J Periodontal Implant Sci. 2024 Aug;54(4):209-223
https://doi.org/10.5051/jpis.2301420071
pISSN 2093-2278·eISSN 2093-2286

JPIS
Journal of Periodontal & Implant Science

Review Article
Periodontal Science

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Phytotherapy in periodontics as an effective and sustainable supplemental treatment: a narrative review

Abeer Saad Gawish [1,2], **Mohammed Sherif ElMofty** [3,4], **Safa Jambi** [5], **Doaa Felemban** [6], **Yassmeen SalahEldin Ragheb** [7], **Shadia Abdelhameed Elsayed** [2,6,*]

[1]Dean of Postgraduate Faculty, Sinai University, El Arish Branch, El Arish, Egypt
[2]Department of Oral Medicine and Periodontology, Faculty of Dental Medicine, Al-Azhar University, Cairo, Egypt
[3]Community Service and Environmental Development, Faculty of Dentistry, Nahda University, Beni Suef, Egypt
[4]Department of Oral Medicine, Periodontology and Oral Diagnosis Faculty of Dentistry, Ain Shams University, Cairo, Egypt
[5]Department of Preventive Dental Sciences, College of Dentistry, Taibah University, Almadinah Almunawwarah, Saudi Arabia
[6]Department of Oral & Maxillofacial Diagnostic Sciences, College of Dentistry, Taibah University, Almadinah Almunawwarah, Saudi Arabia
[7]Department of Clinical Pharmacy, Al-Munirah General Hospital, Ministry of Health, Cairo, Egypt

OPEN ACCESS

Received: Mar 15, 2023
Revised: Sep 27, 2023
Accepted: Nov 2, 2023
Published online: Dec 11, 2023

***Correspondence:**
Shadia Abdelhameed Elsayed
Department of Oral Medicine and Periodontology, Faculty of Dental Medicine, Al-Azhar University, 1 ElMokhayam El Daem St., Nasr City, Cairo 11884, Egypt.
Email: shadiaelsayed@azhar.edu.eg
Tel: +2-01001438432
Fax: +2-0683346847

ORCID iDs
Abeer Saad Gawish
https://orcid.org/0000-0002-9932-1773
Mohammed Sherif ElMofty
https://orcid.org/0000-0002-6829-0134
Safa Jambi
https://orcid.org/0000-0002-2658-8215
Doaa Felemban
https://orcid.org/0000-0002-5527-2789
Yassmeen SalahEldin Ragheb
https://orcid.org/0000-0002-6148-1923
Shadia Abdelhameed Elsayed
https://orcid.org/0000-0002-3348-3382

Conflict of Interest
No potential conflict of interest relevant to this article was reported.

ABSTRACT

Purpose: Periodontal disease is a chronic condition caused by microbial infection and mediated by the host's immune response. Phytotherapy is a therapeutic approach that utilizes a renewable resource capable of supplying less expensive medicines for the world's growing population. This review aimed to present clinical evidence on the use of complementary medicinal herbs in the treatment of periodontal diseases.
Methods: Different databases were searched using the terms "herbal" and "periodontitis." All included studies were examined with a focus on herbal indications, type, and prescription length. Dentists' therapeutic and prophylactic herbal prescribing habits were also assessed.
Results: Various herbs such as turmeric, neem, aloe-vera, pomegranate, catechu, tulsi, cloves, lemon grass, green tea, tea tree oil, peppermint, garlic, pineapple, oak bark, babul, bakul, sage, coriander, moringa, amla, guava, and grape seed extract have been used in the treatment of periodontitis. These herbs have been reported to exhibit a range of therapeutic effects, including anti-inflammatory, antiplaque, antihalitosis, antiresorptive, antioxidant, antibacterial, antifungal, antiviral, and antimicrobial properties. These components can be utilized in various forms such as mouth rinse, gel, oil, toothpaste, aqueous extract, mouthwash, or tooth powder.
Conclusions: Several readily available herbal formulations are now available on the market and have been shown to be effective as supplemental periodontal phytotherapy. However, these should be used under the supervision of a dental professional to ensure optimal benefits and effectiveness. Therefore, it is necessary to improve the understanding of suggested herbal prescription practices among dental professionals.

Keywords: Dentists; Herbal; Medicine; Periodontitis; Prescriptions

JPIS Journal of Periodontal & Implant Science

Author Contributions

Conceptualization: Abeer Saad Gawish, Mohammed Sherif ElMofty, Doaa Felemban, Shadia Abdelhameed Elsayed; Formal analysis: Abeer Saad Gawish, Mohammed Sherif ElMofty, Yassmeen SalahEldin Ragheb, Shadia Abdelhameed Elsayed; Investigation: Abeer Saad Gawish, Mohammed Sherif ElMofty, Safa Jambi, Doaa Felemban, Shadia Abdelhameed Elsayed; Methodology: Abeer Saad Gawish, Mohammed Sherif ElMofty, Yassmeen SalahEldin Ragheb, Safa Jambi, Shadia Abdelhameed Elsayed; Project administration: Abeer Saad Gawish, Mohammed Sherif ElMofty, Doaa Felemban, Shadia Abdelhameed Elsayed ; Writing – original draft: Abeer Saad Gawish, Mohammed Sherif ElMofty, Yassmeen SalahEldin Ragheb, Shadia Abdelhameed Elsayed; Writing – review & editing: Abeer Saad Gawish, Mohammed Sherif ElMofty, Safa Jambi, Shadia Abdelhameed Elsayed, Doaa Felemban.

INTRODUCTION

The aim of this review is to compile and evaluate evidence regarding the most commonly used herbal plants for the treatment of periodontal diseases, primarily focusing on their role in reducing inflammation and pain symptoms. Periodontal disease is regarded as one of the most widespread conditions affecting the oral cavity worldwide [1]. Subgingival biofilm can be eradicated through subgingival debridement, the use of adjunctive agents (physical, chemical, or host-modulating), and the administration of systemic or local antimicrobials [2].

Phytotherapy refers to treatment with herbal medicine. Herbal products are often favored over traditional chemical drugs due to their wide-ranging biological activity, increased safety margin, and lower cost [3,4]. Moreover, the prolonged use of conventional medicines can lead to numerous adverse drug reactions, side effects, and resistance [5].

Herbal phytomedicines are known for their long shelf life and are generally well-tolerated and accepted by patients. As a renewable resource, they provide a consistent supply of less costly medicines to meet the needs of the world's expanding population. Medicinal plants are readily accessible in both developing and advanced countries. In certain regions, these drugs serve as the sole therapeutic agents available to specific rural communities. Other reports indicate that these herbs are consumed by millions of people worldwide [6].

Numerous types of herbs are utilized globally, each offering calming and swift effects on patient conditions. These effects include antimicrobial, anti-inflammatory, antiseptic, and antifungal properties. Examples of such herbs include *Acacia arabica*, *Aloe vera*, *Azadirachta indica*, *Curcuma longa*, *Cymbopogam*, *Camellia sinensis*, and *Ocimum sanctum* [7] The importance of these types of adjunctive therapy became evident during the coronavirus disease 2019 pandemic lockdowns. During this time, dental patients experiencing severe and acute pain turned to these readily available herbs for relief [8]. Some doctors even advised their patients to use these herbs as a temporary solution during telemedicine consultations.

