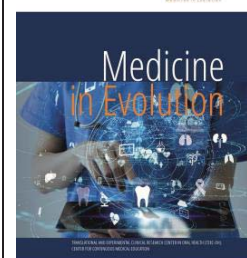


# Plant-Derived Essential Oils –An Alternative Option for Oral Health Management

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## Abstract

1. Background: Oral health is a subject of public interest. Also, it is one of the most pressing aspects of human well-being, complemented by the health of the digestive or respiratory system. As oral hygiene and dental care are essential health missions, products of natural origin are becoming increasingly recognized for their multifaceted benefits (reduced side effects, multiple therapeutic effects). Hence, essential oils proved to be valuable alternatives due to their therapeutic qualities, holding promise in the treatment of various dental diseases. 2. Methods: The present paper focuses on the literature analysis of the last 25 years, targeting sources mainly found in PubMed or Google Scholar. 3. Results: The review of the literature showed evidence of a multitude of essential oils (lavender, oregano, eucalyptus, cinnamon) with medicinal effects (antimicrobial, antifungal, soothing) used in oral health. 4. Conclusion: This overview presents the applicability and effects of different essential oils in oral health as potential candidates for oral treatments. Essential oils can be a safe, affordable, and efficacious alternative to standard therapies in dental ailments.

**Keywords:** dentistry, oral health, essential oils, natural products

## INTRODUCTION

Oral health is a crucial aspect of people's wellbeing, also coming with the reward of having a healthy digestive and respiratory system. Moreover, poor oral health comes with different consequences, such as pain, halitosis, and an unattractive smile [1].

Nowadays, it is hard to maintain an impeccable oral health because people's daily routine includes a lot of processed food, which also contains varied amounts of sugar. Bigger quantities of processed food and sugar consumed cause more problems at the dental level. Problems of the oral cavity include periodontitis, which causes halitosis, tooth loss, and tooth decay, which usually progresses by infecting the dental nerves and generating granulomas, abscesses, or even cysts. These complications can also lead to many other health problems for overall well-being. Improved oral hygiene should be the first step towards achieving proper oral health and improving health in other systems [2]. In order to improve the oral hygiene and prevent dental diseases, dentists have two types of approaches: (i) regular visits to the dentist for professional cleaning or (ii) improving oral hygiene through new tooth brushing techniques and patient self-awareness of the problem [3]. The quality and composition of dental materials must be of the highest standard and must be carefully selected for each patient. Many people have also started to look for dental products based on natural compounds [4], which have become an increasingly popular alternative in recent decades.

Currently, botanical compounds are gaining growing interest in stomatology, and in particular for dental problems that require treatment. Due to the fact that they are easy to find, less expensive, and well tolerated, and because numerous studies have demonstrated their beneficial effects, these compounds are beginning to be preferred to conventional, synthetic treatments [4,5]. Plants-based essential oils have also sparked considerable attention in dentistry. In recent years, there has been an increasing interest in using essential oils in oral hygiene products [6]. The essential oils have been used since antiquity, and have prevailed in different cultures around the world, such as those of the Greeks, Egyptians, Chinese, and Persians for antibacterial, antiviral, antifungal, antiparasitic, antioxidant, anti-inflammatory, anticancer, and neuroprotective properties [6]. Essential oils are liquid extracts from aromatic plants. Extraction of essential oils can be done using a variety of advanced methods, such as supercritical fluid extraction, subcritical liquid extraction, and solvent-free microwave extraction [7]. From a safety perspective, a product that contains essential oils or a mixture of it should be tested prior to use. In general, essential oils are safe, but they may act as an allergen, especially for consumers having sensitivity [8]. Natural products are low-cost, effective and safe, making them a popular choice for patients, especially when conventional treatments fail [5]. Additionally, several studies have found that mouthwash containing essential oils is more effective in preventing periodontitis and can potentially replace dental floss [9,10].

