Review Article

Role of essential plant oils in the treatment of periodontal and oral diseases

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ABSTRACT

Essential oils (EO) have been used as an adjuvant modality of treatment in the management of several orofacial diseases. They are primarily herbal extracts composed of complex organic hydrocarbons. The EO are extracted through a strenuous process of filtration and distillation from the naturally available botanical sources. They exhibit various therapeutic properties including antibacterial, antifungal, and antiviral properties. They also possess anxiolytic and antipsychotic properties. EO are relatively free of harmful side effects and allergic reactions. This review describes the potential applications of various EO in the management of periodontal and other oral diseases.

KEY WORDS: Antimicrobials, Essential oils, Hydrocarbons, Oral diseases

INTRODUCTION

Oral cavity harbors a multitude of microflora. The microflora ranges from aerobic, anaerobic, and facultative anaerobes as commensals and opportunistic pathogens. These microbial pathogens cause several infectious diseases in the oral cavity, with caries and periodontitis being the predominant and widely prevalent diseases. Periodontal disease is a well complex pathological phenomenon affecting the supporting tissues of the teeth. The alveolar bone, gingiva, cementum and periodontal ligament complex constitute the periodontium. Any infection affecting any one of these tissues can lead to progressive inflammatory changes characterized by pain, bleeding, mobility, suppuration, and eventually tooth loss when the disease is severe. The main etiological factor initializing periodontitis is a dental plaque. Dental plaque is a biofilm that forms over tooth surfaces, which if left undisturbed can progress into calculus formation through progressive mineralization and microbial contamination. The calculus that is formed apart from mechanically irritating the periodontal structures also functions as an abode for multiple pathological microorganisms. The microorganisms release exo- and endo-toxins inflicting severe damage to the periodontium.

The conventional management strategies for periodontal disease range from simple plaque control measures such as brushing, flossing, and complex procedures including surgical interventions such as curettage, flap surgery, reconstructive plastic and osseous surgery, and preventive measures using microbicidal mouthwashes. Alternate interventions through herbal medication in the form of essential oils (EO) and mouthwashes can also be used in the management of periodontitis.

Aim

The aim of the study was to review the literature to study the effects of herbal oils in the treatment of periodontal and oral diseases.

GENERAL COMPOSITION OF EO

EO are comprised combination terpenic hydrocarbons, aldehydes, alcohols, esters, and ketones in varying proportions.[1] The EO vary in their composition depending on the species, geographical locations and the maturity of the herbal plants from which they are extracted. The EO also show variations in their content and composition based on the site of extraction.[2,3]

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MECHANISM OF ACTION

The major mechanism of action to induce microbicidal effect is predominantly by membrane damage. These EO being organic has solubility in the cell membrane that is composed bilayer of phospholipids and can permeate them and cause osmotic instability. They also reduce the quantity of certain components in the fungal cell membrane like ergosterol. They can also affect energy metabolism in the microbial cells through downregulation of certain enzymatic reactions.[4-7]

The properties and uses of different EO are described below:

Lavender Oil

Lavender oil, obtained from the flowers of Lavandula angustifolia (Family: Lamiaceae) by steam distillation, is chiefly composed of linalyl acetate (3, 7-dimethyl-1, 6-octadien-3yl acetate), linalool (3, 7-dimethylocta-1, 6-dien-3-ol), lavandulol, 1, 8-cineole, lavandulyl acetate and camphor.[5]

Essential oils extracted from *Lavandula stoechas* L. exhibit effective antimicrobial activities against most of the bacteria, filamentous fungi, and yeasts. In the study of Benabdelkader *et al.*, minimum inhibitory concentrations were found to be ranging from 0.16 to 11.90 mg/ml.[2] It also shows antipseudomonal activity.[8] *In vitro* study on the antibacterial activity of the EO of *Lavandula coronopifolia* against antibiotic-resistant bacteria suggested its bactericidal effect.[9] Lavender EO is reported to reduce stress, anxiety, and improve mood when inhaled or orally administered.[10-12] EOs of *Lavandula luisieri* show an inhibitory effect on yeast, dermatophyte, and Aspergillus strains.[13] *Lavandula viridis* is reported to have a fungicidal effect. *Cryptococcus neoformans* is the most sensitive fungus, followed by *Candida* species.