Nonetheless, the literature indicates that the prescribing practices of dentists are often suboptimal, due to a range of factors including insufficient knowledge and societal considerations. In this context, we review studies that have investigated the use of herbal remedies, or phytotherapy, by periodontists globally. The main gaps in knowledge regarding the prescription of herbs are outlined.

THERAPEUTIC USES OF HERBS FOR PERIODONTITIS

Turmeric (*C. longa*)

The bioactive polyphenol curcumin, isolated from turmeric (*C. longa*), has been established to possess anti-inflammatory, antibacterial, antioxidant, hepatoprotective, antiseptic, and analgesic activities [9]. The active ingredients in turmeric include the flavonoid curcumin (diferuloylmethane) and various essential oils such as tumerone, atlanton, and zingiberone. Sugars, proteins, and resins are also present. Curcumin is the most extensively studied active antimicrobial and health-preserving ingredient in turmeric [10]. It has been found to decrease histamine levels and potentially increase adrenal gland production of natural cortisol. Orally administered curcumin was found to be as effective as cortisone in acute inflammation, but less effective in chronic inflammation. It inhibits both neutrophil

https://doi.org/10.5051/jpis.2301420071

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activity during inflammatory states and the synthesis of inflammatory prostaglandins from arachidonic acid. Due to its potent antioxidant properties, curcumin also defends against free radical damage. Turmeric and its curcumin component have powerful antioxidant properties that are comparable to those of vitamins C and E in water. According to Sharma and Kalsi (2016) [11], the topical administration of *C. longa* as a supplement to subgingival scaling and root planning (SRP) may enhance currently used therapeutic methods for the management of plaque-induced periodontal disease. Additionally, curcumin enhanced cellular resilience to oxidative damage after 18 hours of incubation of bovine aortic endothelial cells. Curcumin's anti-inflammatory actions are explained by its inhibitory activity at several stages of the arachidonic acid inflammatory cascade. Research has demonstrated that curcumin can block a number of enzymes and cytokines connected to inflammation [12]. Curcumin use in conjunction with SRP has been found to improve clinical indicators and have a beneficial impact on patients with chronic periodontitis. According to Nagasri et al. (2015) [13], the use of 1% *C. longa* L. extract had antibacterial efficacy against common periodontopathic bacteria. It appears that a local drug administration system made of 2% whole turmeric gel can enhance SRP. The activity of the trypsin-like enzyme in the "red complex" species was greatly diminished [14,15]. Using a 1% curcumin solution as a subgingival irrigation led to a greater remission of inflammatory symptoms than using chlorhexidine (CHX) and saline irrigation [16,17]. *C. longa* extract gel applied twice daily for 3 weeks was effective in treating gingivitis. Curcumin exerts antioxidant effects both directly and indirectly by initiating antioxidant responses. Moreover, it has been demonstrated that curcumin inhibits lipoxygenase 5 to provide its antiapoptotic properties. Curcumin may therefore influence the atherogenic activity of inflammatory monocytes' phosphorylase kinase. The application of a paste to the teeth and gums twice a day can be used to treat periodontal diseases. In a separate double-blind clinical trial, curcumin was found to be more effective than a placebo and the non-steroidal anti-inflammatory drug phenylbutazone at reducing post-surgical inflammation. Its strong antioxidant qualities also aid in protecting against the harm caused by free radicals. It was shown that 0.1% turmeric mouthwash might be used as a helpful supplement to mechanical plaque removal in the fight against gingivitis [18-20].

Neem (*A. indica*)

The majestic neem tree, native to India, has been dubbed the "tree of the 21st century." it is known by various names in India, such as "divine tree," "life-giving tree," "nature's drugstore," "village pharmacy," and "panacea for all ailments" [11]. Neem leaf extract can potentially reduce the amount of bacteria and plaque that contribute to the onset of periodontitis. It may physically limit the number of bacteria able to bind to the tooth surface. The effective suppression of glucosyltransferase activity and the reduction in bacterial adherence further support its potential antiplaque efficacy. A study by Vennila et al. (2016) [21] examined the effectiveness of 10% neem chips as an adjunct to scaling. The use of neem leaves, seeds, roots, bark, and fruits has been shown to be effective in treating dental issues, inflammation, infections, and skin problems. Neem has long been used to maintain healthy, strong gums and teeth. Several compounds found in neem, including azadirachtin, sodium nimbidate, nimbin, nimbidin, and nimbidol, exhibit antibacterial, antifungal, anti-inflammatory, antipyretic, antihistamine, and antifungal properties [5,22].

Numerous toothpaste formulas have effectively incorporated neem leaves, barks, or twigs for the treatment of gingivitis and periodontitis. Neem's anti-inflammatory effect works by inhibiting prostaglandin, thereby reducing inflammation. Its antibacterial activity is attributed to the azadirachtin component, which breaks down bacterial walls and inhibits

https://doi.org/10.5051/jpis.2301420071

growth. A dental gel containing neem extract has been shown to decrease the quantities of 2 bacteria commonly found in plaque, *Streptococcus mutans* and *Lactobacillus* species [23]. A double-blind, randomized, controlled study evaluated the use of 0.19% neem in combination with mechanical therapy for the treatment of gingivitis caused by plaque. This approach is vital for developing an affordable and effective oral health intervention for communities with low socioeconomic status [24].

For improved overall oral health, frequent brushing with toothpaste containing neem can decrease plaque formation, prevent cavities, and strengthen the immune system. Regular use of mouthwash with neem extract can also treat gingival issues and minimize halitosis. Furthermore, *A. indica* has been found to be highly effective in treating periodontal diseases and is biocompatible with human periodontal fibroblasts [25]. Neem inhibits matrix metalloproteinase (MMP)-2 and MMP, both of which are associated with the breakdown of the extracellular matrix in periodontitis. According to a 2015 study by Kala et al., [26] the use of dental gel containing neem extract significantly reduced the presence of plaque microorganisms. In addition to these benefits, neem also possesses antiviral, antidiabetic, and antioxidant properties [26].

Neem leaf has been shown to have excellent antiviral, astringent, antimicrobial, antiarrhythmic and antihyperglycemic effects on animals both *in vitro* and *in vivo*. The fibrous texture of neem chewing sticks aids in mechanical plaque removal, and gallotannins can successfully reduce the number of germs that adhere to the tooth surface. Gallotannin extracts have also been demonstrated to successfully block the activity of glucosyl transferase and decrease bacterial adhesion, which suggests a potential antiplaque action. Antibacterial plant extracts did not cause a gingival allergy, unlike antibiotics [22].

Aloe vera

Aloe vera is a member of the *Asphodelaceae* family. There are more than 300 species of aloe vera plants, but only 2 of them—*Aloe barbadensis Miller* and *Aloe aborescens*—have undergone in-depth research [5]. Aloe vera is reported to have a range of pharmacological effects, including antiviral, antifungal, antibacterial, anti-inflammatory, and hypoglycemic properties. It is effective in reducing gum edema, inflammation, and bleeding. In areas where frequent cleaning is challenging, it serves as an effective antiseptic. It is also a potent healing agent following extractions [27]. Aloe vera gel is beneficial in wound healing. Most healing techniques still focus on minimizing inflammation, and acetylated mannans from aloe vera seem to play a crucial role in this process due to their immunomodulatory properties. The use of both toothpaste and mouthwashes containing aloe vera has been associated with reduced plaque scores and gingivitis [7,28]. Furthermore, treating diabetic rats with aloe vera extract resulted in a significant increase in the activity of glutathione S transferase in the liver and kidneys [29,30].

