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J Int Soc Prev Community Dent. 2015 Sep-Oct; 5(5): 335–340.
doi: 10.4103/2231-0762.165933: 10.4103/2231-0762.165933
PMCID: PMC4606594
PMID: 26539382

Essential oils, their therapeutic properties, and implication in dentistry: A review

Namrata Dagli, Rushabh Dagli,[1] Rasha Said Mahmoud,[2] and Kusai Baroudi[2]

Ethics Committee, Care Institute of Medical Sciences, Ahmedabad, Gujarat, India
[1]Department of Public Health Dentistry, Vyas Dental College and Hospital, Jodhpur, Rajasthan, India
[2]Department of Preventive Dental Science, Alfarabi Colleges, Riyadh, Saudi Arabia
Corresponding author (email: <dr.namrata.dagli@gmail.com>) Dr. Namrata Dagli, Care Institute of Medical Sciences, Ahmedabad, Gujarat, India.

Abstract

Background:

Antibacterial treatments currently used for treatment cause several side effects, and bacterial resistance to the antibiotics is also increasing. Therefore, there is need to find better alternatives. Essential oils (EOs) have been used for treatment of various ailments since ancient times and have gained popularity over the years. Safety and efficacy of EOs have been proved by several clinical trials. This review gives an overview on the EOs, their uses, and adverse effects.

Materials and Methods:

A literature search was performed in the PubMed for clinical trial studies and review articles on EOs published up to February 2015. The search was performed during March 2015. The following keywords were used: “Lavender essential oil,” “cinnamon oil,” “clove oil,” “eucalyptus oil,” “peppermint oil,” “lemon EOs,” and “tea tree oil.”

Results:

Total 70 relevant articles were found in PubMed database. After screening of abstracts, 52 articles were selected to be included in the present review.

Conclusion:

On the basis of the available information, it can be concluded that EOs have the potential to be developed as preventive or therapeutic agents for various oral diseases, but further clinical trials are required to establish their safety and efficacy.

Keywords: *Alternative medicine*, *essential oils*, *oral pathogens*

INTRODUCTION

According to the World Oral Health Report, despite great improvements in oral health in several countries, oral health problems still persist, particularly among underprivileged groups in both developing and developed countries.[1] Dental caries and periodontal diseases are identified as the most important among oral health problems globally. Oral diseases adversely affect the general health too. Quality of life and the working capacity of an individual are also affected.[2]

The antibacterial agents that are currently used for treatment of oral health problems are reported to cause several side effects such as diarrhea, vomiting, etc., Increasing bacterial resistance to the drugs is also a major concern. Because of the adverse effects, increasing bacterial resistance, and high cost associated with the standard therapeutic procedure, there is a need to explore new therapeutic agents and conduct further clinical research on traditional medicines obtained from various plant sources.

Many traditionally used medicines for treating infections have been studied again, and clinical trials are being done to establish their efficacy and possible side effects. One of these natural medicines is essential oils (EOs).[3,4] In the recent years, there has been an increased interest toward EOs.

Approximately 3000 Eos are known till now.[5] EOs are one of the plant extracts that have been used for treatment of various medical and dental problems since ancient times. These are secondary metabolites produced by various medicinal plants and possess antibacterial, antifungal, and antioxidant properties. [6,7,8]

The purpose of this systematic review is to analyze the published data related to the EOs. A number of studies have been conducted to prove the therapeutic properties of various EOs, but very few reviews have been published on their implication in dental treatment. The review gives an overview on the EOs, their therapeutic properties, and adverse effects.

MATERIALS AND METHODS

To identify relevant literature, an electronic search was performed on PubMed database.

Titles and abstracts were screened. Only articles related to lavender oil, eucalyptus oil, clove oil, cinnamon oil, and lemon EOs have been included in this review. Studies related to several other EOs were excluded. Total 52 articles found relevant were selected for this review.