It can be used in dental clinics to reduce patients' anxiety. It is found to be useful as an anxiolytic agent when used in waiting area.[10,12] The study performed by Kim *et al.* showed a statistically significant reduction in anxiety scores when the fragrance of lavender oil was used in the reception area. It is also helpful during surgical procedures, as it has been shown to reduce the pain of needle insertion[11] and hence can be recommended for periodontal surgical procedures.

Eucalyptus Oil

The main ingredient is 1, 8-cineole followed by cryptone, α-pinene, *p*-cymene, α-terpineol, trans-pinocarveol, phellandral, cuminal, globulol, limonene, aromadandrene, spathulenol, and terpinene-4-ol.[14]

Antimicrobial activity was found to be related to the synergic effects between major and minor components rather than the concentration of a single component.[14] EO of the leaves of *Eucalyptus globulus* has antimicrobial activity against Gram-negative bacteria (*Escherichia coli*) as well as Gram-positive bacteria (*Staphylococcus aureus*).[15] Studies done on eight eucalyptus species show that *Eucalyptus odorata* oil possesses strong cytotoxic effect and also antibacterial effect against *S. aureus*, *Haemophilus influenzae*, *Staphylococcus pyogenes*, and *Staphylococcus pneumonia. Eucalyptus bicostata* and *Eucalyptus astringens* showed antibacterial effects.[14] The study of Serafino *et al.* demonstrates that eucalyptus EO can stimulate the innate cell-mediated immune response suggesting its use as adjuvant in immunosuppression, in infectious disease, as well as in tumor chemotherapy.[16] It shows an inhibitory effect on oral pathogens like *Lactobacillus acidophilus,* which makes this suitable to be used as an anticariogenic agent.[17]

Peppermint Oil

Peppermint (*Mentha piperita*) oil is one of the most popular and widely used EOs. In the EO from *M. piperita*, menthol is identified as the major compound, followed by menthyl acetate and menthofuran.[18]

Peppermint oil shows an inhibitory effect on the proliferation of staphylococci.[19] Studies show that EOs exhibit mycostatic and fungicidal activities against both the standard and clinical strains of *Candida* species at concentrations ranging from 0.5 to 8 µL/mL. EOs exhibit similar antifungal effect against the azole-resistant and azole-susceptible strains.[18] Biofilm inhibition in fungal strains helps to decrease pathogenesis and drug resistance. Studies show that EO inhibits the biofilm formation of *Candida albicans* completely up to 2 µl/ml in a dose-dependent manner.[25]

Eugenol oil is used widely in dentistry. It is active against oral pathogens associated with dental caries and periodontal disease.[20] Studies conducted on five EOs (tea tree oil [TTO], lavender oil, thyme oil, peppermint oil, and eugenol oil) against four common oral pathogens (*S. aureus*, *Enterococcus faecalis*, *E. coli*, and *C. albicans*) showed significant inhibitory effect of eugenol oil, peppermint oil, and TTO. Among them, eugenol oil showed antimicrobial activity at the lowest concentration level.[21]

TTO and some of its individual components, specifically terpinen-4-ol, exhibit strong antimicrobial efficacy against fungal biofilms. TTO can be a solution for the increasing resistance of *C. albicans* to established antifungal drugs. It can be used to treat oral candidiasis[22] and is suitable for use in prophylactic oral hygiene products. The study performed by Ramage *et al.* shows that it is more appropriate and

safe to use terpinen-4-ol, the major component of TTO, than TTO itself.[23]

TTO: (*Melaleuca alternifolia*)

Its composition shows terpinen-4-ol, γ-terpinene, *p*-cymene, α-terpinene, 1, 8-cineole, α-terpineol, and α-pinene.[24] In a clinical trial, the melaleuca gel was found to possess an inhibitory effect on various bacterial colonies and dental biofilm.[25] It shows strong antibacterial action against oral pathogens.[26] *M. alternifolia* possesses antimycotic activity, terpinen-4-ol being its most effective component.[27]