Given the current developments in dental treatments and the acknowledgement that natural alternatives have started to receive in comparison to conventional treatments, the purpose of the present study is to highlight and detail the evidence that underlines the therapeutic effects of natural oils and their importance in oral health care and stomatological treatments.

### *Aim and objectives*

As oral health is a globally important concern, the aim of the present paper is to highlight the potential implications of essential oils (e.g. Lavender, Peppermint, Eucalyptus, Cinnamon) of natural origin in different oral problems, underlining studies from the specialized literature that have demonstrated their therapeutic benefits.

## MATERIAL AND METHODS

A comprehensive review of the literature published over the last 25 years (2002-2025) was conducted using databases such as PubMed and Google Scholar. The search focused on relevant terms, including “oral health”, “essential oils”, “antimicrobial activity”, “antifungal activity”, “natural products in dentistry”, and specific oil names like “lavender”, “peppermint”, “eucalyptus”, “oregano”, “cinnamon”, “tea tree oil”. The inclusion criteria focused on in vitro, in vivo, and clinical studies evaluating the therapeutic properties of essential oils in oral or dental fields.

### *Lavender oil*

Lavender essential oil is obtained from the flowering tops of the lavender, *Lavandula angustifolia* Mill., by steam distillation. This type of essential oil is well-known in traditional herbal medicine for carminative, sedative, antidepressive, hypnotic, antifungal, antimicrobial, analgesic, acaricidal, and aphrodisiac properties [11].

Lavender oil has shown therapeutic benefits, including in stomatology. A study conducted on 30 volunteers showed a statistically significant reduction in anxiety scores, stress and a decrease in needle insertion pain when lavender oil was used in the recipient site. [12]. Moreover, a study conducted on 126 children showed significantly lower anxiety and pain scores after tooth extraction by using lavender oil [13]. An in vivo study that examined lavender oil and benzocaine gel as topical analgesic agents concluded that lavender oil had a greater impact on reducing pain perception after intraoral injection. Additionally, lavender oil could be a superior choice over topical analgesic agents, as it has a sweet scent that alleviates anxiety and has anesthetic properties [14]. A study on animals showed that lavender oil was tested positive for antinociceptive action, showing significant pain reduction in the rats, in oral treatments, while using the formalin-induced pain model [15].

### *Peppermint oil*

Peppermint oil is obtained from the leaves and flowering aerial parts of the peppermint, *Mentha x piperita* L. [11], being one of the most commonly used essential oils. In the composition of peppermint oil, menthol is recognized as the major compound and, according to numerous investigations, is one of the botanicals with the strongest antifungal, antibacterial, and antiviral properties [16, 17].

Studies showed that peppermint oil (0.5 to 8  $\mu\text{L/mL}$ ) demonstrated fungicidal and fungistatic activities against both the standard and clinical strains of *Candida* species. Additionally, the peppermint oil indicated similar antifungal effects against the azole-susceptible and azole-resistant strains [18]. Also, a paper suggested that a proprietary blend of peppermint that includes Japanese mint, bergamot mint, and spearmint essential oils called SuperMint (SM), encapsulated in a tiny soft beadlet, decreased the abundance of some microbial families and genera, including *Prevotella*, *Haemophilus*, *Neisseria*, and *Streptococcus*. In addition, the findings indicated that SM treatment decreased the number of various bacteria linked to periodontal disease and halitosis, including *Actinomyces* and *Streptococcus*. Furthermore, the consumption of SM resulted in a rise in *Corynebacterium* species and a decrease in *Streptococcus* spp. occurrences [19].

Apart from those mentioned above, peppermint has proven to be effective against halitosis. Peppermint mouth rinse was disclosed as an effective measure to reduce halitosis according to a 1-week study on a group of students [20]. Furthermore, clinical research has demonstrated that regular use of a mouthwash that contains peppermint oil can improve periodontal health by reducing gingival pocket depths and effectively combating *Candida albicans* [21].

