horny layer of hypo-pigmented lesions is often slightly hyperkeratotic, and the stratum spinosum may have fewer melanosomes (Gupta et al., 2003)

Clinical Findings

The hallmark of tinea versicolor is mildly scaly hypo-pigmented or hyper-pigmented macules/patches. These are most frequently seen on skin regions with high sebum production, such as the upper arms, neck, trunk (particularly the top portion), and shoulders Adults are less likely to make facial gestures. However, in youngsters, facial involvement is prevalent and may be the only place affected. Usually, facial involvement occurs on the forehead (Katz et al., 2008).

Etiology

The predominant causative agents of tinea corporis are *Microsporum canis*, *Trichophyton rubrum*, and *T. tonsurans* (Adams, 2002; Takenaka et al., 2020). *T. rubrum* is widely recognized as the primary cause of dermatophytosis on a global scale and is notably prevalent as the leading cause of tinea corporis in North America (Kelly, 2012; Costa et al., 2015). *T. tonsurans* is commonly the cause of tinea corporis subsequent to tinea capitis. However, *M. canis* frequently causes tinea corporis that results from intimate contact with dogs or cats. Additional organisms that cause harm are *T. interdigitale* (formerly known as *T. mentagrophytes*), *T. verrucosum*, *T. violaceum*, *T. concentricum*, *Epidermophyton floccosum*, *M. audouinii*, and *M. gypseum*. In Southeast Asia, *T. interdigitale* has supplanted *T. rubrum* as the most frequent cause of tinea corporis in recent times. Some uncommon organisms that cause problems are *T. erinaceid*, *T. equinum*, *T. simii*, and *T. schoenleinii*, *Nannizzia gypsea*, *N. nana*, and *M. gallinae* and *M. fulvum* (Leung et al., 2020).

Tinea Corposis causes

Most regions of the world are home to tinea corporis, although hot, humid areas are where it is most common. People of any age, including newborns, can be affected, although the majority of instances include children and young adults.

Among the Medical Risk Factors are:

- Tinea infection in the past or concurrently
- Diabetes type I
- Lack of immunity
- Overheating
- Ichthyosis Xerosis

Among the Environmental Risk Factors are:

- Overcrowding in households
- Infection of family members
- Keeping animals indoors
- Doing recreational activities that require close social interaction, such as sharing changing rooms, while wearing occlusive apparel (Shelley et al., 2005)

Tinea Corposis clinical variation

The following kinds of tinea corporis can occur as clinical variations. A severe pustular inflammatory response brought on by zoophilic fungus is known as keremia.

Tinea gladiatorum

It is a condition that occurs when skin-to-skin contact occurs in contact sports like martial arts or wrestling. Usually, *T. tonsurans* is the reason.

Tinea Imbricate

Caused by *T. concentricum*, large concentric rings that form polycyclic plaques with thick scale. It itches quite badly. The Pacific Islands and other equatorial tropical regions are home to this kind. Because topical corticosteroid or calcineurin inhibitor therapy suppresses the inflammatory response.

Tinea incognito is characterised by the absence of the characteristic symptoms of tinea corporis. Lesions typically lack size and erythema and have widely dispersed, poorly defined edges (Chong et al., 2013).

Majocchi granuloma

A variation that affects the subcutaneous tissue and hair follicles; typically discovered on the limbs after shaving. It appears as pustules or papules within the hair follicles. The typical organism is *T. rubrum* (Ansari et al., 2016; Veraldi et al., 2018). These clinical variations are shown in Fig 2.

Kerion **Majocchi granuloma** **Tinea incognito**

Fig. 2: Clinical variants of tinea corporis
(Source: https://dermnetnz.org/topics/tinea-corporis)

Signs and Symptoms

The symptoms of ringworm may manifest as follows:

- A circular area of scales that typically induces itching on the trunk, arms, legs, and buttocks.
- Enlarging, slightly raised rings accompanied by a clear or scaly area inside the ring, potentially with a few scattered bumps of varying colors. These colors may range from reddish, purplish, and brown, to grey on different skin tones.
- An overlapping ring of itching on a flat, rounded patch of skin (Katz et al., 2008).

Essential oils

Essential oils are hydrophobic, concentrated, volatile, fragrant, oily liquids having different functional groups, and can be extracted from a variety of plant parts, including flowers, seeds, leaves, branches, bark, fruits, and roots. Crucial terpenoids, often known as volatile oils because of their propensity to readily diffuse into the atmosphere, are typically the molecules that give herbs, spices, and perfumes their distinctive flavour and aroma. Monoterpenes and sesquiterpenes, which include alcohols, ethers, phenols, polysaccharides, aldehydes, and ketones, are the primary constituents of EOs and are also responsible for their aroma and biological activity. Essential oil's phenolic constituents have also been identified as antibacterial bioactive ingredients (Chanthaphon et al., 2008). A wide range of plant materials are believed to possess antifungal qualities, and a multitude of essential oils have demonstrated antifungal activities without inducing any adverse reactions in people or animals (Sokmen et al., 1999).

