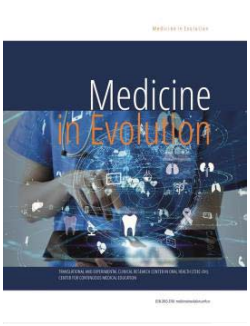
The implications of phytotherapy in the management of periodontal disease



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Abstract

Periodontal disease has a high prevalence worldwide and is estimated to affect up to 90% of the world population. Currently, the attention was directed towards the effects of the herbal extraction in prevention and management of the periodontal disease. Taking into consideration their antimicrobial activity and immunomodulatory action, plant extracts can influence the treatment outcome. This review aims to provide an overview of the implications of different herbal extracts as adjuvant therapy and the outcome of the cases compared to standard controls. By integrating the herbal plant extracts and essential oils into different oral hygiene products as well, the first signs of inflammation can be controlled. The results highlighted an important antimicrobial action upon the most common pathogens of the periodontal disease, offering important advantages in the management of this disease.

Keywords: phytotherapy; plant extracts; periodontal disease; adjuvant therapies

INTRODUCTION

The periodontal disease is an infectious disease of the oral tissue that induces an inflammatory response. It is described as an inflammation determined by a various microorganism, host mediated, that has as a result the loss of periodontal attachment. Periodontal tissues include the structures surrounding the tooth, such as the gingiva, alveolar process mucosa, alveolar bone, periodontal ligament, and root cementum. The periodontium supports the tooth, protects against oral microflora and makes it possible to attach it to the jawbone. The inflammatory process leads to loss of connective tissue and alveolar bone, resulting in loss of bone support and thus causing pathological tooth mobility.

Defining the periodontal health is very important if we want to have a common point of reference for evaluating periodontal disease and determining meaningful treatment outcomes. Health can be analyzed on a general or clinical level and must be considered both as a preventive starting point and as a therapeutic endpoint [2]. Thus, periodontal health may exist before the onset of disease, but conversely, periodontal health may be restored to an anatomically reduced periodontium [2]. Periodontal diseases can no longer be considered simple bacterial infection. Rather, these are complex diseases of a multifactorial nature involving an interplay between the subgingival microbiome, the host's immune and inflammatory response, and environmental modifiers thus, periodontal health should not be considered solely in the context of plaque/bacteria levels and control but must embrace a systemic analysis and evaluation of all the factors responsible for the onset of disease, as well as the restoration and maintenance of health [3,4].

Phytotherapy is a field of medicine that uses plants either to treat disease or as health promoting agents. It is often mentioned in Western medicine, due to the increased level of vegetation with beneficial properties. The traditional use of phytotherapies usually preserves the original composition and integrity of the original plant, so that it is used for medicinal purposes either the whole plant or only an essential component that undergoes processing with a minimal process of altering the structures and properties. Practitioners and distributors may use either single-herb treatments, as multiple herbs are thought to have complementary properties, or mixtures with non-herbal substances such as minerals and vitamins [5]. Among the most used vegetable agents are the used as active substances in dental medicine and also in periodontal diseases cases are green tea, carotenoids, curcuma (turmeric), vitamin C and vitamin B complex from fruits and vegetables.

Herbal compounds can be a powerful and dominant method for combating the local inflammation caused by periodontitis. The action of the plants is due to the active compounds they contain, so the beneficial effects are potentiated by flavonoids, coumarins, glycosides, phenolic acids, resins, phytoesters, choline, carotenoids, tannins, vitamins, mineral salts (magnesium, iron, lithium) and oils essential. The most popular compounds are flavonoids and essential oils. Depending on these compounds, the plants have different roles: anti-inflammatory, antioxidant, antimicrobial, antihyperglycemic, antifungal and antiedematous [6].

The aim of the present review is to evaluate the reported implications of several herbal compounds in the management of the periodontal disease as an adjuvant therapy, and to quantify the existent results.