### *Eucalyptus oil*

Eucalyptus essential oil is steam distilled from the leaves of certain species of Eucalyptus, belonging to Myrtaceae Family [22].

Literature studies have indicated that eucalyptus can be a notable alternative for various dental conditions, supporting oral health. According to a study conducted on 74 human subjects, eucalyptus oil is an effective alternative to chlorhexidine, reported as safe and effective to use in order to reduce the bacterial plaque levels [23]. It was reported that Eucalyptus oil is effective against *P. gingivalis* and *A. actinomycetemcomitans* and also, because of the natural phytochemicals existing in the essential oil, it serves as an effective, promising alternative to antibiotics in the prevention of oral infection [24].

Another important effect for which eucalyptus oil is used in dentistry is the anticariogenic effect, showing an inhibitory effect on oral pathogens such as *Lactobacillus acidophilus* and *Streptococcus mutans* [25].

Furthermore, the use of eucalyptus essential oil as an innovative material in preventive dentistry can contribute to maintaining both oral and systemic health. A study on an eucalyptus essential oil-based nanoemulsion presented adequate physicochemical characteristics and antimicrobial activity against *S. mutans* [26].

### *Cinnamon oil*

The leaves, bark, fruits, and flowers of *Cinnamomum* spp. are the sources of cinnamon essential oil. The main components are represented by cinnamaldehyde, eugenol, phenol, and linalool. The antibacterial and antifungal properties of cinnamon essential oil may have potential applications in mouth rinses, toothpastes, or as a root canal irrigant. Additionally, it has the potential to act as an antimicrobial agent in dentistry [27]. In the same context, Cinnamon and Lemongrass essential oils were shown to have an antifungal effect on *C. albicans* biofilm and stop the formation of fungal biofilm on heat-polymerized PMMA in an in vitro study [28]. According to a registered clinical trial, based on Newton classification, cinnamon essential oil and nystatin showed clinical effectiveness in decreasing *Candida* spp. [29]. A research has shown that a nanoencapsulation of grapefruit seed, cinnamon oil, and chitosan/carrageenan is an effective technique for inhibiting oral bacteria [30].

### *Clove oil*

Clove essential oil, obtained from the buds of *Syzygium aromaticum*, a tree belonging to the Myrtaceae family, is a well-known botanical agent with multiple pharmacological properties relevant to oral health care [31]. Rich in eugenol, it demonstrates potent antibacterial, antifungal, anti-inflammatory, analgesic, neuroprotective, anticarcinogenic, and antibiofilm activities [31]. Recent research highlights its strong efficacy against the main oral pathogens [31]. Zhang et al. demonstrated that both clove and eugenol essential oils have a significant impact on *Porphyromonas gingivalis*' growth by affecting their bacterial membrane integrity, promoting intracellular leakage, and interfering with early biofilm formation [32]. Furthermore, these effects support its use in managing gingival inflammation and microbial imbalance [32].

The primary cariogenic agent in dental caries (e.g., *Streptococcus mutans*), is a primary cariogenic agent that clove essential oil can combat. Antibiotics remain an option for treatment, but they can cause disruption of oral and intestinal microbiota. Clove essential oil is a natural alternative that inhibits acid-producing bacteria without any negative side effects [31]. Its antifungal action against *Candida albicans* further extends its application to oral candidiasis, especially in root caries [31]. The findings suggest the use of clove in oral hygiene products that target the prevention and treatment of gingivitis, periodontal disease, dental decay, and oral fungal infections [31,32].

*Tea tree oil*

Tea tree oil (TTO), extracted from the leaves of *Melaleuca alternifolia* through steam distillation, represents a traditional remedy used by Australian Aboriginal populations and is now widely recognized for its therapeutic applications [33,34]. The tea tree belongs to the Myrtaceae family and, indigenously, it is defined as “the most versatile healer of nature” [33-34]. According to ISO 4730 standards, terpinol-4 and 1,8-cineole are the primary constituents and are essential for both therapeutic efficacy and safety. To ensure antimicrobial activity and minimize irritation, terpinol-4 must be below 30%, and cineole must be below 15% [33, 36].