Concerning oral pathogens, Jain et al. [31] investigated the antibacterial activity of aloe vera gel and claimed that it was effective against *Aggregatibacter actinomycetemcomitans, Clostridium bacilli*, *S. mutans*, and *Staphylococcus aureu*s. Bhat et al. (2011) [32] supports this, indicating that the subgingival injection of aloe vera gel can enhance periodontal health. Given these findings, it is reasonable to infer that extracts from the aloe vera species, due to their antioxidant properties, could be beneficial in both the prevention and management of periodontal diseases.

https://doi.org/10.5051/jpis.2301420071

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Pomegranate tree (*Punica granatum*)

P. granatum is a fruit-bearing tree native to Iran and a member of the Punicaceae family. It is more commonly known as the pomegranate tree. This plant is recognized for its medicinal properties [33]. The plant contains phytochemicals such as ellagic acid, punicic acid, phenols, and flavonoids. Pomegranate may possess antigingivitis properties due to the direct antioxidant capabilities of its flavonoids, as well as their indirect effects, which include enhancing the free radical scavenging activity of hepatic enzymes such as catalase, superoxide dismutase, and peroxidase [34]. A rinse made from pomegranate can inhibit alpha-glucuronidase, an enzyme that breaks down sucrose, while simultaneously boosting the activity of the antioxidant ceruloplasmin. The plant's polyphenolic flavonoids, including punicalagins and ellagic acid, can help prevent gingivitis [35]. A recent study suggested that using pomegranate extracts in the form of chips and gel could complement SRP in treating periodontal pockets, based on a comparison of the effectiveness of these procedures in adult patients with periodontitis [36].

Chamomile (*Matricaria recutita*)

The active ingredients found in chamomile, namely bisabolol, chamazulene, and spiroether, work to inhibit the release of histamine, serotonin, and bradykinin. Chamomile has been shown to promote wound healing at a faster rate than corticosteroid therapy, and it also encourages the epithelium to mature more rapidly. *M. recutita* extract, when used as a mouthwash, exhibits anti-inflammatory and antibacterial properties that can reduce the bleeding index in periodontitis. This is comparable to the effects of 0.12% CHX, and it can help maintain periodontal health [37]. Chamomile mouthwash has demonstrated potential in treating chronic periodontitis, with results that are on par with those of the gold standard mouthwash, chlorohexidine.

Black khair (*Acacia catechu Wild*)

Black khair, also known as *A. catechu Wild*, is a member of the *Fabaceae* family and the *Mimosoideae* subfamily. The mouthwash derived from this plant is utilized for the treatment of gingival infections. The plant's preparations exhibit antipyretic, anti-inflammatory, antidiarrheal, hypoglycemic, hepatoprotective, antioxidant, and antibacterial properties. A herbal tooth powder formulation, which includes acacia catechu, menthol, and camphor powder, has been found to remove plaque stains and polish teeth surfaces without the use of abrasives [3]. These powders are distributed in proportions of 91%, 2.7%, and 6.3%, respectively. Menthol and camphor granules are incorporated into the compound as flavoring agents. After 15 days of treatment, both plaque scores and gingivitis showed a decrease [26,30]. The active components in *A. catechu* include catechins, epicatechins, epigallocatechins, gallates, rocatechins, phologlucin, and protocatechuic acid [38]. *A. catechu* has been employed to achieve astringent coagulation, heal wounds, reduce inflammation, and prevent infection. Black catechu, an extract from the heartwood, is used to treat a variety of conditions, such as bronchitis, colic, skin issues, ulcers, and stomatitis. The heartwood of *A. catechu* is a potent immunostimulant. In addition to the aqueous solution, the bark of *A. catechu* also demonstrates an antioxidant effect through its ability to inhibit lipid peroxidation [39].

Tulsi (*O. Sanctum*)

Tulsi (*O. Sanctum*) is a member of the *Labiatae* family and is distinguished by a square stem and distinctive scent. The volatile oil found in tulsi leaves, which makes up about 0.7% of its composition, is primarily composed of eugenol (approximately 71%) and methyl eugenol (around 20%). Both linolenic acid and the fixed oil in tulsi have demonstrated

https://doi.org/10.5051/jpis.2301420071

anti-inflammatory effects against edema induced by prostaglandin E2 (PGE2), leukotriene, and arachidonic acid. Tulsi is also effective against bacteria such as *S. aureus*, *S. mutans*, and *E. coli*. Furthermore, it possesses antiviral, antifungal, anticariogenic, and antiulcerogenic properties [40].

Tulsi's extremely complicated chemical composition includes a number of naturally occurring nutrients and biologically active compounds. The antibacterial properties of *O. sanctum* leaves are primarily derived from essential oils. These biologically active compounds have the ability to disrupt the cytoplasmic membranes of microbial strains by promoting the release of cellular potassium. It is plausible that the periodontal pathogen *A. actinomycetemcomitans*, found in human dental plaque, may also be affected by these processes, which are effective against germs causing systemic disease [41]. A literature search revealed very few studies investigating the antibacterial activity of *O. sanctum* against infections causing oral disease. According to a clinical study by Gupta et al. (2014) [42], a mouth rinse made from *O. sanctum* was as effective as CHX in reducing plaque and gingivitis.

Mallikarjun et al. (2016) [43] demonstrated the antibacterial potency of Tulsi leaf extract against *A. actinomycetemcomitans* in their *in vitro* research. Furthermore, it has been proposed that tulsi may have an immunomodulatory effect, enhancing the host's resistance to infections by elevating levels of interferon, interleukin-4, and T helper cells.

Clove essential oil (CEO; *Syzygium aromaticum L. Myrtaceae*)

S. Aromaticum, or clove, is a natural dried flower bud from the *Myrtaceae* family that has antibacterial and antioxidant qualities. CEO is commonly used for healing burns and wounds, managing tooth infections and toothaches, and alleviating pain from dental procedures. It has been found that clove oil exhibits anticoagulant properties and inhibits the synthesis of thromboxane and platelet aggregation. Furthermore, platelet activating factor, arachidonic acid, or collagen did not induce platelet aggregation in the presence of clove oil. The findings suggest that clove oil is more effective than collagen in preventing aggregation caused by platelet activating factor and arachidonic acid. Eugenol, another component of clove, has been shown to inhibit prostaglandin biosynthesis, thromboxane B2 synthesis, and platelet aggregation [26]. Clove oil has demonstrated potent germicidal effects against several periodontal pathogens, including superinfections such as *Candida albicans*, *Pseudomonas aeruginosa*, *S. aureus*, and *E. coli*. The use of clove buds can reduce oral bacteria by 70%, which is supported by the fact that clove oil is a frequent ingredient in toothpaste [44]. Eugenol's anti-inflammatory activities have been linked to its ability to reduce prostaglandin synthesis, neutrophil/macrophage chemotaxis, and the expression of the cyclooxygenase II enzyme. Additionally, eugenol dimers have exhibited chemopreventive effects by decreasing macrophage cytokine production [45].