EOs and their composition

EOs are secondary metabolites of plants whose constituents are basically a complex mixture of terpenic hydrocarbons, especially monoterpenes and sesquiterpenes, and oxygenated derivatives such as aldehydes, ketones, epoxides, alcohols, and esters.[9] EOs greatly differ in their compositions. Even the composition of EOs extracted from the plants of same species differ in different geographic locations.[10] Composition also depends on the maturity of the plant from which the EOs are extracted.[10,11]

Mechanism of action

The mechanisms of action of EOs are dependent on their chemical composition and the location of one or more functional groups on the molecules present in them.[12]

Membrane damage is proposed to be the main mechanism of action.[13] Solubility of EOs in the phospholipid bilayer of cell membranes seems to have an important role in their antimicrobial activity. Clove oil has reported to reduce the quantity of ergosterol which is found specifically in fungal cell membrane.[14] Terpenoids in EOs have been found to interfere with the enzymatic reactions of energy metabolism.[15]

Essential oils that have potential to be used in oral disease prevention and treatment are discussed subsequently.

Lavender oil

Composition Major components found are linalool, linalyl acetate, 1,8-cineole, B-ocimene, terpinen-4-ol, l-fenchone, camphor, and viridiflorol.[10,16] However, the relative level of each of these constituents varies in different species. 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.

The activity of linalool reflects that of the whole oil, indicating that linalool may be the active component of lavender oil.[13]

Therapeutic properties

- Antimicrobial activity: EOs extracted from *Lavandula stoechas* L. exhibit good 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.[10] It also shows antipseudomonal activity[16]
- *In vitro* study on the antibacterial activity of the EO of *Lavandula coronopifolia* against antibiotic-resistant bacteria suggested its bactericidal effect[17]
- Anxiolytic: Lavender EO is reported to reduce stress, anxiety, and improve mood when inhaled or orally administered.[18,19] It is not very effective in cases of high anxiety[20]
- Antifungal: EOs of *Lavandula luisieri* show an inhibitory effect on yeast, dermatophyte, and *Aspergillus* strains.[21] *Lavandula viridis* is reported to have fungicidal effect. *Cryptococcus neoformans* is the most sensitive fungus, followed by *Candida* species.

Eucalyptus oil

Composition The main component is 1,8-cineole followed by cryptone, α-pinene, *p*-cymene, α-terpineol, trans-pinocarveol, phellandral, cuminal, globulol, limonene, aromadendrene, spathulenol, and terpinene-4-ol.[22]

Therapeutic properties

- Antimicrobial effect: Antimicrobial activity was found to be related to the synergic effects between major and minor components rather than the concentration of a single component.[22] EO of the leaves of *Eucalyptus globulus* has antimicrobial activity against Gram-negative bacteria (*Escherichia coli*) as well as Gram-positive bacteria (*Staphylococcus aureus*).[23] 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[22]
- Anti-inflammatory effect: Immunoregulatory agent: 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.[24]

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.[25]

Therapeutic properties

- Antibacterial: Peppermint oil shows an inhibitory effect on the proliferation of staphylococci[26]
- Antifungal: Studies show that EOs exhibit fungistatic 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[25]
- Antibiofilm: 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]

Melaleuca alternifolia (Myrtaceae) It is also known as Tea Tree Oil (TTO). Its composition shows terpinen-4-ol, γ-terpinene, *p*-cymene, α-terpinene, 1,8-cineole, α-terpineol, and α-pinene.[27]

Effects

- Antibacterial: In a clinical trial, the melaleuca gel was found to possess an inhibitory effect on various bacterial colonies and dental biofilm.[28] It shows strong antibacterial action against oral pathogens[29]
- Antifungal activity: *Melaleuca alternifolia* possesses antimycotic activity, terpinen-4-ol being its most effective component.[30]

Lemon EO

Composition Mostly, it contains almost exclusively terpenes and oxygenated terpenes.[31]

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*.[31,32]

Clove oil

Main constituents found in the clove bud oil are the phenylpropanoids eugenol, eugenyl acetate, carvacrol, thymol, cinnamaldehyde, β-caryophyllene, and 2-heptanone, when analyzed by gas chromatography. [33,34]

Medicinal properties Eugenol is well-known for its therapeutic properties and is widely used in dentistry.