Tea tree oil exhibits a broad spectrum of pharmacological activities, specifically antimicrobial effects against various bacteria (e.g., *Staphylococcus aureus*, *Streptococcus mutans*, *Porphyromonas gingivalis*), as well as antifungal activity against *Candida albicans* and antiviral effects on pathogens such as herpes simplex virus [33].

Additional pharmacological actions of tea tree include anti-inflammatory, antiseptic, immunostimulatory, wound-healing, soothing, and slight anesthetic properties [33]. Tea tree oil has demonstrated therapeutic benefits in several dental conditions, including gingivitis, chronic periodontitis, denture-induced stomatitis, and halitosis [34,35].

The efficacy of TTO in managing oral pathologies has been confirmed by multiple clinical studies. A randomized study by Ripari et al. showed that TTO mouthwash had a significant effect on plaque and gingival bleeding over 14 days, with improved tolerability compared to 0.12% chlorhexidine [34]. Maghu et al. stated that the use of 0.25% tea tree oil mouthwash was able to significantly improve oral *Candida* infection compared to standard care, with outcomes similar to clotrimazole and no side effects noted [35]. In another paper, Srikumar et al. demonstrated that tea tree oil mouthwash significantly reduced halitosis scores and *Solobacterium moorei* levels after one week of use, with efficacy comparable to chlorhexidine [37]. Using current clinical evidence, tea tree oil has been shown to be a valuable and well-tolerated alternative for managing and preventing various oral conditions, with consistent efficacy across multiple studies [34,35].

*Oregano oil*

Oregano essential oil (OEO) is extracted from *Origanum vulgare* L., a perennial plant native to the Mediterranean region and western Eurasia, part of the Lamiaceae family [38,41]. OEO is rich in phenolic and terpenoid compounds, notably carvacrol, thymol, and rosmarinic acid, which are responsible for its antioxidant, anti-inflammatory, and broad-spectrum antimicrobial activities [38,40].

In dentistry field, OEO has shown effectiveness against *Candida* species and *Streptococcus mutans*, playing a role in managing denture stomatitis, dental caries, and halitosis [39,41]. Moreover, the ability to destroy biofilms and reduce inflammation suggests potential for inclusion in therapeutic oral care products such as toothpaste and mouthwash [40,41].

Traditional uses of oregano oil include alleviating oral pain and throat irritation [38,40]. Additionally, carvacrol exhibits antiangiogenic and antiproliferative effects [38]. OEO has also been applied topically for skin infections and taken orally for gastrointestinal disruption [40].

Baj et al. suggested that oregano essential oil, containing carvacrol, 1,8-cineole, and thymol, exhibited notable antifungal activity against oral yeasts such as *Candida albicans* and *C. glabrata*, by inhibiting their growth and killing them at similar or slightly higher concentrations [42]. Khan et al. found that carvacrol and thymol from *Origanum vulgare* L. have antimicrobial and antibiofilm effects against *Streptococcus mutans* and suggest that they can be used as potential agents to control dental caries [43]. Saeed et al. conducted a clinical trial and concluded that an OEO-based mouthwash had a significant reduction in halitosis scores, with an efficacy equivalent to chlorhexidine and no reported adverse effects [39].



Hosny et al. developed an OEO nanoemulsion that inhibited *S. mutans* and *Candida albicans* growth in vitro, suggesting its utility in oral therapeutics [40]. A study by Hejazinia et al. reported strong in vivo anti-biofilm effects of OEO in mice, confirming plaque reduction [44].

Oregano essential oil has proven to be a valuable agent in both current and future dental applications for its effectiveness against oral pathogens and biofilms [41,44].

### ***Basil oil***

Basil (*Ocimum basilicum* L.) is an aromatic plant from the Lamiaceae family, widely used in traditional medicine and culinary practices [45]. The active compounds present in its essential oil include eugenol, linalool, methyl chavicol, and other terpenoids, which are recognized for their antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties [45].

