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## THE ROLE OF ESSENTIAL OILS IN ORAL HYGIENE - A REVIEW OF THE LITERATURE

Patrycja Łanowy<sup>1</sup>, Miłosz Bichalski<sup>1</sup>, Elżbieta Zajkowska<sup>1</sup>,  
Joanna Komasa<sup>1</sup>, Katarzyna Mocny-Pachońska<sup>1</sup>, Marta Tanasiewicz<sup>1</sup>

<sup>1</sup>Medical University of Silesia in Katowice, School of Medicine with the Division of Dentistry, Department of Conservative Dentistry with Endodontics, Pl. Akademicki 17, 41-902 Bytom, Poland-  
E-mail addresses: patrycjalanowy@gmail.com, milosz.bichalski@gmail.com,

### ABSTRACT

Due to increasing of resistance of the microorganisms which causes periodontitis, mucositis - essential oils - source known from antiquity, may be helpful. Extracted from plants essential oils (EO of the selected plants) - contain in selected oils, can reduce the amount of pathogens in the mouth and help the action of antibiotics and other active components used in the prevention and the treatment of oral diseases. Essential oils are widely used: to reduce the formation of the plaque which is a biofilm produced by bacteria on the surface of hard tooth tissues. Dental plaque contributes to the development of periodontitis and tooth decay. The article contains an overview of the most popular essential oils and analysis of the results of the long-term studies on the effectiveness of mouthwashes containing essential oils.

**Aim of the article:** Determination of the range of use the essential oils in various fields of dentistry and determination the actual effectiveness of essential oils in reducing plaque based on available researches.

**KEYWORDS:** essential oils, tea tree oil, TTO, plaque, dentistry

### INTRODUCTION

The main cause of development and progression periodontal diseases are bacterias which also cause caries. This disease processes besides their destructive nature - which threatens the structure and function of teeth and periodontium - generate treatment costs. Therefore, it is important to prevent them. Plaque is a product composed of a variety of microorganisms contributing to the development of caries and periodontitis. Regular use of mouthwashes containing

essential oils (EO) enables the reduction of plaque and weakens its re-formation - preventing germs from multiplying and preventing adhesion to the surface of the plate and tissues of the oral cavity (1,2,3,4,5). It is worth noting that many oils also have antifungal activity - extending the use of EO oils in addition to prophylaxis, also as an additional element of treatment of oral fungal infections caused by *C. albicans* or *C. glabrata* (6,7,8,9). The popularity of essential oils is related to their antibacterial, antifungal, clinically proven efficacy and safety of use (6).

The composition of these secondary plant metabolites is complex. The oil mixtures contain sesquiterpenes and their oxidized derivatives and terpene hydrocarbons (especially monoterpenes). It is estimated that an important role in the antimicrobial activity of EO fulfills their solubility in phospholipid bilayers. Essential oils applicable in dentistry are described below (6).

**Clove oil** contains eugenol acetate, thymol, phenylpropanoid eugenol, and carvacrol. It has antioxidant and antibacterial effects. Its antifungal activity is related to the possibility of reducing the amount of ergosterol in the fungal cell membrane (6,10).

**Peppermint oil (Mentha piperita)** is known from its antibacterial activity - it inhibits proliferation of staphylococci - and antifungal activity against *Candida* species (6).

Mint oil, which is called eugenol oil has a proven antibacterial effect (including *Escherichia coli* and *Enterococcus faecalis*) have a significant role in prevention infection of the teeth after root canal treatment. In addition, this oil has an antifungal effect against *Candida albicans* - a substance that is strongly active in this range is terpene-4-ol - it determines the use of oil in the treatment of oral candidiasis (6,10).

