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REVIEW ARTICLE

A Scoping Review: Topical Treatment of Infectious Skin Diseases with Remedial Plant Oils

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ABSTRACT

Skin infections are common ailments that affect people of all ages. One of the approaches to treating these infections is the topical application of plant oils. However, research on the therapeutic use of plant oils as remedies for skin infections remains limited. This scoping review aims to identify research gaps by assessing the types of skin infections that respond effectively to plant oil treatments. The review is conducted in three phases: the planning, conducting and analysing phases. During the planning phase, an outline of the review is developed. The conducting phase utilises the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISM) method to extract relevant data. The analysing phase involves summarising and reporting the findings. This review focuses on the usage of two classes of plant oils: essential and cooking oils, in treating bacterial, fungal, viral, and parasitic infections by evaluating their efficacies, formulations, and dosages. It also explores the methodologies, application frequencies, treatment durations, and trial limitations. Overall, tea tree oil emerged as the most commonly used treatment, with other oils showing beneficial outcomes despite variations in methodologies. Applying standardised treatment protocols, optimum sample sizes and control groups may improve the result of these studies.

Keywords: *Human study, Skin infection, Topical treatment, Plant oil, Remedy*

INTRODUCTION

Skin infections are very common, particularly among school children, hospital patients and athletes (Anderson et al., 2023; Kelly et al., 2021; Shen & Lu, 2010). They affect all age groups due to their contagious nature, spreading through direct skin contact or contaminated surfaces (van Seventer & Hochberg, 2017). Various pathogens cause these infections, including bacteria, viruses, fungi and parasites. Given the widespread nature of these diseases and various risk factors, finding effective treatments is crucial.

Synthetic drugs that are commercially available are tested and widely used as conventional treatments. However, in recent years, consumers increasingly prefer natural remedies for their affordability and fewer side effects (Karimi et al., 2015). There was also a rising trend of newly registered drugs derived from plant extracts used in treating infectious diseases since 1981 (Palmeira-de-Oliveira et al., 2013). Though plant oils have shown potential in treating skin infections (Lin et al., 2017), research remains limited, and more studies are needed.

Apart from this, the effectiveness of plant oils remains uncertain due to varying formulations and treatment regimens. For example, studies suggest antimicrobial properties of tea tree oil may treat acne (Carson et al., 2006; Kramer, 2019), but results are often inconsistent due to small sample sizes, differing application frequencies, and oil concentrations (Bassett et al., 1990; Malhi et al., 2017).

While plant oil therapy is anticipated to alleviate infections, differing methodologies may result in inconsistent outcomes. Therefore, this review aims to investigate the formulations, application frequency and treatment duration of skin infections treated with medicinally proven plant oils, encouraging further research to establish the safety and efficacy of these oils before they can be used commercially.

MATERIALS AND METHODS

Planning Phase

A research question was formulated using the PICOS framework (Population, Intervention, Comparison, Outcomes and Study) as previously reported (Eldawlatly et al., 2018). By using Table 1, the formulated research question: What is known from the human survey papers about plant oils as a treatment for skin infections as compared to synthetic drugs?

Table 1: Outlines the key elements of the PICOS framework; Population, Intervention, Comparison, Outcome, and Study, along with the corresponding keywords.

Elements	Keywords
Population	Humans
Intervention	Plant oils
Comparison	Synthetic drugs
Outcome	Treatment of skin infections
Study	Human survey

Then, the inclusion and exclusion criteria were developed as listed in Table 2. These criteria were used in the conducting phase for article screening, a process that filtered out relevant papers applicable to this study. Any paper that answered the research question and fit the inclusion criteria was included in this scoping review.

The criteria for this study included timeline, subject area, publication type and language. The timeline was set from 1980-2022 to capture trends over the past 40 years that showed a significant rise in studies on plant oils for skin infections (Figure 1). The focus was limited to human skin diseases, excluding other species as they did not answer the research question. Only human survey papers in English were included to ensure uniform data and clarity.