Pharmacologically, basil oil has demonstrated bactericidal and antifungal effects against pathogens involved in oral infections, notably *Streptococcus mutans*, *Lactobacillus rhamnosus*, and *Porphyromonas gingivalis* [46]. Clinical studies have shown that mouth rinses that contain extracts of *Ocimum sanctum* and *Ocimum gratissimum* have a clinical efficacy comparable to that of chlorhexidine in reducing plaque index, gingival bleeding, and oral bacterial levels [47]. A recent in vitro investigation explored the incorporation of *Ocimum basilicum* essential oil (OBEO) into a tissue conditioner, a soft denture lining material used to manage inflamed oral mucosa. The essential oil was added during the mixing process and retained its antifungal efficacy against *Candida albicans*. The modified material demonstrated a significant reduction in fungal adherence, suggesting its applicability in antifungal therapies related to denture use. Additionally, OBEO inhibited the formation of fungal biofilms over time, highlighting its potential as an antibiofilm agent. The integration of basil essential oil into tissue conditioners proved to be both stable and biocompatible. Despite these promising results, further clinical studies are needed to confirm its effectiveness in dental practice [48].

### ***Overview of the therapeutic effects of essential oils in dentistry***

Figure 1 summarizes the therapeutic effects attributed to essential oils with potential in improving oral health and various dental problems.

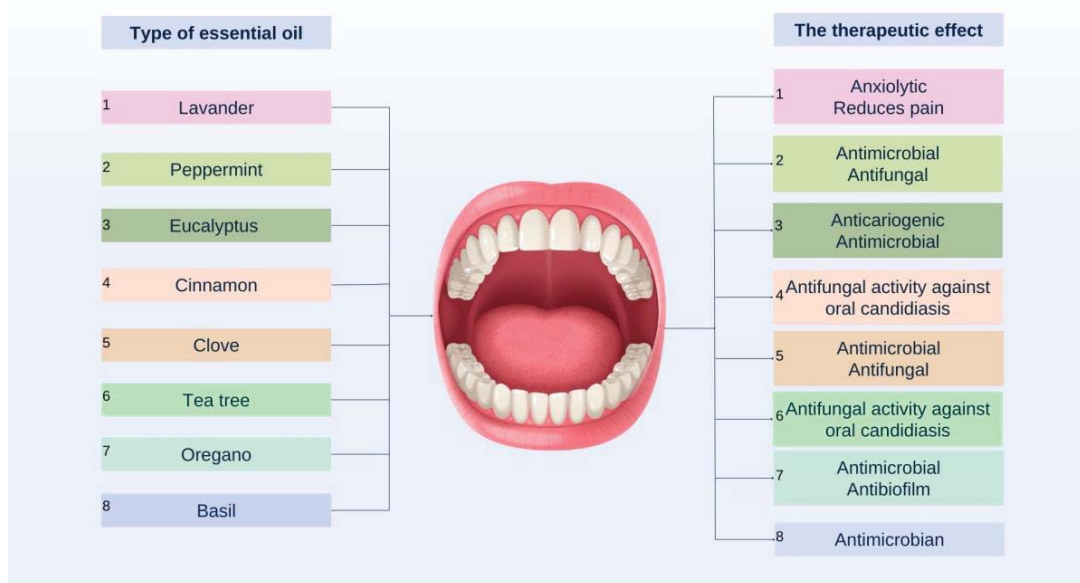


Figure 1. The therapeutic effects of essential oils. The image was created using Canva

Table 1. Relevant studies regarding the activity of essential oils in the dental field