**Eucalyptus oil** is known in medicine due to its effect in preventing infection of the upper respiratory tract. Its bacteriostatic activity against *Lactobacillus acidophilus* and antibacterial against *Staphylococcus aureus* and *Streptococcus pyogenes*. It also has antifungal properties. Especially oils extracted from *E. urophylla*, *E. grandis* and *E. citridora*. In vitro studies conducted by *Elassi et al.* showed that *S. aureus* or *S. pygoenes* were more sensitive to *E. odorata* oil than to ampicillin and rifamycin. Antiviral activity of this oil has also been demonstrated, but it requires the extension of research (6,7,11).

**Tea tree oil (TTO)** extracted from the leaves of *Melaleuca alternifolia*. Its components include monoterpenes and monoterpene alcohols, among others cineol and terpineol, which are necessary with the right concentration in the oil to work effectively. The oils show antibacterial, anti-inflammatory and antiviral activity. Its antifungal effects owes to the terpien-4-ol content. The essence of its anti-inflammatory activity is the inhibition of inflammation mediators - including IL-1 and TNF. Studies have also shown that TTO prevents the adhesion of *S. mutans* and *P. gingivalis* to plaque (6, 7,8,9,12,13,14).

**Cinnamon oil** is characterized by fungistatic and bacteriostatic activity. We can get it from the bark of the *Cinnamomum zeylanicum* tree. In *C. zeylanicum* bark mainly occurs trans-cinnamaldehyde, linalool, and eugenol. The alternative is the leaves of the plant, where the main ingredient of the oil, in this case, is eugenol. Cinnamon oil also has antioxidant effects. Cinnamon (in a concentration of 1.25-2.5 mg/ml) shows a stronger antibacterial effect than Manuka or tea tree oil (1,6).

**Lavender oil** has an anxiolytic effect, it should be noted that, according to available studies, lavender can reduce anxiety at a low level, not having such a significant impact on the reduction of intense anxiety (6,15).

Worthy of note are the oils extracted from *Orthosiphon stamineus* and *Ficus deltoidea*. The research on the properties of oils from these trees was made by *Nuramirah et al.* and he focused on the antibacterial activity of oils against oral pathogens - against aerobic bacteria (*E. faecalis*, *S.*

*mutans*, *S. mitis*, *S. salivarius*) and ana-aerobics (*A. actinomycetemcomitans*, *P.gingivalis*, *F.nucleatum*).

LISTERINE® is a liquid mouthwash (alcohol or non-alcoholic), which contains, among others, eucalyptol, menthol, thymol and sodium fluoride. In patients who regularly use LISTERINE®, in addition to the reduction of the bacterial plaque, a reduction in the severity of gingivitis has been observed, which may be from bundles with the reduction of *P. gingivalis* in saliva (1). Thymol, a monoterpene obtained from *Thymus vulgaris*, has antifungal activity against, among others, *C. albicans*, *C. tropicalis*, *C. krusei*, and even *Aspergillus flavus*. It also has activity against free radicals, has antibacterial and anti-inflammatory effects. The synergistic effect of shows thymol with nystatin (1,17,18,19).

Worthy to note is that essential oils have a small potential traumatizing potential to the oral mucosa. There are cases of poisoning with essential oils - especially tea tree oil and peppermint oil - which are mainly connected with aromatherapy procedures (symptoms of neurotoxicity) (1,6).

The combination of chlorhexidine with essential oils may be helpful to reduce the concentration of chlorhexidine in the medicinal product, thereby gaining analogical antibacterial efficacy (1). It is equally important to report the antifungal activity of essential oils. *Candida albicans* is sensitive to essential oils - mostly to cinnamon and laurel (20).

## REVIEW OF RESEARCH ON ESSENTIAL OILS EFFECTS ON ORAL HYGIENE

In 2017, *Marchetti et al.* carried out the study. They compared the action of mouthwashes containing essential oils - alcohol-based and non-alcoholic - on a three-day model of de novo plaque formation. Volunteers abstaining from any other methods of oral hygiene - for 3 consecutive days, they rinsed twice a day 15 ml of given fluids (Listerine products, solution with CHX, saline), after this period the PI index was examined. In their study, they compared the products Listerine Zero® (non-alcoholic) and Listerine Difesa Denti e Gengive® (with alcohol) - their effectiveness proved to be comparable. Studies have shown that EO containing lotions are more effective in inhibiting platelet recovery than flavored saline (a placebo in the control group). The chlorhexidine-containing formulation showed the highest effectiveness, which was also a positive test.