Lemon Oil

It contains almost exclusively terpenes and oxygenated terpenes.[28] Therapeutic activity shows antifungal potential against three *Candida* species (*C. albicans*, *Candida tropicalis*, and *Candida glabrata*). Lemon EO is suggested to be used as an effective remedy against candidiasis caused by *C. albicans*.[28,29] Lemon EO is suggested to be used as an effective remedy against candidiasis caused by *C. albicans*.[29]

Clove Oil

Main constituents found in the clove bud oil are the phenylpropanoids eugenol, eugenyl acetate, carvacrol, thymol, cinnamaldehyde (CA), β-caryophyllene, and 2-heptanone, when analyzed by gas chromatography.[30,31] Eugenol is well-known for its therapeutic properties and is widely used in dentistry.

When tested against *tert*-butylated hydroxytoluene, EO exhibited a very strong radical scavenging activity.[30] It possesses antifungal activity.[30] Clove oil and its main content eugenol also reduce the quantity of ergosterol, which is a specific component of fungal cell membrane. Germ tube formation by *C. albicans* is also inhibited.[6] It was found to possess an inhibitory effect on multi-resistant *Staphylococcus* species.

Cinnamon Oil

The volatile oils obtained from the bark, leaf, and root barks vary significantly in chemical composition. Three of the main components of the EOs obtained from the bark of *Cinnamomum zeylanicum* (CZ) are *trans*-CA, eugenol, and linalool, which represent 82.5% of the total composition. CA is the major constituent of cinnamon EO, and studies show that it is the most active component too.[32]

It shows inhibitory effect on the growth of various isolates of bacteria including Gram-positive, Gram-negative, and fungi.[33] It has antimutagenic potential against spontaneous mutations in human cells.[34] Furthermore, the study of Cabello *et al.* performed in animals shows that oral administration of CA exerts significant anti-melanoma activity.[35] 38 besides these activities, studies suggest that CZ has antiparasitic, antioxidant, and free radical scavenging properties.[36] A clinical trial conducted on cinnamon EO concluded that it is safe to be used in healthy patients with dentures for the treatment of oral candidiasis.[37]

Combinations of EO

Combining EO and antibiotics can reduce antibiotic resistance in multidrug-resistant bacteria. Peppermint, cinnamon bark, and lavender EOs were found to be antibiotic resistance-modifying agents when used in combination with piperacillin.[38]

LIMITATIONS AND ADVERSE EFFECTS WITH THE USE OF EO

Several studies support the benefits of EOs, but few studies have disputed their efficacy. A study in which 0.2% chlorhexidine rinse and an EO mouth rinse were compared for their efficacy showed that EOs are effective only for very short duration, i.e. 2–3 h, and concluded that use of chlorhexidine is preferable over EOs.[39] A study conducted on EOs to measure their efficacy when used as a coolant concluded that there was no benefit over water during ultrasonic root debridement for the treatment of chronic periodontitis.[40] Adverse effects are also reported with EOs. In the study of Millet *et al.,* commercial preparations of essences of sage, hyssop, thuja, and cedar have been reported to cause neurotoxicity and human intoxication, of which tonic-clonic convulsions formed the major symptom.[41] According to a review by Posadzki *et al.*, mild to severe adverse effects including fatality can be caused by EOs such as lavender, peppermint, TTO, and ylang-ylang when used in aromatherapy. Most common adverse effect among them was dermatitis.[14] Toxicological tests are often lacking for traditional medicines. Therefore, further clinical trials are required to exclude the possibility of side effects, allergy, and adverse reactions with the tissues.

CONCLUSION

As described in this review, there is considerable evidence that EOs have potential to be developed as preventive or therapeutic agents for various oral and periodontal diseases. Although several other potential uses of EOs have been described[42] and many claims of therapeutic efficacy have been validated adequately by either *in vitro* testing or *in vivo* clinical trials, still there is a need for conducting further research to establish the safety and efficacy of these EOs before including them in clinical practice. If used properly, they may prove very useful in dental therapy and may contribute to improving the quality of dental treatments. Clinical trials that confirm the therapeutic potential of EOs *in vivo* with a comprehensive understanding of issues

such as adverse effects, toxicity, and their interaction with other drug molecules would be of immense importance in oral healthcare delivery.

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