Essential Oils	Type of Experimental Study	Results	Reference
Lavender	Randomized double-blind placebo-controlled study	The antioxidant effect of lavender has a significant activity in the healing process of oral ulcers.	[49]
	Male Swiss mice	Anxiolytic-like effect through 5HT <sub>1A</sub> receptors	[50]
Eucalyptus	In vitro	Antibacterial (against <i>Escherichia Coli</i> ) and anti-inflammatory effects	[51]
Oregano	In vitro	Significant reduction of bacterial lipopolysaccharide-induced osteoclastic cells	[52]
Basil	Randomized group (40 children)	Significant statistically antimicrobial action against aerobic and anaerobic strains	[53]
Tea Tree	Comparative study (60 participants aged 28-60 years)	Safe and effective alternative for managing plaque-induced gingivitis	[54]

5HT<sub>1A</sub> – serotonin 1A receptor

## DISCUSSIONS

Collective evidence highlights the potential of these alternatives or complementary agents to be effective and generally well-tolerated alternatives to conventional dental treatments. Among the essential oils reviewed (e.g., clove oil, tea tree oil, peppermint oil) stand out as the most extensively investigated, with evidences from both in vitro experiments and clinical studies supporting their therapeutic efficacy. Eugenol-rich clove oil is highly effective against both fungal and bacterial infections, particularly against *Streptococcus mutans* and *Candida albicans*, and also provides beneficial analgesic effects for dental uses [31, 32]. Tea tree oil has a wide-spectrum antimicrobial profile and is well-tolerated, providing consistent clinical benefits in treating gingivitis, halitosis, and denture-related stomatitis, often producing results similar to those obtained with chlorhexidine [33-36]. Peppermint oil also displays significant antifungal activity and halitosis-reducing effects, with promising utility in both preventive and therapeutic dental contexts [11-21]. In addition to these, other essential oils such as eucalyptus, oregano, cinnamon, and lavender exhibit notable bioactivity relevant to oral health. Eucalyptus oil has demonstrated antiplaque and anticariogenic properties, while oregano oil possesses pronounced antimicrobial and biofilm-inhibitory effects [22-26]. Cinnamon oil has shown efficacy in disrupting *Candida* biofilms, supported by clinical findings [27-30]. In addition to its documented antimicrobial activity, lavender oil also has anxiolytic and analgesic benefits, which could improve patient comfort and compliance during dental procedures [11-15]. *Ocimum basilicum* essential oil shows significant antifungal activity against *Candida albicans* and inhibits biofilm formation, suggesting that it could be useful in managing denture-induced stomatitis. This product's compatibility with dental materials, biocompatibility, and formulation stability all indicate its viability for future clinical applications [45-48].

Despite the promising results and in order to advance the development of alternative therapies with essential oils, future research directions should focus on the identification of safety and toxicity, studies to elucidate the mechanisms of action (antimicrobial, antifungal), and randomized controlled clinical trials to validate efficacy and optimization in clinical practice. Also, potential challenges to be addressed prior to translocation into clinical practice should be oriented towards verifying patient tolerability, standardization of formulations, stability and optimal dosage.

## CONCLUSIONS

This work highlights the effectiveness and applicability in dentistry of eight essential oils, including lavender, peppermint, eucalyptus, cinnamon, clove, tea tree, oregano, and basil. All these have demonstrated therapeutic benefits due to their antimicrobial, antifungal, and anti-inflammatory properties and their excellent effect on biofilm destruction. However, of these essential oils, clove oil, tea tree oil, and peppermint oil have been the most extensively studied over the years in many clinical trials, proving their safety and efficacy in dental problems time and time again, and therefore, they represent an important step in the prevention and management of dental conditions such as periodontitis, gingivitis, halitosis, and dental stomatitis, which are attributed both to poor oral hygiene and as a consequence of dentures.

The study concluded that the integration of oral hygiene products based on essential oils (e.g. mouthwashes, gels, toothpastes, dental materials) led to promising results, but to fill the gaps in the literature and to develop future applications of essential oils, mechanistic studies (in vitro and in vivo), verification of optimal dosages and assessment of possible adverse reactions on patients are needed.

### *Conflicts of Interest*

The authors declare no conflict of interest.

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