Tab. 1. Comparison of the composition of the tested medical products containing essential oils on the basis of the table included in the *Marchetti et al.* study (1,21).

Listerine Zero®	Listerine Difesa Denti e Gengive®
-water	-water
-sodium fluoride	-alcohol 21,3%
<b>-thymol 0,036%</b>	-sodium fluoride
<b>-menthol 0,042%</b>	<b>-thymol 0,064%</b>
<b>-eucalyptol 0,091%</b>	<b>-menthol 0,042%</b>
	<b>-eucalyptol 0,092%</b>

A study conducted by *Vlachojannis et al.* shows that the use of mouthwashes containing essential oils significantly reduces the number of harmful bacteria, favorably affecting the oral cavity (22).

Many studies comparing the efficacy of alcoholic rinses with EO (essential oils) have shown that they are equally effective or even more effective than solutions containing 0.075% Cetylpyridinium chloride (CPC) in the context of antiplatelet activity (1,23). However, in other long-term studies - 6 months - comparing the efficacy of EO fluids compared to CPC showed no significant differences in antibacterial and anti-gingivitis effects when compared to patients using the CPO containing 0,07% during this period (1,24).

However, long-term research conducted by *Bauroth et al.* showed that two daily toothbrushes combined with a double daily mouthwash with EO fluid showed equally good efficacy in reducing dental plaque as daily threading - thus confirming the results of research carried out by *Sharma et al.* (1,20,25).

At the same time, it should be noted that in comparison to preparations with fluorine or chlorhexidine, EO preparations are less effective. This is evidenced by the study of *Charugundla et al.* in which the effects of fluoride, chlorhexidine, and EO rinses on plaque accumulation and gingivitis was examined using the Lo and Sillness PI index as well as the gum index (26).

*Bagdan et al.* developed an ongoing 6-month study involving 60 patients, in which the effect of mouthwash was compared to essential oils (Listerine 26.9% ethanol) and a fluid that was only slightly different from the previous one. Based on the experience, similar results were obtained in both trials, showing that these rinses did not have an adverse effect on the oral cavity (27,28).

*Salvatori et al.* conducted a study in which they compared the effect of the mouth rinse liquid that contains tea tree oil (TTO) with two other liquids: 0.12% chlorhexidine and a fluid containing thymol, menthol, eucalyptol, sodium fluoride, zinc and xylitol on antibacterial and anti-inflammatory efficacy in oral hygiene. The hygiene status during the experiment was examined by determining the following indicators: FMPS, FMBS, GI, language status. Based on the results obtained, it was found that the best results of oral hygiene improvement were achieved after the use of chlorhexidine. A slightly smaller difference was seen in the case of TTO. And the fluid based on the mixture of substances obtained the worst results (12).

Also, *Arweiler et al.* studied the role of the TTO used in the mouthwash in relation to the formation of plaque. The researchers found that PI in the group of patients who used TTO is not significantly different from the rinsing fluid, which is based on an aqueous NaCl solution. Similar results were obtained by *Soukoulis and Hirsch*, who carried out the experience of applying gel (2.5%) to a toothbrush twice a day. They succeeded on the basis of the study to conclude that TTO does not reduce the amount of plaque (29,30).

*Saxer et al.* after 6 months of research, found that TTO reduces the number of bacteria in the mouth, which help to reduce inflammation and accelerates tissue healing. There are reports, that tea tree oil may be an additive to non-surgical treatment of periodontitis in patients suffering from chronic periodontitis (14,31).