Terpenes (phenolic compounds) are the main antibacterial components of essential oils. They target infections by attacking their cell walls and membranes. Therefore, a variety of invasive targets may be occupied by active phenolic compounds, potentially leading to the suppression of human pathogenic fungal infections (Sharma et al., 2014).

Tea Tree oil

Tea tree oil, derived from the *Melaleuca alternifolia* plant, has been used in traditional Australian medicine. Its powerful antimicrobial properties have led to its widespread adoption across the globe. As per 'ISO 4730:2004' TTO is extracted from foliage and terminal branches of *Melaleuca alternifolia* (Maiden et Betche) Cheel, *Melaleuca linariifolia* Smith, and *Melaleuca dissitiflora* by using steam distillation. There are significant differences in the yield and chemical composition are reported as these characteristics are strongly reliant on the quality of plant's natural resource (Bejar, 2017).

Chemical Composition

International guidelines govern the chemical composition of TTO, which establishes minima and/or maxima for 14 compounds i.e. Terpinen-4-ol (30-48), γ-Terpinene (10-28), α-Terpinene (5-13), α-Terpineol (1.5-8), p-Cymene (0.5-8), α-Pinene (1-6), Sabinene (tr-3.5), Aromadendrene (tr-3), δ-Cadinene (tr-3), Viridiflorene (ledene) (tr-3), Limonene (0.5-1.5), Globulol (tr-1) and Viridiflorol (tr-1) (International Organization for Standardization, 1996; Zeng et al., 2015; de Groot and Schmidt, 2016).

Antimicrobial Activity

TTO is utilized as a local formulation for a variety of dermatological problems due to its lipophilic nature, which allows for easier skin penetration (Martindale, 2009). TTO contains several medicinal effects, including anti-inflammatory and antimicrobial properties. That is why, it has effectively been utilized as a topical treatment against dermatophytes and *Candida albicans* in human medicine. Its antimycotic action includes modifying cell permeability, limiting respiration and reversibly inhibiting the development of germ tubes. In veterinary medicine, the antimycotic activity of TTO has been effectively proven against many strains of *Malassezia pachydermatis* from seborrheic dermatitis (Nardoni et al., 2010) and more recently in vivo

by topically treating horses diagnosed with *T. equinum*. This treatment approach appeared to be effective in this and many other dermatological infections as well as versatile since it could be used right away following a physical examination even before receiving a laboratory response (Nardoni et al., 2010; Thomas et al., 2016; Bezabh et al., 2022).

Neem oil

Neem (*Azadirachta indica*) is commonly called 'Indian Lilac. Owing to its broad range of antibacterial activity, the neem plant is regarded as a dental panacea. It contributes significantly to the cosmetics sector because of its widespread use in hair and skin care products. *Azadirachta indica* fruits and seeds are used to extract vegetable oil, which is known as neem oil. Neem oil comes in a variety of colours: bright red, golden yellow, yellowish brown, reddish brown, dark brown, and greenish brown. Every part of the neem tree has certain therapeutic properties, and can be exploited commercially (Aneesa, 2016).

Chemical Composition

A variety of bioactive phytochemical compounds have been distilled from neem essential oil including triterpenoids (nimbin and azadirachtin), isomargolonone, proteins, tannins, quercetin, coumarin, carbohydrates, glycosides, salannin, margolonone, dihydrochalcone, diterpenoids (like nimbidine), gedunin, margolone, and glycosides (Alzohairy, 2016).

Antimicrobial Activity

Neem and its components can suppress the growth of variety of microorganisms, including bacteria, viruses, and harmful fungi. Methanol and ethanol extracts of neem proved growth inhibitors against *Aspergillus flavus, Alternaria solani*, and Cladosporium. A further investigation additionally shown the antibacterial properties of neem cake aqueous extracts in preventing spore germination from three sporulating fungus, namely *C. lunata, H. pennisetti,* and *C. gloeosporioides* f. sp. mangiferae (Kumari et al., 2013). The ability of neem plants to disintegrate cell walls and prevent microbial development are two indications of its antibacterial qualities (Alzohairy, 2016).

***Eucalyptus citriodora* oil**

The essential oil of *Eucalyptus citriodora* is a natural product with a variety of biological qualities. It is among the most extensively utilized species in the culinary, pharmaceutical, and cosmetics sectors today. *Eucalyptus citriodora* oil is frequently used to treat headaches, fever reduction, body pains, chronic bowel problems, and diarrhea (Tiple et al., 2024).