Aim and objectives

The purpose of the review is to present the importance of introducing phytotherapy as an adjuvant treatment in the management of the periodontal disease. From the beginning it is relevant to mention that phytotherapy is a complementary treatment. In order to have an

optimal response, it must be associated with a pharmacological or surgical treatment, depending on the patient's periodontal condition. The interest in herbal pharmaceutical preparations is constantly growing, as they are being studied to combat and prevent periodontal diseases. The ideal formula for successful treatment consists of conventional periodontal treatment based on scaling and root planning and adjuvant therapy. The latter containing substances that have antimicrobial, antioxidant, anti-inflammatory properties to reduce plaque and limit the destruction of periodontal tissue caused by the progressive inflammatory process. By presenting these findings, the future treatment of the periodontal disease could be substantially improved by combining all the therapeutical measures.

MATERIAL AND METHODS

Data collection

Electronic databases (MEDLINE-PubMed, EMBASE, Google Scholar, Semantic Scholar, Elsevier and Academia.edu) were searched for relevant articles for the subject of this systematic review. The main inclusion criteria was based on the year of publication, all studies considered are not older than 10 years, thus the publication range is 2014 – 2023. All search results were screened for relevance by titles, abstracts and keywords. Irrelevant records were excluded. Subsequently all full-text articles initially identified were assessed for eligibility based on inclusion and exclusion criteria. Only English language texts that have the full text available were retained for this analysis. Randomized and non-randomized studies on human subjects were included, thus excluding texts based on experimental animal or in-vitro studies, articles of the case series type, letters to editors, comments and abstracts of presentations.

Combinations of terms and keywords were used: periodontitis, periodontal disease, chronic periodontitis, gingival inflammation, phytotherapy and periodontal disease, oral cavity and herbs effect, herbs in dentistry, periodontal regeneration, herbal mouthwash, chlorhexidine and herbal products, natural tooth paste, herbal oral gel, oral care products, oral gels.

The research hypothesis is supported by studies selected based on the PICO (population, intervention, comparison and outcome) technique. The study protocol and inclusion/exclusion criteria were specified in advance. The hypothesis of this study is: Are herbal oral products (mouthwash, toothpaste, gel, chips) effective in patients diagnosed with periodontal disease?

Population: Adult human subjects diagnosed with periodontitis based on clinical examination (probing depth measurement and/or clinical attachment loss, probing bleeding) and/or radiographic evaluation.

Intervention: Use of herbal dental products (mouthwash, toothpaste, gel) before or after subgingival mechanical instrumentation of periodontal pockets by scaling and root planning (SRP)/supragingival scaling (SPD) or without phytotherapeutic treatment.

Control: Use of conventional/non-herbal dental products (mouthwash, toothpaste, gel, chips) or placebo before or after SRP/SPD or no phytotherapeutic periodontal treatment.

Outcome: Periodontal clinical parameters, including measurement of probing depth, gingival inflammation, plaque, bleeding on probing, clinical attachment loss.

Included studies must report on at least one periodontal clinical parameter, including probing depth (PD), clinical attachment loss (CAL), gingival inflammation index (GI) and plaque index (PI).

This systematic review included randomized and non-randomized clinical trials that assessed the effect of any herbal dental products (mouthwash, toothpaste, gel, chips) and compared them with conventional chlorhexidine products or placebo in patients with

periodontitis. These studies also have inclusion criteria for patients: to be examined human subjects diagnosed with untreated chronic periodontitis in the last 6 months, cooperative, who follow the instructions and who want to be monitored over a period of time, the age of the included patients must be at least 18 years old. At the level of periodontal parameters, the following were observed: the existence of at least 15 dental units, the probing depth of at least 4 mm, the attachment loss of at least 3 mm, the presence of inflammation and bleeding on probing.

Data processing

All basic information was centralized in Table 1. Data extraction was performed according to a certain model that followed aspects related to: periodontal parameters examined, adjuvant therapy, treatment information including type of periodontal therapy, adjuvant treatment groups, number of patients, follow-up period and important clinical findings.