*Dolińska et al.* investigated the effectiveness of oral hygiene fluid containing (Listerine). Researchers compared the changes obtained after two weeks of using Listerine and Meridol for 30 patients with chronic periodontitis-rinsing twice a day (morning and evening), 30 seconds with ten milliliters of fluid. The results showed that both preparations contributed to the reduction of dental plaque and gingivitis, but the OE mouth rinse (Listerine) achieved a more satisfactory effect (32).

Worthy of note are studies conducted by *Wyganowska-Świątkowska et al.* which showed that essential oils and herbs have lower tissue toxicity (especially visible at the healing stage) when compared with chlorhexidine. They were used in rinsing liquids containing 0.1% of chlorhexidine, a mixture of four essential oils (thymol, eucalyptol, methyl salicylate, menthol), sage, chamomile, and calendula. It was found that essential oils in higher concentrations caused a significant decrease in the number of fibroblasts after 24 hours and 48 hours, in comparison to the control group. The differences were significant (33).

However, when it comes to comparing the effectiveness of rinses with essential oils and herbal rinses, the herbal rinsing is more effective than rinsing with the essential oil in inhibiting the growth of bacteria found in the oral cavity *in vitro*. This conclusion is based on the study of antimicrobial efficacy on bacteria that predominate in the oral cavity. The minimum inhibitory concentration (MIC) values were used (34).

A study by *Charles et al.*, on 165 volunteers, confirmed greater efficacy in reducing symptoms of gingivitis and bleeding by rinses with essential oils than rinsing with cetylpyridinium chloride. Although both showed a favorable outcome after 4 weeks, the statistically significant reduction in gingivitis and plaque associated with the effects of oils was significantly better (35).

The basis for further reflection is the study conducted on a group of 20 people by *Wikén Albertsson et al.* -the task was to determine the effect of rinses with essential oils on salivary streptococci and lactobacilli in comparison to rinsing with non-alcoholic chlorhexidine. The rinses were used twice a day for 16 days: first group mouth rinse with 20 ml of solution with EO, second group with 10 ml mouth rinse with chlorhexidine and the last one group was mouthrinsing with placebo. After 16 days of using these agents there was a significant reduction of bacteria (which causes caries) in the saliva in second group (rinse with non-alcoholic chlorhexidine) but no such effect in group using rinse with essential oils were shown (36).

When discussing mouth rinses, it is impossible to omit its probability of discoloration of the tongue and teeth. *West et al.* studied the dyeing potential of rinses with amine fluoride/tin dye and phenol-etheric oil. Volunteers rinsed the oral cavity with specific rinse, and after that with a warm solution of black tea every eight times a day for 4 days. After three repetitions of the test cycle, it was found that rinses with essential oils produced less discoloration, but this difference was not significant (37).

A meta-analysis based on a study conducted by *Araujo et al.* showed that mouth washing with mouth rinses containing essential oils has greater benefits than mechanical cleaning of the oral cavity in reducing plaque accumulation as well as gingivitis (38).

Rinsing the mouth with the rinses with the essential oil by the patients is also acceptable before scaling and root planning during the treatment of periodontitis in the dental office. That may reduce plaque index and bleeding index values during probing (39).

Tab. 2. Based on research - comparison of the effectiveness of mouth rinses (12,14,21,26,27,29,30,32,33,34,35,36,37,38,39).