Table 2 : Inclusion and exclusion criteria for the review.

Criteria	Inclusion	Exclusion
Timeline	Reports within years 1980 - 2022	Reports before the year 1980
Subject area	Investigation on humans	Investigation on animals
Publication Type	Human survey articles	Systematic reviews, scoping reviews, meta-analyses, animal testing, in vitro trials

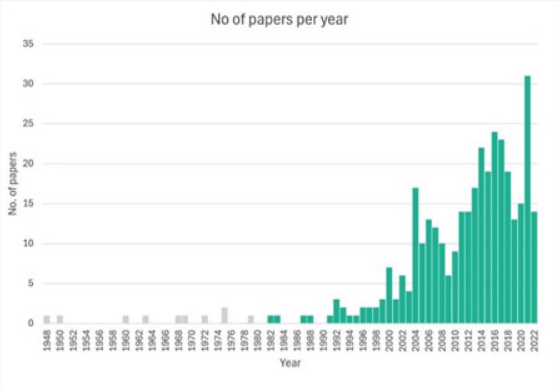

Figure 1 : The trend of studies on skin infection treatment using plant oils (1980-2022) as a source from PubMed (2022).

Conducting Phase

The research protocol was developed based on a method called Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). It is a step-by-step guide created to assist in filtering out relevant study papers.

A reliable online database, such as PubMed, was used to search for scientific literature related to this review. PubMed was the sole database used because it offers extensive data for the period from 1980-2022. Before looking up papers on the database, a search string was constructed using a strategy mentioned previously (Zein et al., 2016) and shown in Table 3.

Table 3 : Search strategy for reviewing the use of oils in treating skin infections: This table outlines the specific search terms employed to identify relevant literature for a systematic review on the treatment of skin infections using oils. The search strategy includes combinations of terms related to "infection," "treatment," and various types of oils, such as "plant oil" and "topical oil." The use of logical operators (AND, OR) ensures a comprehensive retrieval of studies from electronic databases.

List of search terms				
"infection"		OR		"skin infection"
		AND		
		"treatment"		
		AND		
"plant oil"	OR	"oil"	OR	"topical oil"

A total of 442 articles were initially identified. After title screening based on the inclusion-exclusion criteria, irrelevant studies were excluded, leaving 64 articles for full-text assessment. These were downloaded and managed using Mendeley. After a thorough review, 50 articles were deemed relevant for this scoping review. The screening process is summarized in Figure 2.

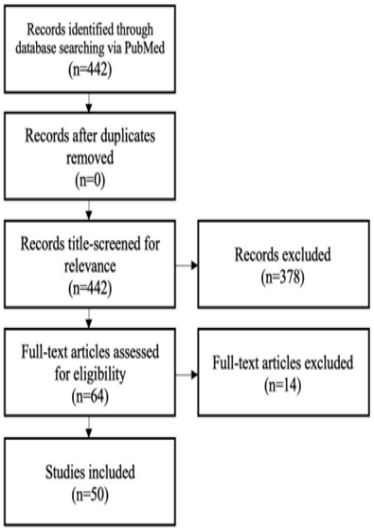

Figure 2 : Flowchart of the screening process for this study: This figure illustrates the systematic screening process used in this study to identify relevant articles on the treatment of skin infections using plant oils. The last 14 full-

text articles were excluded as they passed the initial process of title screening based on the inclusion-exclusion criteria but did not fulfil the full-text assessment .

The articles were categorised by infection type; bacterial, fungal, viral, and parasitic diseases, as outlined in Table 4. Data extraction was then performed for the final review phase.

Table 4 : Distribution of articles by disease type studied.

Disease type	No. of articles
Bacterial disease	12
Fungal disease	17
Viral disease	6
Parasitic disease	15
Total	50

Analysing Phase

This phase involved analyzing, reporting, and summarizing data to address the research question and objectives. Key details, including the type of skin infection, plant oils used, formulations, application methods, frequency, treatment duration, effectiveness, and comparison drugs, were extracted from each article. The studies were then analyzed and compared to identify knowledge gaps.