- Antioxidant: When tested against *tert*-butylated hydroxytoluene, EO exhibited a very strong radical scavenging activity[33]
- Antifungal: It possesses antifungal activity.[33] 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[14]
- • Antibacterial: It was found to possess inhibitory effect on multi-resistant *Staphylococcus* spp.[34]

Cinnamon oil

Composition

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 are *trans*-cinnamaldehyde, eugenol, and linalool, which represent 82.5% of the total composition. Cinnamaldehyde is the major constituent of cinnamon EO, and studies show that it is the most active component too.[35]

Medicinal properties

Antimicrobial effect: Inhibitory effect on the growth of various isolates of bacteria including Gram-positive, Gram-negative, and fungi.[36]

Antimutagenic: It has antimutagenic potential against spontaneous mutations in human cells.[37] Furthermore, the study of Cabello *et al*. performed in animals shows that oral administration of cinnamaldehyde (CA) exerts significant anti-melanoma activity.[38]

Besides these activities, studies suggest that cinnamomum zeylanicum (CZ) has antiparasitic, antioxidant, and free radical scavenging properties.[39]

Implications in dental practice

Potential implications of EOs have been described below and the information is consolidated in Table 1.

Lavender oil 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.[18,20] The study performed by Zabirunnisa showed statistically significant reduction in anxiety scores when the fragrance of lavender oil was used at the reception area. It is also helpful during surgical procedures, as it has been shown to reduce the pain of needle insertion.[19]

Eucalyptus oil It shows an inhibitory effect on oral pathogens like *Lactobacillus acidophilus*, which makes this suitable to be used as an anticariogenic agent.[44]

Peppermint oil

Eugenol oil is used widely in dentistry. It is active against oral pathogens associated with dental caries and periodontal disease.[45] Studies done on five EOs (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.[41]

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[42] 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.[46]

Cinnamon oil

A Phase I 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.[40]

Lemon EO

Lemon EO is suggested to be used as an effective remedy against candidiasis caused by *C. albicans*.[32]

Combination of EOs

Combining EOs 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.[43]

Studies not supporting the use of EOs

Several studies support the benefits of EOs, but some studies raise questions about 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.[47]

A study done 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.[48]

Adverse effects caused by EOs

Natural medicines are not always free of side effects. 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.[49]

According to a review by Posadzki *et al*., mild to severe adverse effects including fatality can be caused by EOs like lavender, peppermint, TTO, and ylang-ylang when used in aromatherapy. Most common adverse effect among them was dermatitis.[22]

Toxicological tests are often lacking for traditional medicines. Therefore, further clinical trials are required to exclude the possibility of side effect and poisoning.

Limitations

Only seven EOs that are found to be used commonly are included in this review. The review is subjected to publication bias as it is written on the basis of published literature. Only English language articles were referred. Article search was performed only in one database, PubMed.

CONCLUSIONS

As described in this review, there is considerable evidence that EOs have potential to be developed as preventive or therapeutic agents for various oral diseases. Although several other potential uses of EOs have been described[50] and many claims of therapeutic efficacy have been validated adequately by either *in vitro* testing or *in vivo* clinical trials, still there is 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 in improving the quality of dental treatments.

In particular, clinical trials that confirm the therapeutic potential of EOs *in vivo* and address issues such as adverse effects, toxicity, and their interaction with other drug molecules would be of great value.

Footnotes

Source of Support: Nil

Conflict of Interest: None declared.

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Figures and Tables

Table 1

Essential oils and their potential implications in dentistry

Name of EO	Potential implications in dentistry
Lavender EO	As an anxiolytic in dental clinics Reduces pain of needle insertion[19]
Eucalyptus EO	Anticariogenic agent
Peppermint EO	Antimicrobial activity Use in oral hygiene products
Cinnamon EO	In treating oral candidiasis[40]
Lemon EO	In treating candidiasis[32]
Eugenol EO	Shows antimicrobial activity against several oral pathogens[41]
Tea Tree Oil	Oral candidiasis[42] Suitable for use in prophylactic oral hygiene products
Combination of EOs	Antibiotic resistance-modifying agent[43]

EO=Essential oil