Author of the study	Duration	Size of the research group	Tested substances	Results	Plaque reduction
Marchetti et al.	3 days	21 patients + method – rinsing (by selected rinse) twice a day with 15 ml of solution for 60 seconds	-alcohol-based essential oils, -essential oils, -chlorhexidine, -saline (placebo).	Plaque reduction 1.Chlorhexidine (CHX). 2.A rinsing liquid containing essential oils with alcohol (EO+). 3.Listerin Zero (LZ). 4. Saline	CHX - PI index is 54% lower than the placebo solution. EO+ - PI index is 28.6% lower than the placebo solution. LZ - PI index is 26% lower than the placebo solution.
Salvatori et al.	14 days	16 patients with gingivitis	-essential oils, -chlorhexidine, -tea tree oil, -placebo.	Plaque reduction 1.Chlorhexidine. 2.Tea tree oil -TTO. 3.Essential oils (EO). 4.Placebo.	Full Mouth Plaque Score- index values of active inflammation(FMBS) after application of the preparations was respectively: CHX - 49,75% -> 28% TTO - 65% -> 36,5% EO - 33,5% -> 19,75% Placebo- 58% -> 42,75%

Arweiler et al.	2 weeks	8 patients	- gel (2.5%), containing tea tree oil, - water solution, -chlorhexidine.	Gingivitis reduction 1.Chlorhexidine. 2.Tea tree oil and water - no significant improvement.	PI decrease after 2 weeks TTO - 0.18 CHX - 0.59 CPC - 0.34
Soukoulis and Hirsch	8 weeks	49 patients Method: applying gel on the brush and brushing teeth with gel twice a day; after that patients were instructed not eat and do not rinse the mouth for 30 minutes	- gel with tea tree oil(2.5%), -gel with chlorhexidine (0.2%), - placebo gel.	Plaque reduction 1.Chlorhexidine. 2.Placebo gel. 3.Gel with tea tree oil.	No data available

Saxer et al.	3 months	40 patients	-Tebodont® containing 1.5% TTO and 10% Xylitol and others, -placebo.	Plaque reduction compared to placebo.	During the study, the plaque level increased during placebo use, while the use of rinses allowed the PI to drop by 10-21%  The reduction of inflammation during the usage of the rinse was significant - 26-32% from the beginning of the application until the end of the experiment.
Dolińska et al.	2 weeks	30 patients	- etheric oils (Listerine), -Meridol.	Plaque reduction: 1. Listerine. 2. Meridol.	No data available
Bagan et al.	6 months	60 patients	- rinse with OE content (Listerine® - 26.9% ethanol) - rinses of similar composition, containing no alcohol.	In both trials, the same results were obtained.	No data available
Charugundla et al.	8 weeks	36 patients	-chlorhexidine, -mouth rinse with fluoride, -mouth rinse with essential oils.	The effectiveness of reduction of the accumulation of the plaque: 1. Rinse with chlorhexidine 2. Rinse with fluorine 3. Rinse with essential oils	



Wyganowska-Świątkowska et al.	48h	Human CCD16 fibroblast cell lines grown in incubation medium	-chlorhexidine -essential oil -sage -calendula -chamomile	Chlorhexidine, essential oils and sage reduce the rate of fibroblast proliferation and also cause cell death. However, the infusion of chamomile or calendula does not cause changes in cell proliferation and morphology.	In the control group, fibroblasts have a large variety of shapes.  In the medium with chlorhexidine after 48 hours: the majority of cells are prolonged. In the medium with essential oils after 48 hours: the cells were shrunken and dead cells were observed.
Haffajee et al.	No data	assessment of the inhibitory effect of tested agents in mouthwash on the growth of 40 species of bacteria found in the oral cavity	- a cure with essential oils -sleek with herbs -0.12% chlorhexidine gluconate	The lowest MIC values: 1) Rinse with chlorhexidine gluconate. 2) Rinse with herbs. 3) Rinse with essential oils.	