RESULTS AND DISCUSSION

1. Bacterial Diseases

Out of 12 articles reviewed on bacterial diseases, 75% of them used tea tree (Melaleuca alternifolia) oil as the treatment of choice (Table 5).

1.1. Acne vulgaris

Tea tree oil

Two different studies found that tea tree oil reduced acne lesions by half, using 5% and 20% concentrations, respectively. This indicates that higher concentrations may not enhance its effectiveness (Bassett et al., 1990, Malhi et al., 2017). However, the lack of data on application frequency in the former study leaves a gap in determining its optimal usage. Meanwhile, two double-blinded studies were conducted using 5% tea tree oil in gel and cream formulation (Enshaieh et al., 2007, Kwon et al., 2014). Despite longer treatment duration, the latter study showed poorer outcomes than the former, suggesting that cream formulation may have hindered oil penetration and reduced its efficacy. These findings highlight the importance of determining effective concentration, administration frequency, and topical formulation.

Other oils

Various formulations of ocimum (Ocimum gratissimum) oil were tested, and they found that the 2% concentration was the most effective in reducing the lesion by 50%, particularly in ethanol and cetomacrogol bases (Orafidiya et al., 2002). This suggests that increasing the concentration beyond 2% may not improve its efficacy, and the choice of vehicle plays a key role in enhancing the oil's penetration.

Another study has tested a blend of antimicrobial therapy with tea tree, lavender (Lavandula angustifolia), and jojoba (Simmondsia chinensis) oil, showing significantly reduced inflammatory lesions (Kim & Shin, 2013). The blend may work synergistically and act as an adjunct to the conventional therapy. However, further research is needed to explore the therapeutic potential of individual plant oils.

1.2. Methicillin-resistant Staphylococcus aureus (MRSA) skin infection

Tea tree oil

Edmondson et al. found that a 3.3% solution was ineffective in eliminating MRSA, while Lee et al. achieved an 87.5% elimination rate with a 10% formulation, suggesting that a higher concentration is more effective (Edmondson et al., 2011, Lee et al., 2014).

Another two studies compared tea

tree oil preparations (nasal ointments, body washes, creams) to Mupirocin as control groups. In a study of 30 participants, lesion clearance was 33% in the intervention group and 13% in the control (Caelli et al., 2001). However, a larger study with 224 participants showed 41% clearance in the intervention group and 49% in the control (Dryden et al., 2004), highlighting that small sample sizes can produce misleading results and larger studies are needed.

1.3. Staphylococcus aureus atopic dermatitis

Other oils

In studies on atopic dermatitis, they found that pure virgin coconut (Cocos nucifera) oil (VCO) had a higher recovery rate than virgin olive oil (VOO) (Verallo-Rowell et al., 2008). The lower efficacy of VOO may be due to the presence of gallate, an antioxidant that can act as a contact allergen, potentially worsening dermatitis symptoms (Holcomb et al., 2017). This underscores the importance of selecting

Table 5 : Summary of bacterial skin infections in this scoping review.

Disease	Plant oil	*Formulation	Frequency of administration (per day)	Treatment duration (days)	References
Acne vulgaris	Tea tree	5% EO in gel	?	90	Bassett et al., 1990
		20% EO in gel	2	90	Malhi et al., 2017
		5% EO in gel	2	45	Enshaieh et al., 2007
		5% EO in cream	2	60	Kwon et al., 2014
	Odium	2% EO in ethanol	2	30	Orafidiya et al., 2002
		2% EO in cetomacrogol base	2	30	
	A mixture of tea tree, lavender, jojoba	3%, 2% and 2% EO respectively with antimicrobial treatment	2	30	Kim & Shin, 2013
MRSA skin infection	Tea tree	3.3% EO in a wound wash solution	1	84	Edmondson et al., 2011
		10% EO in paraffin	1	28	Lee et al., 2014
		4% EO in nasal ointment	?	34	Caelli et al., 2001
		5% EO in body wash		5	Dryden et al., 2004
		10% EO in nasal ointment	3		
		5% EO in body wash	1		
		10% EO in cream	1		
Staphylococcus aureus atopic dermatitis	Coconut, olive	100% CO	2	28	Verallo- Rowell et al., 2008
		100% CO	2		
Erythrasma	Olive	100% ozonised CO	2	10	Ramírez-Hobak et al., 2016