Chemical Composition

The primary components of *Eucalyptus citriodora* are citronellal, citronellol, and DL-isopulegol. Other significant components include limonene, P-cymene, alpha-pinene, geraniol, and camphene (Tolba et al., 2015).

Antimicrobial Activity

It was found that *Eucalyptus citriodora* oil was highly effective on *Trichophyton rubrum*, antifungal-resistant mutants of *Candida albicans*, and pathogenic microbes. It also demonstrated greater antifungal activity as compared to *Eucalyptus globulus* and traditional pharmaceuticals against zoophilic fungi such as *C. albicans*, *T. mentagrophytes*, and *Microsporum gypseum* (Luqman et al., 2008).

Palmarosa oil

High value essential oil obtained from *Cymbopogon martini* (common name palmarosa) is called palmarosa oil. Palmarosa oil possesses substantial market value due to its versatile applications in perfumery, agriculture, medicine, and environmental contexts (Sinha et al., 2014).

Chemical Composition

According to GC and GC-MS analytical findings *Cymbopogon martini* essential oil is composed of alcohols(geraniol, geranyl acetate) (Padalia et al., 2011), fatty acids, myrcene, b-elemene, linalool, monoterpenes, sesquiterpenes, linalool, E-citral, farnesol, terpinene, and b-elemene (Kakaraparthi et al., 2015). Some other compounds that are present in *C. martini* oil are nerolidol, α-bisabolol, α-terpinene, and terpinen-4-ol (Prasad et al., 2010).

Antimicrobial Activity

The Cymbopogon species shown noteworthy properties such as anthelmintic, anti-inflammatory, analgesic, anti-aging, pesticidal, antibacterial, antifungal, larvicidal, and antioxidant (Kumar, 2000; Raina et al., 2003; Tsai et al., 2011). Scientists discovered that the oils from *Cymbopogon ambrosioides* and *Cymbopogon martini* together may be utilized as a natural treatment for tinea corporis (ringworm) and other superficial fungal diseases in humans, in place of synthetic antifungal drugs (Prasad et al., 2010).

Fennel oil

Essential oil extracted from *Foeniculum vulgare* L. is called fennel oil (Ahmad et al., 2018). *Foeniculum vulgare* L. is an economically significant member of the Apiaceae family that is native to central and Mediterranean Europe. Fennel oil is produced by distilling fennel seeds and is used as an antiseptic, cough medicine, and laxative in the pharmaceutical industry (Damayanti and Setyawan, 2012), as well as in bakery, confectionery, medicines, and cosmetics as an addictive ingredient.

Chemical Composition

GC-MS analysis showed that there are 29 compounds in fennel oil accounting for 98.96%. The most prevalent constituents in the fennel oil were fenchone (8.32%), trans-anethole (63.30%), and pinene (11.11%). There were smaller concentrations of some compounds, including 2, 3-cyclohexen-1-methanol (2.58%), apiole (2.01%), 3-carene (1.44%), 1-methyl-4-(1-methylethyl) benzene (1.32%), methyl chavicol (1.28%), and limonene (1.09%). However, only negligible quantities of other chemicals, including hydrocarbons and oxygenated sesquiterpenes, were discovered (Shahat et al., 2011; Zeng et al., 2015).

Antimicrobial Activity

The mechanism of fennel oil, which demonstrated stronger antifungal activities against *T. tonsurans*, *T. mentagrophytes*, and *T. rubrum*, compared to the ubiquitous antifungal medications amphotericin B and fluconazole. Flow cytometry along with transmission electron microscopic studies were also used to examine the anti-fungal action of fennel essential oil. The outcomes demonstrated that damage to the plasma membrane and cell organelles was the root cause of the inhibitory effect. Fennel essential oil may reduce the activity of mitochondrial enzymes, specifically succinate dehydrogenase, malate dehydrogenase, and ATPase (Zeng et al., 2015).

Research has demonstrated that fennel oil possesses extensive antimicrobial capabilities against an array of diseases, such as Bacillus species, *Staphylococcus aureus*, *Micrococcus luteus,* Pseudomonas species, and *Pseudomonas fluorescens* (Singh et al., 2006; Mohsenzadeh, 2007; Kazemi et al., 2012).

Bergamot oil

Bergamot oil is the essential oil produced by *Citrus bergamia*. Italy is the major producer of bergamot oil (Pizzimenti et al., 1998). This oil is obtained directly from cold-pressed fruit peels, characterized by yellow green colour and also called natural essence.