Charlesa et al.	4 weeks	165 patients	-rinse with essential oils, -rinse with cetylpyridinium chloride.	Reduction of gingivitis and supragingival plaque: 1) Rinse with essential oils. 2) Rinse with cetylpyridinium chloride.	Value reduction 1) MGI: -for essential oils - 13% - for cetylpyridinium chloride -7.6%  2) PI: -for essential oils - 18.9% -for cetylpyridinium chloride - 13.3%
Author of the study	Duration	Size of the research group	Tested substances	Results	Plaque reduction
Wikén Albertsson et al.	16 days	20 patients	- a cure with essential oils - non-alcoholic caffeine with chlorhexidine		The soft alcohol rinse with chlorhexidine significantly reduces the amount of bacteria which causes caries compared to rinses with essential oils, but no significant difference in the prevention of caries was found.
West et al.	20 days	healthy participants	-rinse with phenol / essential oils, -rinse with amifluoride, -rinse with tin fluoride, -water.	Most discolorations: 1. Amine fluoride washing. 2. Lotion with tin fluoride. 3. Rinse with phenol / essential oils.	All rinses compared to placebo showed more discoloration.

Alshehri et al.	30 days	90 patients	-a fragrance based on essential oil -chlorhexidine lotion -rinsing with water	The decrease in PI, BOP and PD values is similar for both oils and chlorhexidine, whereas for water, there are no significant reductions in the above indicators.	Decreasing the value 1) PI: -EO- around 69% -CHX- approx. 52% -water-ok. 17% 2) BOP: -EO- around 56% -CHX- approx. 65% - water - approx. 8% 3) PD -EO- around 31% -CHX- approx. 31% -water-ok. 7%
Meta-analysis from 32 tests	6 months or longer	-2562 patients only treatment by mechanical methods -2544 treatment with mechanical methods with oral rinses	-method of mechanical cleaning of teeth, -mechanical cleaning method + mouth rinses containing essential oils.	Reduction of plaque accumulation and gingivitis: 1)Mechanical tooth cleaning method + oral rinses containing essential oils. 2)Mechanical cleaning tooth method.	MGI / GI reduction (at least 20%): -in the group of patients using the method of mechanical cleaning of teeth + rinse- 66% - in the group of patients using only the method of mechanical cleaning of teeth - 24%  PI reduction (20%): - in the group of patients using the method of mechanical cleansing + rinsing - 83% - in the group of patients using only the method of mechanical cleaning of teeth - 25%

Essential oils are widely used in other fields of dentistry. A study by Kim et al. proved that essential oils can also reduce pain during treatments - patients which receive on five minutes oxygen mask covered with lavender oil, felt less stress and intensity of pain from other patients who had masks without this essential oil (40). Some essential oils (cinnamon and clove) can be used

together with dental implants (titanium and made of zirconium oxide). Covering the surface of implants with oils inhibits biofilm production (41). A study conducted by *Benbelaid et al.* confirmed that essential oils show good antimicrobial activity characterized in high eradication of *E. faecalis*, including both sensitive and multi-drug resistant strains. The results of this study indicate that essential oils can be used to treat intractable for treatment mouth infections (42). The use of natural oils in topical preparations has been beneficial for maintaining a healthy oral cavity. Studies of *Mazutti et al.*, which focused on the huge potential EO in wound healing and treatment, proved that in vitro topical usage of essential oils from *Eugenia dysenterica* DC (oEd), mucosal cells migrate to accelerate regeneration and healing both on the mucous membranes and skin (43).

## CONCLUSIONS

The above-presented studies prove the effectiveness of the use of mouthrinses with essential oils against the formation of plaque, antibacterial effect, and effectiveness as an adjuvant in the treatment of gingivitis. It should be noted that these agents are not as effective as chlorhexidine-containing rinses, but are an alternative worth considering in cases where chlorhexidine cannot be used. It is also a prophylactic agent in preventing the formation of plaque deposits and preventing periodontopathic and diseases in the oral cavity. The systematic use of mouthrinses based on essential oils contributes to the increase of the anticariogenic and anti-inflammatory potential. However, there are reports that the use of mouthrinses containing alcohol may contribute to the increase throat cancer morbidity - due to the accumulation of alcohol that the patient eats and the alcohol contained in the mouthwash. However, no research has been published that confirms this theory, and the effectiveness of individual oils, as well as their components in the treatment of specific oral conditions, requires further research.

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