*EO: essential oil; CO: cooking oil

appropriate oils to prevent adverse effects.

1.4. Erythrasma

Other oils

A paper reported that ozonated olive oil could cure all patients in 10 days (Ramírez-Hobak et al., 2016). Even though this study proved that it is effective in curing erythrasma, this trial lacks a control group, making the outcome ambiguous.

2. Fungal Diseases

A total of 17 studies were reviewed. Similar to bacterial diseases, tea tree oil is the most extensively researched plant oil for fungal diseases (Table 6).

2.1. Dandruff (commonly due to Malassezia furfur)

Tea tree oil

A study conducted to examine tea tree oil's effectiveness against fungi causing dandruff revealed that a 5% concentration in shampoo reduced lesions by 41% (Satchell et al., 2002a). While it shows potential as an antifungal treatment, tea tree oil may be more effective as an adjunct therapy rather than a standalone solution. Further research is needed to optimize its potential combinations with other active ingredients to enhance its benefits.

Other oils

Another report tested different concentrations of lemongrass (Cymbopogon flexuosus)

Table 6 : Summary of fungal skin infections in this scoping review.

Disease	Plant oil	*Formulation	Frequency of administration (per day)	Treatment duration (days)	References
Malassezia furfur (commonly caused by dandruff	Tea tree	5% EO in shampoo	Daily usage	28	Satchell et al., 2002a
	Lemongrass	10% EO in hair tonic	Twice daily	14	Chaisripipat et al., 2015
Tinea unguium	Tea tree	100% EO	Twice daily	180	Buck et al., 1994
		5% EO in cream	Thrice daily	56	Syed et al., 1999
	Sunflower	100% ozonised CO	Twice daily	90	Menendez et al., 2011
	Eucalyptus	100% EO	?	120	Bramston et al., 2015
Tinea versicolor	Artemisia	5% EO in cream	Twice daily	14	Mansouri et al., 2010
		5% EO in cream	Twice daily	14	Rad et al., 2008
		3% EO in cream	Twice daily	14	Khosravi et al., 2009
	Lemongrass	0.125% in cream	Twice daily	40	Carmo et al., 2013
		0.125% in shampoo	Thrice weekly		
Tinea pedis, corporis and cruris	Bitter orange	25% EO in emulsion	Thrice daily	28	Ramadan et al., 1996
	Eucalyptus	1% EO in ointment	Twice daily	21	Shahi et al., 2000
Tinea pedis, corporis and versicolor	Thyme	3% EO in cream	Twice daily	28	Shimelis et al., 2012

*EO: essential oil; CO: cooking oil

oil in tonic (Chaisripipat et al., 2015) and revealed that the 10% concentration was the most effective in reducing dandruff by 81%. The results indicate that the oil's antifungal properties are likely concentration-dependent, with optimal efficacy and tolerability at specific levels. The reduced effectiveness at higher concentrations could be due to potential irritation or diminished absorption. Identifying the best concentration is crucial for maximising benefits and minimising adverse effects.

2.2. Tinea unguium

Tea tree oil

A study has documented a 60% resolution rate with pure tea tree oil, while another report achieved an 80% cure rate using only 5% formulation (Buck et al., 1994, Syed et al., 1999). Differences in oil concentration, treatment duration (180 vs. 56 days), and control drugs used (clotrimazole vs. butenafine) complicate these comparisons, with butenafine showing better cure rates than clotrimazole in other studies (Singal et al., 2005). These variations highlight the need for standardization when evaluating tea tree oil's effectiveness.

