

Chapter 11

Role of Essential Oils in the Treatment of Sarcoptic Mange

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ABSTRACT

The cause of scabies, a highly contagious and itchy skin disease that affects people and animals around the world, is *Sarcoptes scabiei*, a mite that is a member of the *Sarcoptidae* family. The World Health Organization has identified scabies as a neglected disease in recent years, which emphasizes the need for adopting the efficient control measures. Due to issues with resistance and side effects, traditional acaricides have been replaced by other treatments regimens, especially herbal products. An overview of herbal remedies—specifically, essential oils—for managing infestations of *Sarcoptes scabiei* is given in this chapter. The effectiveness, mechanisms of action, and potential uses of important essential oils, such as tea tree, lemongrass, lavender, cinnamon, clove, palmarosa, and neem, in the treatment of scabies are discussed. In addition, the chapter summarizes current studies and clinical trials that assess the acaricidal effects of these essential oils, providing important information for the creation of fresh anti-scabies treatments.

KEYWORDS

Scabies, *Sarcoptidae*, Resistance, Essential oils, Herbals

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INTRODUCTION

The organism *Sarcoptes scabiei*, belongs to the family *Sarcoptidae* (Bornstein et al., 2001) which causes severe infectious, itchy skin disease in animals and humans around the world. In humans, its infection is known as scabies and globally 130 million people are affected from this infection (Figure 1) (Currie BJ, 2015). In 2013, this problem was added in World Health Organization (WHO) in the list of ignored diseases. Scabies is a developing issue and causes death of many animals including cattle, buffalo, dogs and cats (Arlan and Morgan, 2017, Bernigaud et al., 2020). It becomes difficult to control the mites because of the resistance against many acaricides and no availability of vaccines (Van Leeuwen et al., 2010; Absil et al., 2022). Because of these reasons, the world will have to focus on natural products to control mites (Zhu et al., 2020; Liao et al., 2023). The natural products include metabolites obtained from plants or different microorganisms. Essential oils are produced during the metabolism by plants as secondary products and are effective against bacteria, virus, fungi and parasites (Blenau et al., 2012; Peterfalvi et al., 2019; Sandner et al., 2020). Some oils are also very effective against ticks and mites (Selles et al., 2021). Important oils are obtained from tea tree, lavender, lemongrass, cinnamon, clove, tulsi and palmarosa. This book chapter is aimed to offer valuable insights and references for the development of novel acaricidal drugs.

Tea Tree and Lemon Grass for Treating *Sarcoptes Scabies*:

Several chemical drugs having acaricidal effects have been successfully applied to treat mite infestations including scabies but their extensive usage led to the emergence of resistance and presence of residues in animal products (Bezabh et al., 2022). Therefore, traditional and modern medical practices have been employing herbal remedies due to their cost-effectiveness and minimal side effects (Khare et al., 2019; Nardoni and Mancianti., 2022). Plants have therapeutic properties due to the presence of active ingredients like flavonoids, glycosides, vitamins, alkaloids etc. (Koomson et al., 2018).