RESULTS

After applying the inclusion and exclusion criteria, 28 studies were eligible for this analysis. The main characteristics were presented in Table 1. SRP therapy was associated with the use of herbal products in 23 studies [7,8,9,10,11–22), while in one study adjunctive herbal therapy was initiated one month before SRP was performed of [31]. Other studies included only SPD treatment [6] or no treatment [26,27]. All examined patients were diagnosed with chronic periodontitis. The severity and extent of disease varied between studies. Three studies included patients with generalized chronic periodontitis and severe generalized chronic periodontitis [7,28,25], two studies with mild to moderate chronic periodontitis [29,30], one study with mild to moderate localized chronic periodontitis [8], others with moderate to severe chronic periodontitis [24,22]. A study with chronic periodontitis with residual periodontal pockets after SRP therapy [26] and another in which patients present with grade II furcation lesions [21] are integrated. The follow-up period ranged from one week to three months. Results at one week were presented in 5 studies [28,31,30,10,15] and at three months in 11 studies [7,32,23,9,24,25,12–14,16,19]. The rest of the studies presented results at certain time intervals such as: two weeks, 21 days, one month or 45 days, 6 or even 12 months. Various plaque indices and bleeding indices were used in the included studies. Mainly plaque deposits, bleeding/inflammation and probing depths were reported.

After analyzing the studies [7,31,8,10,22,25,11–22] a considerable improvement of certain initially recorded parameters was found in the subjects who followed an adjuvant herbal therapy compared to the subjects who underwent only SRP therapy with/without placebo effect substances.

All included studies reported significant differences in favor of herbal products compared to placebo or no adjuvants. There are two comparative clinical studies that reported no differences between the parameters of the two groups of subjects: SRP ± placebo and SRP + phytotherapeutic substances. They analyzed the effect of Liquorice (licorice) mouthwash and Salvia Officinalis gel [10,15]. However, Salvia Officinalis has an influence on the immunological indices, which after the second application of the gel had a significant decrease [15].

Table 1. Table 2: BOP: Bleeding on probing; CAL: Clinical Attachment Loss; CHX: Chlorhexidine; GI: Gingival index; PI: Plate Index; PD: Probing depth; SPD: supragingival scaling; SRP - Scaling and Root planning (subgingival scaling and root planing); MTC: Matricaria chamomilla - chamomile; Punica granatum, Piper nigrum - pomegranate, black pepper; Salix alba, Malva sylvestrais and Althaea officinalis - white willow, forest mallow, big mallow; Triclosan - antimicrobial and antifungal organic compound; Ocimum sanctum - holy basil, tusli; Camellia synesis - green tea; Nigella sativa - black cumin; Licorice - licorice; Lemongrass - lemon grass; Platango

lanceolata – narrow plantain; Emblica officinalis - Indian currant; Plant extract - Mimusops elengi, Acacica arabica, Punica granatum (pomegranate); Quercus bratii and Coriandrum sativum - oak bratii and coriander; Alendronate – medicine for treating osteoporosis; Metformin – antidiabetic drug