Lemongrass (*Cymbopogon citratus*)

Lemongrass is a widely used medicinal plant. It is extensively incorporated into teas, cosmetics, and traditional medicine due to its antibacterial, antiemetic, antirheumatic, analgesic, antispasmodic, and antipyretic properties. Chemical components such as phenol and flavonoids have been identified, exhibiting both *in vitro* and *in vivo* biological activity. These activities include antioxidant, anti-inflammatory, and antimutagenic effects [46].

Lemongrass essential oil, at a concentration of approximately 2%, has been found to inhibit the growth of various bacteria, including pathogens associated with periodontal disease

https://doi.org/10.5051/jpis.2301420071

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[19,47]. Notably, this includes strains of *Actinomyces lundii* and *Porphyromonas gingivalis* that have shown resistance to tetracycline hydrochloride. A study conducted by Warad et al. in 2013 identified a promising new approach: the local application of 2% lemongrass oil in gel form as a safe and effective adjunct to SRP procedures [48].

Green tea (*C. sinensis*)

Green tea is rich in numerous bioactive substances, including a high concentration of flavonoids such as catechins and their byproducts. This beverage offers a range of therapeutic benefits, functioning as an anti-inflammatory, anticaries, antifungal, antiviral, and antibacterial agent. Additionally, it exhibits collagenase-inhibiting and antioxidant properties. Hattarki et al. (2013) [49] found that green tea catechins were more effective than SRP alone when delivered as a local drug into periodontal pockets. That study investigated the antibacterial effects of green tea extracts on *P. gingivalis* and discovered that an alcohol-based green tea extract can inhibit and eliminate the pathogen.

Tea tree oil (TTO; *Melaleuca alternifolia*)

TTO is extracted from trees characterized by their papery bark. TTO possesses a wide range of antibacterial, antifungal, antiviral, antioxidant, and anti-inflammatory properties. As noted by Elgendy et al. (2013) [50], TTO can be used in conjunction with SRP to assist patients with chronic periodontitis in improving their clinical indicators. A recent randomized controlled study demonstrated that the local application of TTO gel, when used as an adjunct to SRP, was effective in treating stage II periodontitis [51]. Moreover, Singh and colleagues compared the effectiveness of TTO and CHX in managing gingival and periodontal diseases. They concluded that TTO could serve as an alternative to CHX in reducing gingival inflammation, especially when combined with efficient plaque control strategies [52].

Peppermint (*Mentha piperita*)

Peppermint is the most commonly used mint in liqueurs, toothpastes, soaps, and mouthwashes due to its potent and pure properties. Peppermint essential oil has been utilized to treat a variety of conditions, including colic, headaches, indigestion, and gingivitis. Mint is also a viable treatment for gingivitis [5,46]. Both peppermint oil and several extracts of *M. piperita* possess strong antibacterial capabilities, which can inhibit the growth and persistence of bacteria, including certain strains of both gram-positive and gram-negative bacteria [53]. Furthermore, these oil and *M. piperita* preparations demonstrate significant antioxidant activity. Additionally, menthol mouthwash is employed and has proven effective against plaque and gingivitis [53].

Garlic (*Allium sativum*)

Garlic is rich in antioxidants, specifically phenols and saponins. The antioxidant activity of garlic can vary based on its processing methods. Ethyl linoleate found in garlic serves as an anti-inflammatory agent, reducing levels of nitric oxide, interleukin-1, tumor necrosis factor-alpha, and PGE2. Garlic also contains flavonoids, which have antiviral properties. The enzyme alliinase is responsible for converting alliin (S-allyl cysteine sulfoxide) to allicin. Garlic is also a source of antimicrobial organosulfur compounds such as allicin. Additionally, it contains prebiotic fiber, which is beneficial for digestion and oral health. The antiviral and antifungal properties of garlic may also contribute to oral health [54]. In studies of various extract dosages, these extracts demonstrated inhibitory zones of 20 to 25 mM against *P. gingivalis* and an antiproteolytic effect on the *P. gingivalis* protease enzyme. The aqueous extract of garlic exhibited a higher bacteriostatic action. *A. actinomycetemcomitans* showed

https://doi.org/10.5051/jpis.2301420071

greater resistance to both aqueous and ethanol extracts of garlic, suggesting that garlic extracts could potentially be used to treat periodontitis [55,56]. In a double-blind clinical study, Zini et al. [56] investigated the effects of aged garlic extract on periodontitis. They randomly selected 200 patients and conducted tests at the start of the study, as well as at 12 and 18 months into the study [56].

Pineapple (*Ananas comosus*)

The pineapple (*A. comosus*) is a tropical fruit that is rich in vitamins, enzymes, and antioxidants. The plant belongs to the family Bromeliaceae. The therapeutic benefits of pineapple are largely attributed to an essential extract known as bromelain. This extract contains a variety of proteinases and other chemicals. Bromelain serves as an alternative to non-steroidal anti-inflammatory medications, glucocorticoids, and immunomodulators. It demonstrates a range of antiedematous, fibrinolytic, anti-inflammatory, and antithrombotic activities, both *in vitro* and *in vivo*. It is believed that bromelain reduces the risk of antibiotic toxicity by enhancing antibiotic absorption, thereby facilitating their improved distribution in tissues. Bromelain has been found to eliminate a broad spectrum of aerobic and anaerobic bacteria, including *S. mutans, P. gingivalis, E. coli*, and *A. actinomycetemcomitans* [20]. Another study found that a dentifrice containing bromelain was effective in preventing plaque and gingivitis. Despite the fact that a dentifrice containing bromelain was effective in preventing plaque and gingivitis. Despite the fact that its adverse effects were less severe, its use was limited in patients with renal, liver, and hemophilia disorders due to the anticoagulatory effects of the drug [57].

Oak bark (*Quercus spp.*)

Historically, the oak species belonging to the *Fagaceae* family, native to western Iran, was utilized for the treatment of gastric ulcers, localized inflammation, and superficial wounds. In addition to these uses, it also exhibits antioxidant, antibacterial, anti-inflammatory, and antineuropathic properties [58].

The dried bark of various European oak species, such as *Quercus pubescens*, *robur*, and *petraea*, all of which belong to the *Fagaceae* family, is referred to as oak bark. This bark contains hydrolyzable and condensed tannins (8%–20%), which are its primary biologically active substances. These tannin-rich plant products have been found to effectively treat periodontitis [59]. Oak bark tannins exhibit strong astringent, antibacterial, antioxidant, and anti-inflammatory effects. These effects are due to their ability to inhibit and deactivate proteins by generating stable, insoluble complexes. The astringent effect, in particular, can halt minor bleeding in the mouth caused by the progression of periodontitis. A study conducted by Tsubanova et al. [60] supports the effectiveness of a gel composed of oak bark and aloe vera extracts in treating periodontitis [61].