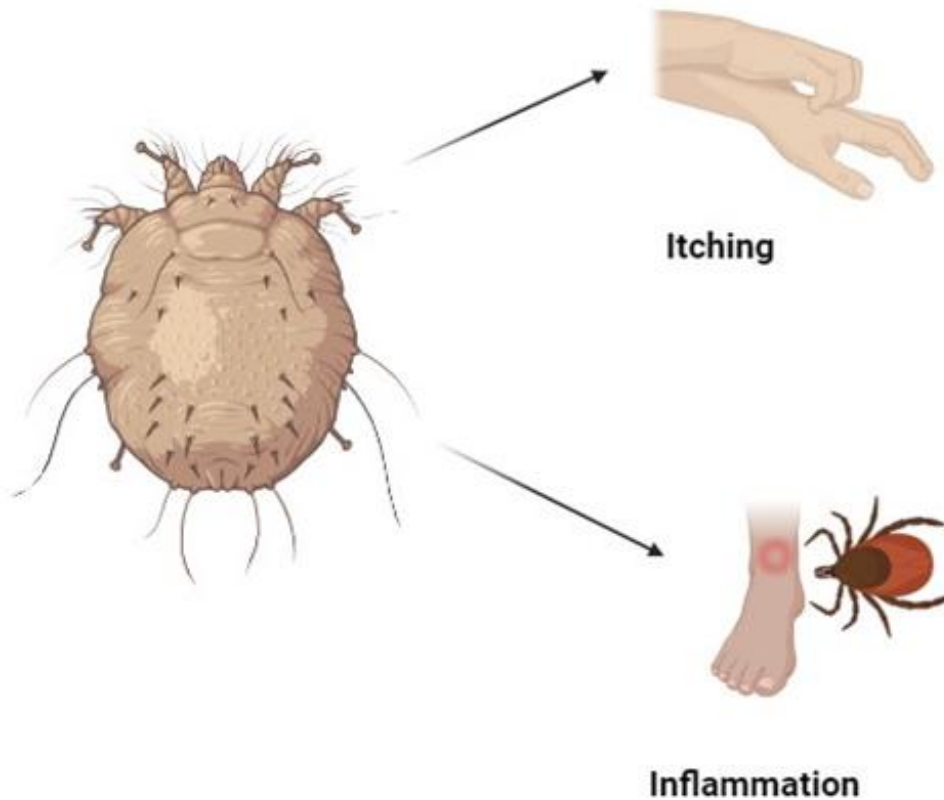


Fig. 1: Clinical signs of Scabies

The tea trees are members of the *Myrtaceae* family, namely *Leptospermum*, *Melaleuca*, and *Kunzea* genera (Çalışkan and Özfenerci, 2018; Bezabh et al., 2022). Australian Aboriginals have been using *Melaleuca alternifolia* leaves as medicine for different dermal and epidermal disorders for over 90 years, and oils distilled through steam have been extensively utilized by Australian communities for the same purpose (Yürekli, 2022). The tea tree plant leaves contain essential oils that are collectively referred to as "TTO" (Sabir et al., 2014). The TTO have acaricidal, antimicrobial, antioxidant, immunomodulatory and anti-inflammatory properties due to availability of terpinene-4-ol content, γ -terpinene, and α -terpinene as the main bioactive components (Nardoni and Mancianti, 2022). The exact mechanism behind TTO's anti-*S. scabiei* var. *cuniculi* effect is currently unknown (Gopinath et al., 2018), however 1,8-cineole, T4O, α -terpinene, γ -terpinene, and p-cymene's anticholinesterase activity cause the mites' muscles to contract and cause spastic paralysis (Li et al., 2023). Additionally, cineole acts as a repellant against *S. scabiei* var. *cuniculi* and modifies the working of an enzyme involved in the scabies mites' nervous system (Hu et al., 2015; Xavier-Junior et al., 2017).

The TTO showed a concentration-dependent anti-mite effect on *S. scabiei* mites in a study conducted to evaluate the relative efficacy of permethrin and TTO (Zulkarnain et al., 2019; Ajan et al., 2022). It has reported that in Australia, TTO has been used to treat scabies (Thomas et al., 2016). A study conducted to evaluate the efficacy of 5% TTO, 5% permethrin cream and 10% permethrin cream. Among all, 5% TTO successfully treated scabies at a higher rate among all. In addition to this, TTOs can also avoid secondary bacterial infections like secondary sepsis, pyoderma, and other bacterial implications due to their antimicrobial properties. Moreover, the inflammatory response generated due to mite antigen can also be lessened by TTO. This is due to the anti-inflammatory and antipruritic properties of TTO (George and Joseph, 2009; Thomas et al., 2016).