Other oils

Application of ozonated sunflower oil (OLEOZON®) with 2% ketoconazole cream revealed 91% of patients were cured, as compared to 14% in the control group. This outcome could be due to enhanced antimicrobial properties from ozonation (Menendez et al., 2011). Furthermore, pure eucalyptus (Eucalyptus pauciflora) oil also showed a high clearance rate for superficial toenail infections, though the application frequency was not specified (Bramston et al., 2015). The latter study emphasizes the need to assess its effectiveness in more severe cases, especially those involving the nail matrix.

2.3. Tinea versicolor

Artemisia (Artemisia sieberi) oil

Two trials found that a 5% concentration in cream achieved over 80% cure rates within a 14-day treatment period, indicating high effectiveness (Mansouri et al., 2010; Rad et al., 2008). In contrast, another study used a 3% concentration, achieving a lower 70% cure rate, suggesting that a stronger formulation is more effective (Khosravi et al., 2009).

Other oils

A study tested 0.125% lemongrass oil in both cream and shampoo formulations for treating tinea versicolor (Carmo et al., 2013). While lemongrass oil shows potential as a natural alternative, it is less effective than ketoconazole. More research is needed to improve its efficacy at par with conventional treatment.

2.4. Tinea pedis

Tea tree oils

Two studies on tinea pedis used tea tree oil treatments (Tong et al., 1992, Satchell et al., 2002b). The former used a 10% tea tree oil cream, while the latter applied 25% and 50% tea tree oil in an ethanol-polyethylene glycol solution. Although clinical cure rates showed no significant difference, the 50% tea tree oil achieved the highest mycological cure rate of 64%, indicating greater effectiveness at higher concentrations.

Other oils

Ozonated sunflower (Helianthus annuus) oil was applied for six weeks and achieved a 75% cure rate (Menéndez et al., 2002), while 6% coriander (Coriandrum sativum) oil in ointment resulted in 71% cure after four weeks (Beikert et al., 2013). Coriander oil was more effective in delivering results within a shorter period, though both oils proved to be effective treatments.

2.5. Other forms of tinea

Other oils

Two reports documented treating tinea pedis, corporis, and cruris with essential oils. The first study found that a 25% bitter orange (Citrus aurantium) oil achieved an 80% cure rate (Ramadan et al., 1996), while the second report

revealed a 60% cure rate using a 1% eucalyptus oil (Shahi et al., 2000).

Meanwhile, Shimelis et al. tested a 3% thyme (Thymus schimperi Ronniger) cream to tinea pedis, corporis, and versicolor, achieving a 67% cure rate (Shimelis et al., 2012). This suggests that few options of plant oils can be used to treat these diseases effectively.

while none in the olive oil group (Burke et al., 2004). This demonstrates that lemon myrtle in olive oil is more effective. A more recent study tested sandalwood (Santalum album) oil in soap, finding a 90% cure rate after 12 weeks of use (Haque & Coury (2018a). However, this study lacked a control group, limiting the ability to compare the results directly.

Table 7 : Summary of viral skin infections in this scoping review.

Disease	Plant oil	*Formulation	Frequency of administration (per day)	Treatment duration (days)	References
Molluscum contagiosum	Tea tree	75% EO in iodine	2	30	Markum & Baillie, 2012
	Lemon myrtle	10% EO in olive oil	1	21	Burke et al., 2004
	Sandalwood	In soap	2	84	Haque & Coury, 2018a
Common warts	Tea tree	100% EO	1	12	Millar & Moore, 2008
	Sandalwood	100% EO	2	84	Haque & Coury, 2018b
Herpes labialis	Tea tree	6% EO in gel	5	9	Carson et al., 2001

*EO: essential oil; CO: cooking oil

3. Viral Diseases

Six articles reported on viral diseases, with all of them utilising essential oils, either in their pure or blended forms (Table 7).