Babul (*Acacia nilotica*)

Babul (*A. nilotica*) contains cyanogenic glycosides along with several enzymes, including oxidases, peroxidases, and pectinases, which have been shown to inhibit antibacterial functions. Tannins, which make up 24%–42% of the plant's bark, possess analgesic and anti-inflammatory properties. These properties can be beneficial in treating suspected periodontal infections caused by bacteria such as *A. actinomycetemcomitans*, *Capnocytophaga* species, *P. gingivalis*, *Prevotella intermedia*, and *Treponema denticola*. In addition, the acacia gum derived from the plant may offer clinical advantages. Lupeol, one of the primary pharmacologically active ingredients in babul, exhibits anti-inflammatory and antimicrobial properties [62].

https://doi.org/10.5051/jpis.2301420071

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Sage (*Salvia officinalis*)

Sage (*S. officinalis*) is a member of the *Lamiaceae* family, and it has two primary types: *S. officinalis* and *S. triloba*. The main chemical components of *S. officinalis* oil are cineole, camphor, borneol, and pinene, while *S. triloba*'s oil primarily contains cineole, camphor, and caryophyllene. Essential oils derived from sage possess antibacterial, antifungal, antiseptic, and antiviral properties. Additionally, *S. officinalis* exhibits antioxidant, antimicrobial, and free radical scavenging capabilities. Sage leaves are frequently utilized for their medicinal properties [5].

Coriander (*Coriandrum sativum*)

Coriander (*C. sativum*), a member of the *Umbelliferae* family, has been traditionally used in Iranian medicine as a carminative and spasmolytic. It possesses anti-inflammatory, analgesic, antibacterial, and antioxidant properties. Tannins are also present in C. sativum extract. Yaghini et al. (2014) [58] conducted a randomized double-blind controlled trial to assess the clinical outcomes of subgingival administration of a herbal gel (extracts of oak and coriander) in periodontal pockets. The results demonstrated statistically significant improvements in periodontal indicators.

Moringa oleifera extract (*Moringaceae*)

The proteins and minerals in moringa leaves contain large amounts of all eight necessary amino acids. The leaves of the *M. oleifera* plant contain a wide range of nutrients, including beta-carotene, minerals, vitamin E, amino acids, fatty acids, and flavonoids. Certain flavonoids, including kaempferol and quercetin, have been linked in human studies to improved bone health. The benefits of these flavonoids extend to cardioprotection, neurotoxicity prevention, anxiety relief, pain alleviation, antioxidant activity, and the ability to inhibit allergy, platelet aggregation, cancer, microbial infection, obesity, hypertension, hyperlipidemia, aging, inflammation, and osteoporotic effects [63]. Additionally, the usage of *M. olifera* extract gel with delayed dental implants may potentially reduce postoperative discomfort and swelling. This is due to its anti-inflammatory and antibacterial properties, which can enhance healing around dental implants [64].

Amla (*Emblica officinalis*)

The plant *E. officinalis Gaerin* (also referred to as *Phyllanthus emblica Linn*), commonly known as Indian gooseberry or amla, plays a noteworthy role in traditional medicine and has a number of beneficial properties. The fruit of *E. officinalis* is recognized for its antimicrobial properties, which are attributed to its flavonoids, phenols, and tannins. Tannins, with their phenolic components and antibacterial properties, are known to reduce both short-term and long-term inflammation [65]. Furthermore, *E. officinalis* has demonstrated strong anti-inflammatory and antioxidant properties in rodent models of acute and chronic inflammation. It is also useful to compare the cytoprotective properties of *E. officinalis* with those of other antiseptics such as CHX, which are known to have cytotoxic and genotoxic properties. The biological significance of the plant *E. officinalis* lies particularly in its anti-inflammatory, immunomodulatory, and antiresorptive characteristics, in addition to its antibacterial properties. Patients with chronic periodontitis who were treated with a 10% sustained-release *E. officinalis* gel, in conjunction with routine mechanical therapy, experienced a significantly greater improvement in clinical measures [66].

https://doi.org/10.5051/jpis.2301420071

Guava (*Psidium guajava*)

Guava (*P. guajava*) contains essential oils, flavonoids, tannins, triterpenoid acids, sesquiterpene alcohols, and vitamins, all of which have antioxidant, anti-inflammatory, antimicrobial, analgesic, antispasmodic, anticancer, antihyperglycemic, and hepatoprotective properties. A traditional method for maintaining oral hygiene involves the use of a paste made from tender guava leaves. This paste's inherent antibacterial properties are effective against both gram-positive and gram-negative bacteria [5]. The development of experimental gingivitis can be prevented by supplementing with 200 g of guava or 200 mg of synthetic vitamin C, according to a 2018 study that looked at the effects of guava and vitamin C supplementation on gingivitis models [67]. Guava contains a substance called quercetin, which has exceptional antibacterial capabilities against periodontal infections. Guava is well known for its ability to reduce prostaglandin and histamine, which helps to explain how it has anti-inflammatory properties.

Grape seed extract (GSE; *Vitis vinifera*)

GSE, derived from the seeds of *V. vinifera*, is a naturally occurring polyphenolic compound. Its proanthocyanidin content has been suggested as a powerful immunomodulator. GSE exhibits numerous biological properties, including anti-inflammatory, anticarcinogenic, and antioxidant activities. These polyphenolic compounds have demonstrated a range of biological activities, such as antioxidant and antibacterial effects. A 2018 study by Rayyan et al. [68] revealed that GSE reduces the gingival and plaque indices in individuals with chronic periodontitis. Furthermore, GSE exhibits a bacteriostatic effect on anaerobes, resists collagen breakdown, and significantly inhibits dental biofilm formation, suggesting its potential usefulness in preventing periodontal disease. A recent study by Toker et al. (2018) [69] suggested that administering GSE could reduce alveolar bone loss and periodontal inflammation by lowering MMP-8 and HIF-1 levels.

Polyherbs

Polyherbs are mixtures of various herbs and plant extracts. They can be used to create natural mouthwashes, toothpastes, and oral rinses. These products may include antibacterial, anti-inflammatory, and astringent plants such as neem, aloe vera, clove, and mint. They can assist in maintaining oral hygiene, reducing plaque buildup, and treating halitosis. Furthermore, they can serve as adjuncts to conventional treatments for gingivitis and periodontitis. Aloe vera, turmeric, and neem are known to decrease gum inflammation and improve overall gum health. Clove oil, in particular, is renowned for its anesthetic properties. To alleviate the discomfort of oral ulcers and promote quicker healing, polyherbs that contain soothing and healing herbs like licorice, chamomile, and calendula can be applied topically or used as mouth rinses. Other uses of polyherbs include alleviating symptoms of xerostomia, preventing oral cancer, providing antioxidant and anti-inflammatory benefits, and serving as supplements for oral health.