The lemongrass produces essential oils having miticidal, ovicidal, anti-inflammatory and antioxidant properties. It is also known as Cochin grass connected to family *Poaceae*. It is commonly grown in tropical and subtropical climates (Mead, 2012; Mukarram et al., 2021). A variety of pharmacologically active chemicals, involving citral (a combination of neral and geranial), citronellal, germacrene-D, geranyl acetate and elemol, in addition to other bioactive components are present in lemongrass essential oil (LEO). The lemongrass essential oils (LEO) exhibit strong dose-dependent miticidal action against all the stages of the life cycle of *S. scabiei*. A study conducted to test the efficacy of different concentrations of lemongrass essential oil against the *S. scabiei* adults. Results explored that LEO killed all adults of *S. scabiei* at percentage concentrations of 10% and 5% in 10 and 25 minutes, respectively. The lemongrass oil at percentage concentrations of 10%, 5%, 1%, 0.5% and 0.1% markedly reduced the hatching rate of mite's eggs taken from the naturally infested rabbits (Li et al., 2020). Citral, which is the main component of LEO, has been reported to exert an ovicidal effect against *S. scabiei* eggs at 4.8% concentration (Li et al., 2021; Paichitrojjana et al., 2023). Ahiberone 1% exhibited mite-killing properties, killing all phases in 62.53 minutes (Andriantsoanirina et al., 2022).

Lavender and Cinnamon

A highly traded essential oil plant species globally, *Lavender angustifolia* Mill (English lavender) ranks among the top 15. It is a small flowering plant that connected to *Lamiaceae* family (Jemimah et al., 2019; Kharraf et al., 2021). The linalyl acetate, monoterpenoids, terpinen-4-ol, camphor and β -ocimene are major ingredients of lavender oil in addition to other therapeutically important components like tannins, coumarin, monoterpenes, phytosterols, anthocyanins, valeric acid, glycolic acid, coumarin etc (Gök et al., 2024). The lavender oil acts as an anti-inflammatory, antioxidant, hypnotizing, antidepressant, anticonvulsive, antimicrobial and antifibrotic agent, among other nutritional and medicinal benefits (Rana, 2021; Bokelmann, 2021; Saeed et al., 2023). On *S. scabiei*, *Lavandula angustifolia* EO demonstrated an LD50 at 10% in 20 minutes (Fang et al., 2016).

Since Biblical times, cinnamon has been utilized as a therapeutic and flavoring agent. There are reportedly more than 200 species of *Cinnamomum* including *Cinnamomum zeylanicum* (also known as *C. verum*), *C. burmannii*, *C. camphora*, *C. cassia*, *C. glaucescens*, *C. iners*, *C. loureirii*, *C. pauciflorum*, *C. tamala* (Sharifi-Rad et al., 2021; Kharisma and Upi Chairun Nisa, 2023). The Cinnamon as essential oil has significant therapeutic effects owing to the attendance of cinnamaldehyde, eugenol, and beta-caryophyllene as its main components (Stevens and Allred, 2022). It has been shown that *Cinnamomum zeylanicum* EO is effective against *P. cuniculi* and has recently shown promising potential against *S. scabiei*. This EO demonstrated a powerful activity, both in contact and fumigant form, killing 100% of mites at 1%. Regretfully, the essential oil did not showed ovicide effect, even though its primary constituents, eugenol and benzyl-benzoate, were thought to be accountable for its mite-killing properties (Andriantsoanirina, 2022). The *Cinnamomum camphora* EO was obtained from two distinct geographical sources: camphorwood from China and *raventsara* from Madagascar. Both sources possessed significant concentrations of 1.8 cineole and limonene, respectively, however the plant only exhibited 5% miticide action when applied topically (for *raventsara*), and both topically and when fumigated (Fichi, 2007; Andriantsoanirina, 2022; Li et al., 2023). Applying this tree's oil on a daily basis for ten days will completely cure the scabies infection (Akram et al., 2020).