Chemical Composition

There are about 80 volatile compounds (such as limonene, linalool, β-pinene, γ-terpinene, and linalyl acetate) that account for 93–96% and non-volatile (like bergamottin, citroptene, psoralens, coumarins, and bergaptene) components that account for 4–7% in bergamot oil formulations (Verzera et al., 2003). Due to the phototoxic properties of furocoumarins, including bergaptene, found in bergamot oil, pharmaceuticals frequently substitute furocoumarin-free, distilled extracts in the place of natural essence.

Antimicrobial Activity

According to (Fisher and Philips 2006), bergamot essential oil is efficient against bacteria. Bergamot oil is a potent antifungal that works well against yeast infections and dermatophytes. Strong evidence is being reported in favor of anecdotal or popular views about the efficacy of bergamot oils in treating skin and mucous membrane infections (Sanguinetti et al., 2007).

Essential oil Combinations

There are a number essential oils and their different combinations have been scientifically tested to treat tinea. Some of the essential oil combinations proven to be very effective in tinea treatment listed in Table 1. (Orchard et al., 2019).

Table 1: Essential oil combinations proven to be effective in tinea treatment

Essential oil 1	Essential oil 2	References
Allium sativum (garlic)	*Citrus limon* (lemon)	(Orchard et al., 2019)
	Cymbopogon martinii (palmarosa)	
	Melaleuca alternifolia (tea tree)	
Boswellia carteri (frankincense)	*Cedrus atlantica* (cedarwood	
	Citrus limon (lemon)	
Cinnamomum verum (cinnamon bark)	*Boswellia carteri* (frankincense)	
	Citrus sinensis (orange)	
Citrus bergamia (bergamot)	*Cupressus sempervirens* (cypress)	
	Lavandula angustifolia (lavender)	
Citrus limon (lemon)	*Cymbopogon martinii* (palmarosa)	
	Eucalyptus globulus (eucalyptus)	
	Lavandula angustifolia (lavender)	
Coriandrum sativum (coriander)	*Cymbopogon citratus* (lemongrass)	
Cymbopogon citratus (lemongrass)	*Rosmarinus officinalis* (rosemary)	
Cymbopogon martinii (palmarosa)	*Boswellia carteri* (frankincense)	
	Cedrus atlantica (cedarwood)	

	Pelargonium graveolens (rose geranium)	
Eucalyptus globulus (eucalyptus)	*Lavandula angustifolia* (lavender)	(de Rapper et al., 2013)
Lavandula angustifolia (lavender)	*Allium sativum* (garlic)	(Orchard et al., 2019)
	Melaleuca alternifolia (tea tree)	(de Rapper et al., 2013)
Melaleuca alternifolia (tea tree)	*Citrus limon* (lemon)	(Orchard et al., 2019)
	Rosmarinus officinalis (rosemary)	
	Santalum austrocaledonicum (sandalwood)	
Origanum vulgare (oregano)	*Commiphora myrrha* (myrrh)	
	Pelargonium odoratissimum (geranium)	
	Pinus sylvestris (pine)	
Syzygium aromaticum (clove)	*Cinnamomum verum* (cinnamon bark)	
	Citrus bergamia (bergamot)	
	Citrus limon (lemon)	
	Lavandula angustifolia (lavender)	
Thymus vulgaris (thyme)	*Citrus bergamia* (bergamot)	
	Citrus limon (lemon)	
	Rosmarinus officinalis (rosemary)	

Conclusion

The use of essential oils in the treatment of dermatophytosis represents a promising avenue due to their natural origin, minimal side effects, and potential effectiveness against fungal infections. Essential oils such as *Melaleuca alternifolia* (tea tree oil), *Azadirachta indica* (neem), and *Eucalyptus citriodora* have demonstrated notable antifungal properties attributed to their bioactive compounds, including monoterpenes and sesquiterpenes. These oils exhibit diverse functional groups that contribute to their antimicrobial activity, making them suitable candidates for combating antifungal resistance observed with conventional treatments. Furthermore, combinations of essential oils, such as those including *Cymbopogon martini* (palmarosa), *Foeniculum vulgare* (fennel seed oil), and *Citrus bergamia* (bergamot), have shown synergistic effects in enhancing efficacy against dermatophytosis. Despite their potential benefits, further research is needed to standardize formulations, determine optimal dosages, and assess long-term safety. Additionally, clinical trials comparing essential oils with standard antifungal therapies are necessary to establish their place in dermatophytosis management protocols. Nonetheless, the current evidence underscores the promise of essential oils as alternative or adjunctive treatments for dermatophytosis, providing clinicians and patients with potentially effective options in the face of evolving fungal resistance patterns.

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