DISCUSSION

For centuries, herbal products have been employed to maintain oral hygiene and address gum disorders. These popular natural remedies include turmeric, neem, aloe vera, clove, cinnamon, and others. Herbal products with no known side effects, such as *A. arabica*, aloe vera, *A. indica, C. longa*, *Cymbopogam*, *C. sinensis*, and *O. sanctum*, are valued for their antimicrobial, antioxidant, antiseptic, anti-inflammatory, and anticollagenase properties, which can potentially enhance wound healing [7].

https://doi.org/10.5051/jpis.2301420071

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Herbs function as antioxidants, scavenging free radicals and thereby preventing oxidative stress. Oxidative stress is a significant factor in the cellular damage linked to the onset and progression of periodontitis [24]. In light of these findings, exogenous antioxidants are being utilized to treat periodontal disease. Phytochemicals either inhibit germs from adhering to the tooth surface or halt the formation of glucan and exopolysaccharide. A range of secondary plant compounds possess bactericidal properties [70]. Therefore, in the treatment of periodontal diseases, herbal extracts could serve as a supplementary treatment to SRP or surgical therapy.

Natural antibiotics known as flavonoids also exert powerful effects against oncogenic viruses and agents that cause cancer. Certain essential oils have the ability to combat bacteria that are resistant to artificial antibiotics [46,64]. It is believed that microorganisms cannot become resistant to essential oils, as demonstrated by studies utilizing clove, eucalyptus, and peppermint oils have proven this [71].

Approximately 50% of infections acquired in hospitals worldwide are attributed to multidrug-resistant microorganisms. Certain strains, including bacteria that produce expanded spectrum beta-lactamases, are particularly worrisome [72]. One promising avenue for curbing the spread of bacterial resistance lies in the ability of certain plant secondary metabolites to act as resistance-modifying agents.

Herbal medicine may offer several benefits. Research has shown that certain plants can be more effective than pharmaceuticals in healing the body as a whole. This is due to the combined preventive effects of the plants' active ingredients, their regulation of the body's defense processes, and their preparation for potential activity against external agents. The therapeutic effects tend to be longer-lasting, and side effects are usually milder due to enhanced tolerance and adaptability. This is in contrast to drugs, which typically serve a specific purpose.

Herbal therapy may be utilized in tandem with conventional drugs or for treating multiple targets simultaneously, depending on the condition. In addition to these benefits, the easy accessibility, minimal known side effects, and low cost position herbal medicine as a highly suitable option for controlling plaque, reducing gingivitis, and potentially mitigating periodontitis [3,46,73].

Further research is required to clinically compare these plants and establish specific indications for each, as well as to identify any unknown adverse or drug reactions. The current clinical reports provide insufficient scientific evidence to evaluate and confirm the long-term effects of the herbs used in periodontal therapy. The effectiveness of polyherbs in treating periodontal disorders varies, necessitating additional research to ascertain their specific benefits and safety. There are multiple methods for administering herbal medicine to patients, particularly for the topical oral treatment of various periodontal diseases. However, the precise prescription, including the amount and dosage, still requires pharmaceutical determination. From a pharmaceutical perspective, the effects of polyherbs are not yet fully understood. While the application of periodontal phytotherapy is promising, the self-usage patterns of patients may vary and be influenced by geographic and ethnic factors.

https://doi.org/10.5051/jpis.2301420071

CONCLUSION

It is critical to approach herbal medicine from a scientific perspective. More research is needed to determine the efficacy and therapeutic potential of herbal preparations. Due to a lack of knowledge, dentists' herbal prescribing practices are inadequate. Guidelines for bettering herbal prescribing practices are strongly recommended. Several readily available herbs have been shown to be effective as supplemental periodontal phytotherapy. Dental professionals' understanding of the suggested principles of herbal prescription practices should be improved.

REFERENCES

1. Chapple ILC, Bouchard P, Cagetti MG, Campus G, Carra MC, Cocco F, et al. Interaction of lifestyle, behaviour or systemic diseases with dental caries and periodontal diseases: consensus report of group 2 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol 2017;44 Suppl 18:S39-51. PUBMED | CROSSREF
2. Sanz M, Herrera D, Kebschull M, Chapple I, Jepsen S, Beglundh T, et al. Treatment of stage I–III periodontitis-the EFP S3 level clinical practice guideline. J Clin Periodontol 2020;47 Suppl 22:4-60. PUBMED | CROSSREF
3. Afroze CA, Ahmed MN, Jahan R, Rahmatullah M. Evaluation of herbal ingredients used in an ethno-polyherbal formulation for treating menorrhagia and dysmenorrhea in Bangladesh. Phytomed Plus 2022;2:100366. CROSSREF
4. Al-Johani LE, AlGhamdi KS, AlShaary A, Aljohani ME, Alolayan AB, Elsayed SA. Prevalence of herbal use for obstetrics purposes in Al-madinah Al-munawwarah, Saudi Arabia. J Herb Med 2023;42:100756. CROSSREF
5. Gavali N, Patil V, Waghmare P, Chaudhari A, Pathare P. Benefits of phytotherapy in periodontics: a review. J Emerg Technol Innov Res 2020;7:3223-37.
6. Ohtani M, Nishimura T. The preventive and therapeutic application of garlic and other plant ingredients in the treatment of periodontal diseases. Exp Ther Med 2020;19:1507-10. PUBMED | CROSSREF
7. Laleman I, Teughels W. Novel natural product-based oral topical rinses and toothpastes to prevent periodontal diseases. Periodontol 2000 2020;84:102-23. PUBMED | CROSSREF
8. Elsayed SA, Abu-Hammad O, Alolayan AB, Eldeen YS, Dar-Odeh N. Fallacies and facts around COVID-19: the multifaceted infection. J Craniofac Surg 2020;31:e643-4. PUBMED | CROSSREF
9. Forouzanfar F, Forouzanfar A, Sathyapalan T, Orafai HM, Sahebkar A. Curcumin for the management of periodontal diseases: a review. Curr Pharm Des 2020;26:4277-84. PUBMED | CROSSREF
10. Çıkrıkçı S, Mozioğlu E, Yılmaz H. Biological activity of curcuminoids isolated from *Curcuma longa*. Rec Nat Prod 2008;2:19-24.
11. Sharma V, Kalsi D. Effects of topical application of *Curcuma longa* extract in the treatment of early periodontal diseases. Indian J Dent Sci 2016;8:118. CROSSREF
12. Jalaluddin M, Jayanti I, Gowdar IM, Roshan R, Varkey RR, Thirutheri A. Antimicrobial activity of *Curcuma longa* L. extract on periodontal pathogens. J Pharm Bioallied Sci 2019;11:S203-7. PUBMED | CROSSREF
13. Nagasri M, Madhulatha M, Musalaiah SVVS, Kumar PA, Krishna CHM, Kumar PM. Efficacy of curcumin as an adjunct to scaling and root planning in chronic periodontitis patients: a clinical and microbiological study. J Pharm Bioallied Sci 2015;7:S554-8. PUBMED | CROSSREF
14. Parle M, Bansal N. Herbal medicines: are they safe? Nat Prod Radiance 2005;5:6-14.
15. Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol 2014;4:177. PUBMED | CROSSREF
16. Li Y, Jiao J, Qi Y, Yu W, Yang S, Zhang J, et al. Curcumin: a review of experimental studies and mechanisms related to periodontitis treatment. J Periodontal Res 2021;56:837-47. PUBMED | CROSSREF
17. Mohammadian Haftcheshmeh S, Karimzadeh MR, Azhdari S, Vahedi P, Abdollahi E, Momtazi-Borojeni AA. Modulatory effects of curcumin on the atherogenic activities of inflammatory monocytes: evidence from *in vitro* and animal models of human atherosclerosis. Biofactors 2020;46:341-55. PUBMED | CROSSREF