Clove and Palmarosa

The *Syzygium aromaticum* is used to extract clove essential oil (Haro-González et al., 2021; Nardoni and Mancianti, 2022). In a contact bioassay, it was found that 1.56% of clove oil eliminated every scabies mite after 15 minutes (Fang et al., 2016). In a contact bioassay, Fang et al. (2016) also found that 1% clove eliminated every mite in 20 minutes. According to El-Saber Batiha et al. (2020), this oil has multiple biological activities in addition to antibacterial, antiparasitic, and antifungal effects. The clove oil is known to have immunobooster and antioxidant qualities (Sandner et al., 2020; Vasantha Kalyani and PM, 2021). The miticidal effect of eugenols has resemblance with that of terpenes. The eugenols exhibit potent miticidal effects. This effect is due to the presence of phenolic hydroxyl groups in their structure. The phenolic hydroxyl group in eugenols binds with GABA and octopamine receptors to show miticidal properties (Li et al., 2023). The eugenol and related compounds are active ingredient of the clove oil and all the effects of clove oil are attributed to the presence of these compounds. These terpenes first disturb the cell membrane and then cell organelles in the cells of mites gut and epidermal epithelium. Furthermore, eugenol inhibited the electron transport chain in the oxidative phosphorylation pathway taking place in mitochondria during respiration, with a stopping rate of 60.26% for 100 $\mu\text{g/mL}$ (Shang et al., 2020) and regulated the expression mRNA for catechinic acid, glutathione S-transferase and thioredoxin (Ma et al., 2019). Due to these mechanisms, the eugenol effectively kills *Psoroptes cuniculi* mites. This killed mites in 5 minutes at 1% concentration and successfully stopped fifty percent (EC50) of hatching of eggs at 0.65%; its fumes also produced surprising results (Fang et al., 2020). The eugenol demonstrated an egg killing effect on *S. scabiei* with an EC50 of 0.9%, (Li et al., 2021). This recommends that eugenols can penetrate the surface of eggs and can be used as sole treatment of *S. scabiei* (Bernigaud et al., 2019; Thomas et al., 2020).

The eugenols are known to cause skin reactions when used in excessive quantities so EC 50 should be critically considered. The topical administration of eugenol should not exceed 0.5% to prevent these adverse reactions on skin (Nardoni and Mancianti, 2022).

The Palmarosa essential oil is the secondary metabolic product of *Cymbopogon martini*. It killed *S. scabiei* in 50 minutes when used at 1% concentration (Fang et al., 2016; Nikolaou et al., 2021). Fang et al. evaluated the efficacy of ten essential oils against *S. scabiei*. Out of the 10 essential oils, the most effective essentials oils were 1 percent (v/v) clove oil and palmarosa oil as they eliminated every mite in 20 and 50 minutes, respectively (Sharma et al., 2020). The active ingredient of palmarosa oil is geraniol (Smitha and Rana, 2015). Different routes of administrations have tested for geraniol but the results have shown that geraniol have a potent acaricidal effect whenever administered by contact as opposed to fumigant form. The terpene also exhibit ovicide activity against *S. scabiei* (Li et al., 2020) with an EC50 of 2% and was effective against both the forms (adult and eggs) of *P. cuniculi* mites (Fang et al., 2020). Being 5.3% of the maximum amount advised, it is well acceptable for dermal use, and this EO seems to be a emerging tool for a secure cure (Nardoni and Mancianti, 2022).

Neem Oil

The *Azadirachta indica* is a plant of India that provides us with neem oil (Upadhayay and Vigyan, 2014), this oil is used in various medicines for the treatment of different issues (Benelli et al., 2017). The main element of neem is azadirachtin that is present in the leaves and seeds. It deregulates the growth of parasites, decreases ecdysone levels, changes the

development and reproduction, and have negative effect on molting. The acaricidal effect active as larvicide against *S. scabiei* var *cuniculi* while octadecanoic acid-tetrahydrofuran-3,4-diyl ester, cause damage to the body wall of mites, hinders mitochondrial activity and oxidative phosphorylation pathway, ultimately results in the death of parasites (Chen et al., 2014; Song et al., 2017).

Conclusion

In conclusion, there are encouraging possibilities for the management of *Sarcoptes scabiei* infestations, including scabies in humans and mange in animals, through the use of herbal remedies, especially essential oils. In place of traditional acaricides, essential oils with notable acaricidal activity against *S. scabiei* include tea tree, lemongrass, lavender, cinnamon, clove, palmarosa, and neem, respectively. These essential oils are effective against mites at different stages of their life cycle due to their diverse mechanisms of action, which include neurotoxicity, ovicidal effects, and disruption of mite physiology. Moreover, herbal products made from these essential oils are usually safe for the environment, well-tolerated, and have few side effects. To maximize efficacy and safety, more research is necessary to optimize formulations, dosages, and application techniques. Researcher, medical professional, and policymaker collaboration is necessary to fully utilize the potential of herbal remedies in the fight against scabies and to enhance public health outcomes worldwide.

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