3.1. Molluscum contagiosum

Pure oils

One study tested three topical treatments for molluscum contagiosum: pure tea tree oil, pure iodine, and a combination of tea tree oil and iodine (Markum & Baillie, 2012). The combined treatment, which contained 75% tea tree oil in iodine, was the most effective, reducing lesions in 80% of subjects after twice-daily application for a month, indicating that combined formulation with plant oil may improve the disease outcome.

Blended oils

Burke et al. (2004) compared the effectiveness of 10% lemon myrtle (Backhousia citriodora) in olive oil to olive oil alone, finding that more than half of the subjects using the former blend achieved a 90% reduction in symptoms,

3.2) Common warts

Pure oils

In the study of warts, the first report applied pure tea tree oil once daily for 12 days, achieving complete resolution (Millar & Moore, 2008). The second report used pure sandalwood oil, with twice-daily application for 12 weeks, resulting in an 80% cure rate (Haque & Coury, 2018b). Although tea tree oil showed greater success, both studies had small sample sizes and lacked control groups, highlighting the need for larger, controlled trials to validate these results.

3.3. Herpes labialis

Blended oils

A single trial investigated the application of 6% tea tree oil gel for herpes labialis until herpes simplex virus DNA tested negative for two consecutive days (Carson et al., 2001). Results showed no significant difference compared to the placebo, likely due to the small sample size of 18 patients.

4. Parasitic Diseases

There are 15 studies involving essential and cooking oils as a treatment for parasitic skin diseases (Table 8).

Table 8 : Summary of parasitic skin infections in this scoping review.

Disease	Plant oil	*Formulation	Frequency of administration (per day)	Treatment duration (days)	References
Pediculosis	Citronella	3.7% EO in emulsion	Six times weekly	120	Mumcuoglu et al., 2005
	Mixture of tea tree, lavender	10% and 1% EO respectively in pediculicide	Once weekly	14	Barker & Altman, 2010
	Mixture of eucalyptus, lemon tea tree	11% and 1% EO respectively in pediculicide	Once weekly	14	Greive & Barnes, 2018
	Coconut	In shampoo	Once weekly	7	Connolly et al., 2008
		1% CO in shampoo	Once weekly	8	Burgess & Burgess, 2020
	Olive	In soap	Once weekly	7	Soler et al., 2017
	Mixture of coconut, anise, ylang ylang	In pediculicide	Once weekly	15	Mumcuoglu et al., 2002
Scabies	Lippia	20% EO in paraffin	Once daily	5	Oladimeji et al., 2000
		20% EO in glyceryl monostearate/sodium lauryl sulphate emulsion	Once daily	5	Oladimeji et al., 2005
Demodex blepharitis	Tea tree	50% EO in mineral oil	Once weekly	30	Gao et al, 2007
		50% EO in mineral oil	Once weekly	30	Gao et al., 2005
		50% EO in mineral oil	Once weekly	30	Koo et al., 2012
		5% EO in ointment	Twice daily	30	Gao et al., 2012
		In face wash	Once daily	30	Murphy et al., 2018
Tungiasis	Neem	20% EO in coconut oil	Every other day	3	Elson et al., 2019

*EO: essential oil; CO: cooking oil

4.1. Pediculosis

Essential oils

The first trial demonstrated a 3.7% citronella (Cymbopogon nardus) oil emulsion against a control emulsion without citronella (Mumcuoglu et al., 2005). After daily spraying for six days a week over four months, the citronella emulsion was effective, with only 12.4% of subjects remaining infested compared to 33.7% in the control group.

The second trial evaluated a combination of 10% tea tree and 1% lavender oils (TTO/LO) (Barker & Altman, 2010), achieving a 97.6% cure rate, similar to a commercially available 'suffocation' lotion. However, another treatment, pyrethrins-piperonyl butoxide mousse only cured 25% of subjects.