https://doi.org/10.5051/jpis.2301420071

18. Chaturvedi TP. Uses of turmeric in dentistry: an update. Indian J Dent Res 2009;20:107-9. PUBMED | CROSSREF
19. Rangrej U, Dave D, Rai J, Vaghani K. Evidence based review on herbal local drug delivery. IOSR J Dent Med Sci 2017;16:77-85.
20. Pai PG, Dayakar MM, Nath AR, Ashwini G. Phytotherapeutics in the management of periodontal disease - a review. SRM J Res Dent Sci 2019;10:82-9. CROSSREF
21. Vennila K, Elanchezhiyan S, Ilavarasu S. Efficacy of 10% whole *Azadirachta indica* (neem) chip as an adjunct to scaling and root planning in chronic periodontitis: a clinical and microbiological study. Indian J Dent Res 2016;27:15-21. PUBMED | CROSSREF
22. Parida MM, Upadhyay C, Pandya G, Jana AM. Inhibitory potential of neem (*Azadirachta indica* Juss) leaves on dengue virus type-2 replication. J Ethnopharmacol 2002;79:273-8. PUBMED | CROSSREF
23. Gupta I, Tripathi A, Gupta R, Ranjan P, Gupta S, Das N. Clinical evaluation of 10% *Azadirachta indica* mouth rinse as a subgingival irrigant along with ultrasonic scaling for the treatment of chronic gingivitis and chronic periodontitis. Int J Health Sci (Qassim) 2022;6:14074-87. CROSSREF
24. Heyman L, Houri-Haddad Y, Heyman SN, Ginsburg I, Gleitman Y, Feuerstein O. Combined antioxidant effects of neem extract, bacteria, red blood cells and lysozyme: possible relation to periodontal disease. BMC Complement Altern Med 2017;17:399. PUBMED | CROSSREF
25. Botelho MA, dos Santos RA, Martins JG, Carvalho CO, Paz MC, Azenha C, et al. Efficacy of a mouthrinse based on leaves of the neem tree (*Azadirachta indica*) in the treatment of patients with chronic gingivitis: a double-blind, randomized, controlled trial. J Med Plant Res 2008;2:341-6.
26. Kala BS, Gunjan C, Disha N, Shobha P. Treatmen of periodental disease – a herbal approach. Int J Pharm Sci Rev Res 2015;33:126-36.
27. Sravya MVN, Koduganti RR, Panthula VR, Surya PJ, Gireddy H, Dasari R, et al. Efficacy of an herbal antioxidant as an adjunct to nonsurgical periodontal therapy on procalcitonin levels in smokers with chronic periodontitis. J Indian Soc Periodontol 2019;23:430-5. PUBMED | CROSSREF
28. Chatzopoulos GS, Karakostas P, Kavakloglou S, Assimopoulou A, Barmpalexis P, Tsalikis L. Clinical effectiveness of herbal oral care products in periodontitis patients: a systematic review. Int J Environ Res Public Health 2022;19:10061. PUBMED | CROSSREF
29. Rajasekaran S, Sivagnanam K, Subramanian S. Antioxidant effect of Aloe vera gel extract in streptozotocin-induced diabetes in rats. Pharmacol Rep 2005;57:90-6. PUBMED
30. Anarthe R, Mani A, Kale P, Maniyar S, Anuraga S. Herbal approaches in periodontics. Galore Int J Health Sci Res 2017;2:18-25.
31. Jain S, Rathod N, Nagi R, Sur J, Laheji A, Gupta N, et al. Antibacterial effect of aloe vera gel against oral pathogens: an in-vitro study. J Clin Diagn Res 2016;10:ZC41-4. PUBMED | CROSSREF
32. Bhat G, Kudva P, Dodwad V. Aloe vera: nature's soothing healer to periodontal disease. J Indian Soc Periodontol 2011;15:205-9. PUBMED | CROSSREF
33. Fakudze NT, Aniogo EC, George BP, Abrahamse H. The therapeutic efficacy of *Punica granatum* and its bioactive constituents with special reference to photodynamic therapy. Plants (Basel) 2022;11:2820. PUBMED | CROSSREF
34. Prasad D, Kunnaiah R. *Punica granatum*: a review on its potential role in treating periodontal disease. J Indian Soc Periodontol 2014;18:428-32. PUBMED | CROSSREF
35. Nirwana I, Rachmadi P, Rianti D. Potential of pomegranate fruit extract (*Punica granatum* Linn.) to increase vascular endothelial growth factor and platelet-derived growth factor expressions on the post-tooth extraction wound of *Cavia cobaya*. Vet world 2017;10:999-1003. PUBMED | CROSSREF
36. Tyagi P, Dodwad V, Kukreja BJ, Kukreja P. A comparison of the efficacy of scaling and root planning with application of pomegranate chip, pomegranate gel, and scaling and root planing in sufferers with adult periodontitis - a prospective study. J Indian Soc Periodontol 2021;25:41-6. PUBMED | CROSSREF
37. Batista ALA, Lins RDAU, de Souza Coelho R, do Nascimento Barbosa D, Moura Belém N, Alves Celestino FJ. Clinical efficacy analysis of the mouth rinsing with pomegranate and chamomile plant extracts in the gingival bleeding reduction. Complement Ther Clin Pract 2014;20:93-8. PUBMED | CROSSREF
38. Kumar A, Kumar Giri A, Kattel B. Herbal home remedies for toothache during the COVID-19 pandemic: a review. Himal J Heal Sci 2021;6:18-29. CROSSREF
39. Sunil MA, Sunitha VS, Radhakrishnan EK, Jyothis M. Immunomodulatory activities of *Acacia catechu*, a traditional thirst quencher of South India. J Ayurveda Integr Med 2019;10:185-91. PUBMED | CROSSREF
40. Singh E, Sharma S, Dwivedi J, Sharma SK. Diversified potentials of *Ocimum sanctum* Linn (tulsi): an exhaustive survey. J Nat Prod Plant Resour 2012;2:39-48.

41. Mondal S, Mirdha BR, Mahapatra SC. The science behind sacredness of tulsi (*Ocimum sanctum* Linn.). Indian J Physiol Pharmacol 2009;53:291-306. PUBMED

42. Gupta D, Bhaskar DJ, Gupta RK, Karim B, Jain A, Singh R, et al. A randomized controlled clinical trial of *Ocimum sanctum* and chlorhexidine mouthwash on dental plaque and gingival inflammation. J Ayurveda Integr Med 2014;5:109-16. PUBMED | CROSSREF

43. Mallikarjun S, Rao A, Rajesh G, Shenoy R, Pai M. Antimicrobial efficacy of Tulsi leaf (*Ocimum sanctum*) extract on periodontal pathogens: an *in vitro* study. J Indian Soc Periodontol 2016;20:145-50. PUBMED | CROSSREF

44. Pulikottil SJ, Nath S. Potential of clove of *Syzygium aromaticum* in development of a therapeutic agent for periodontal disease: a review. South Afr Dent J 2015;70:108-15.

45. Mohammadi Nejad S, Özgüneş H, Başaran N. Pharmacological and toxicological properties of eugenol. Turk J Pharm Sci 2017;14:201-6. PUBMED | CROSSREF

46. Wei H, Kong S, Jayaraman V, Selvaraj D, Soundararajan P, Manivannan A. *Mentha arvensis* and *Mentha* × *piperita*-vital herbs with myriads of pharmaceutical benefits. Horticulturae 2023;9:1-17. CROSSREF

47. Dommisch H, Kuzmanova D, Jönsson D, Grant M, Chapple I. Effect of micronutrient malnutrition on periodontal disease and periodontal therapy. Periodontol 2000 2018;78:129-53. PUBMED | CROSSREF

48. Warad SB, Kolar SS, Kalburgi V, Kalburgi NB. Lemongrass essential oil gel as a local drug delivery agent for the treatment of periodontitis. Anc Sci Life 2013;32:205-11. PUBMED | CROSSREF

49. Hattarki SA, Pushpa SP, Bhat K. Evaluation of the efficacy of green tea catechins as an adjunct to scaling and root planing in the management of chronic periodontitis using PCR analysis: a clinical and microbiological study. J Indian Soc Periodontol 2013;17:204-9. PUBMED | CROSSREF

50. Elgendy EA, Ali SA, Zineldeen DH. Effect of local application of tea tree (*Melaleuca alternifolia*) oil gel on long pentraxin level used as an adjunctive treatment of chronic periodontitis: a randomized controlled clinical study. J Indian Soc Periodontol 2013;17:444-8. PUBMED | CROSSREF

51. Taalab MR, Mahmoud SA, Moslemany RM, Abdelaziz DM. Intrapocket application of tea tree oil gel in the treatment of stage 2 periodontitis. BMC Oral Health 2021;21:239. PUBMED | CROSSREF

52. Singh N, Puzhankara L, Kedlaya MN, Ramanarayanan V. Effectiveness of tea tree oil versus chlorhexidine in the treatment of periodontal diseases: a systematic review. Evid Based Dent. Forthcoming 2022. PUBMED | CROSSREF

53. Sandhya R. Herbal products as mouthwash – a review. Int J Sci Res 2017;6:1334-7.

54. Bayan L, Koulivand PH, Gorji A. Garlic: a review of potential therapeutic effects. Avicenna J Phytomed 2014;4:1-14. PUBMED

55. Sasi M, Kumar S, Kumar M, Thapa S, Prajapati U, Tak Y, et al. Garlic (*Allium sativum* L.) bioactives and its role in alleviating oral pathologies. Antioxidants (Basel) 2021;10:1847. PUBMED | CROSSREF

56. Zini A, Mann J, Mazor S, Vered Y. Beneficial effect of aged garlic extract on periodontitis: a randomized controlled double-blind clinical study. J Clin Biochem Nutr 2020;67:297-301. PUBMED | CROSSREF

57. Tadikonda A, Pentapati KC, Urala AS, Acharya S. Anti-plaque and anti-gingivitis effect of papain, bromelain, miswak and neem containing dentifrice: a randomized controlled trial. J Clin Exp Dent 2017;9:e649-53. PUBMED | CROSSREF

58. Yaghini J, Shahabooei M, Aslani A, Zadeh MR, Kiani S, Naghsh N. Efficacy of a local-drug delivery gel containing extracts of *Quercus brantii* and *Coriandrum sativum* as an adjunct to scaling and root planing in moderate chronic periodontitis patients. J Res Pharm Pract 2014;3:67-71. PUBMED | CROSSREF

59. Gościniak A, Paczkowska-Walendowska M, Skotnicka A, Ruchała MA, Cielecka-Piontek J. Can plant materials be valuable in the treatment of periodontal diseases? practical review. Pharmaceutics 2021;13:2185. PUBMED | CROSSREF

60. Tsubanova NA, Zhurenko DS, Sakharova TS. Research of the influence of a new gel which contains extract of oak bark and aloe extract on the mucous membrane of oral cavity under the conditions of experimental stomatitis. Klìnìčna Farm 2018;22:4-10. CROSSREF

61. A TN, S ZD. A pharmacodynamic study of a new gel containing an extract of Aloe vera and an extract of oak bark for potential treatment of periodontal diseases. Ceska Slov Farm 2020;69:143-8. PUBMED

62. Clark DT, Gazi MI, Cox SW, Eley BM, Tinsley GF. The effects of *Acacia arabica* gum on the *in vitro* growth and protease activities of periodontopathic bacteria. J Clin Periodontol 1993;20:238-43. PUBMED | CROSSREF

63. Imran M, Rauf A, Shah ZA, Saeed F, Imran A, Arshad MU, et al. Chemo-preventive and therapeutic effect of the dietary flavonoid kaempferol: a comprehensive review. Phytother Res 2019;33:263-75. PUBMED | CROSSREF

64. Abdo O, Abdelgawad N, Attia M, Mahmoud A, Gawish A. Efficacy of moringa leaf extract in management of bone healing after implant placement. Al-Azhar J Dent 2021;8:657-65. CROSSREF

65. Muthuraman A, Sood S, Singla SK. The antiinflammatory potential of phenolic compounds from *Emblica officinalis* L. in rat. Inflammopharmacology 2011;19:327-34. PUBMED | CROSSREF

66. Grover S, Tewari S, Sharma RK, Singh G, Yadav A, Naula SC. Effect of subgingivally delivered 10% *Emblica officinalis* gel as an adjunct to scaling and root planing in the treatment of chronic periodontitis - a randomized placebo-controlled clinical trial. Phytother Res 2016;30:956-62. PUBMED | CROSSREF

67. Amaliya A, Risdiana AS, Van der Velden U. Effect of guava and vitamin C supplementation on experimental gingivitis: a randomized clinical trial. J Clin Periodontol 2018;45:959-67. PUBMED | CROSSREF

68. Rayyan M, Terkawi T, Abdo H, Abdel Azim D, Khalaf A, AlKhouli Z, et al. Efficacy of grape seed extract gel in the treatment of chronic periodontitis: a randomized clinical study. J Investig Clin Dent 2018;9:e12318. PUBMED | CROSSREF

69. Toker H, Balci Yuce H, Lektemur Alpan A, Gevrek F, Elmastas M. Morphometric and histopathological evaluation of the effect of grape seed proanthocyanidin on alveolar bone loss in experimental diabetes and periodontitis. J Periodontal Res 2018;53:478-86. PUBMED | CROSSREF

70. Gambhir RS. Herbal formulations: the next level in oral care. Int J Green Pharm 2016;10:S114. CROSSREF

71. Szyszkowska A, Koper J, Szczerba J, Pulawska M, Zajdel D. The use of medicinal plants in dental treatment. Herba Pol 2010;56:97-107.

72. Abreu AC, McBain AJ, Simões M. Plants as sources of new antimicrobials and resistance-modifying agents. Nat Prod Rep 2012;29:1007-21. PUBMED | CROSSREF

73. de Oliveira RC, Costa CA, Costa NL, Silva GC, de Souza JA. Effects of *Curcuma* as an adjunct therapy on periodontal disease: a systematic review and meta-analysis. Complement Ther Clin Pract 2021;45:101493. PUBMED | CROSSREF