Meanwhile, the third trial tested a combination of 11% eucalyptus oil and 1% lemon tea tree (Leptospermum petersonii) oils

(EO/LTT) (Greive & Barnes, 2018), obtaining an 83% cure rate, compared to 36% with the mousse. All trials demonstrated the effectiveness of essential oil treatments.

Vegetable cooking oils

Three studies tested cooking oils for their antifungal properties: two on coconut oil shampoos and one on olive oil soap. Coconut oil shampoos showed varied results, with one study reporting a 59% cure rate (Connolly et al., 2008) and another 39% (Burgess & Burgess, 2020), despite using similar methods. Meanwhile, the study on olive oil soap (Brand: Inex) demonstrated a 76% cure rate, close to the 79% cure rate of the established product, Paranix (Soler et al., 2017), suggesting olive oil soap is comparably effective.

Combination of both oil types

A single study examined a combination of essential and vegetable oils in the product, Chick-Chack, which contains coconut, anise (Pimpinella anisum) and ylang ylang (Cananga odorata) oil against ParaPlus spray, a known pediculicide, as the control (Mumcuoglu et al., 2002). Both were applied according to manufacturer instructions, with Chick-Chack sprayed thrice at five-day intervals, and ParaPlus twice at 10-day intervals. The study found no significant difference, with both products achieving a 92% cure rate.

4.2. Scabies

Essential oils

Two studies tested lippia (Lippia multiflora) oil against benzyl benzoate for scabies treatment. The first study found that 20% lippia oil diluted with paraffin achieved a 100% cure rate over five days (Oladimeji et al., 2000). The second study, using a 20% lippia oil in emulsion, showed an 80% cure rate in the same period (Oladimeji et al., 2005). Both studies confirmed the effectiveness of 20% lippia oil in treating scabies.

4.3. Demodex blepharitis

Essential oils

Three trials tested 50% tea tree oil solution as a weekly lid scrub over four weeks, using either cotton tips or bare fingers. All studies showed positive outcomes with no significant differences in application methods (Gao et al, 2007; Gao et al., 2005, Koo et al., 2012). Additionally, two studies explored tea tree oil in skincare products; a 5% tea tree oil ointment resulted in 67% patient improvement after four weeks of twice-daily use (Gao et al., 2012), and 'Dr Organic Tea Tree Face Wash' also showed positive results after nightly application for four weeks (Murphy et al., 2018).

4.4. Tungiasis

Combination of both oil types

A study compared the effects of neem (Azadirachta indica) in coconut oil with standard potassium permanganate therapy. The oil mixture was applied on days 1 and 3, while the standard treatment was only on day 1. Although the oil mixture was not more effective overall, it killed an average of 40% of the fleas (Elson et al., 2019). Further trials using different dosages and methods may improve the outcome.

CONCLUSION

This review summarizes 42 years of research on using plant oils to treat skin infections, with tea tree oil being the most studied and widely used due to its healing properties. Research during this period investigated various formulations, application frequencies, and treatment durations, leading to promising but varying results. Some studies indicated the need for higher concentrations, while others required less. Overall, plant oil therapies generally showed positive outcomes, though certain diseases responded better when combined with synthetic treatments. Future research should focus on optimizing formulations and standardizing administration to obtain consistent results. It is also best to compare this alternative therapy to conventional treatment, while also evaluating the safety of higher oil concentrations.

Despite this, few studies reported in this scoping review did not include a control group; in which having a control group is crucial before the product can be prescribed commercially. Another important observation in these studies was the use of a small sample size that may have skewed the results. The challenge lies in recruiting enough participants for the mentioned studies, as it was difficult to achieve a sizable sample with the studied skin infection. To solve this issue, collaboration can be done with multiple research centres and study sites, which can help in recruiting more patients.

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CONFLICT OF INTEREST

The author declares that the manuscript produced in the absence of any financial or commercial relationships could be construed as a potential conflict of interest.

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