Reference	Parameters	Adjuvant therapy	Subjects/Groups	Surveillance	Conclusions
[7]	PI, GI, BOP, PD, CAL	Mouthwash	Total subjects= 75 A. 25 = SRP + 1% Matricaria chamomilla (MTC) B. 25 = SRP + 0.12% CHX C. 25 = SRP + placebo	6 weeks, 3 months	MTC has a significant higher effect that the placebo and comparable effect to CHX.
[8]	PI, GI, BOP, PD, CAL	Mouthwash	Total subjects = 45 A. 15 = SRP + 5% green tea B. 15 = SRP + 0.12% CHX C. 15 = SRP	30 days	The green tea has influenced all the parameters compared to CHX and SRP.
[9]	PI, GI, BOP, PD, CAL	Mouthwash	Total subjects = 90 A. 30 = SRP + Triphala B. 30 = SRP + Bakul C. 30 = SRP + CHX	2, 4, 6, 8, 12 weeks	Triphala has the most significant plaque reduction result at 3 months compared to CHX and Bakul
[10]	PI, GI	Mouthwash	Total subjects = 30 A. 15 = SRP + Sweet wood mouthwash B. 15 = SRP	1 week	There is a decrease in plaque and gingival inflammation, but no significant differences between SRP and SRP + licorice mouthwash.
[11]	PI, GI, PD	Subgingival gel	Total subjects = 20 A. 10 = SRP + Aloe vera B. 10 = SRP + distilled water	1, 2 months	PI improved in both groups. Aloe vera gel administration significantly improved GI and PD.
[12]	PI, GI, BOP, PD, CAL	Subgingival gel	Total subjects = 46 A. 23 = SRP + 10% Emblica officinalis B. 23 = SRP + gel placebo	2, 3 months	E. officinalis produces a significantly greater improvement in patients with chronic diseases. There is therapeutic potential to help treat chronic periodontitis.
[13]	PI, GI, PD, CAL	Subgingival gel	Total subjects = 30 A. SRP B. SRP + CHX gel C. SRP + plants gel (Mimusops elengi, Acacia arabica and Punica granatum) D. CHX E. Plants gel	1, 3 months (gel application at every 10 day in a month)	SRP + any gel causes a significant reduction in clinical parameters, compared to SRP. The results of groups B and C are similar, so the herbal gel can be considered as a good adjunctive treatment for chronic periodontitis.
[14]	PI, BOP, PD, CAL	Subgingival gel	Total subjects = 18 A. 9 = SRP + gel: 20% Quercus brantii şi 1% Coriandrum sativum B. 9 = SRP + gel placebo	1, 3 months	The results in group A were improved compared to those in B, but no significant benefit was observed. It is possible that by increasing the concentration and repeating the consumption, significant effects can

Reference	Parameters	Adjuvant therapy	Subjects/Groups	Surveillance	Conclusions
					be observed.
[15]	PI, GI, BOP, PD	Subgingival gel	Total subjects = 14 Nr. Periodontal pockets= 28 A. SRP + gel Salvia officinalis B. SRP	1 week, 1 month	S. officinalis gel has an anti-inflammatory potential observed by monitoring clinical and immunological parameters. The effect accentuated at the 2nd application by the significant decrease of the immunological indices.
[16]	PI, GI, PD	Subgingival gel	Total subjects = 30 A. SPR B. SRP+ Aloe vera gel	1, 3 months	Aloe vera gel improves the periodontal condition. The role is beneficial, without side effects, but requires more studies to certify the antimicrobial, anti-inflammatory properties.
[17]	PI, GI, PD, CAL	Subgingival gel	Total subjects = 30 A. SRP B. SRP + Curcuma gel	1 month	PD is reduced in group B compared to group A, due to the anti-inflammatory effect of turmeric. This plant produces tissue re-epithelialization and neovascularization. The CAL values are not different.
[18]	PI, BOP, PD, CAL	Subgingival gel	Total subjects = 40 A. 20 = SRP B. 20 = SPR + Curcuma gel	1. 2 months	Improvements in PI, BOP, PD in group B. There were no significant differences in CAL.
[19]	PI, GI, PD, CAL	Chips with plant extracts	Total subjects = 30 A. SRP + Cip cu Neem B. SRP+ Cip cu Turmeric C. SRP + Cip placebo	1, 3 months	After 1 month the results were visibly improved in the case of groups A and B compared to C. The results of the parameters after 3 months look the same as those observed after one month. Long-term effects are debatable.
[20]	PI, GI, BOP, PD, CAL	Subgingival gel	Total subjects = 15 A. SRP B. SRP + Curcuma gel C. SRP + 10% Tusli gel	1 month	GI, PD, CAL values improved in group B and C compared to A. Tusli gel shows significant reduction in BOP, PD and CAL and Curcuma gel influences PI and GI. Tusli has antimicrobial properties and

Reference	Parameters	Adjuvant therapy	Subjects/Groups	Surveillance	Conclusions
					turmeric has an effect against plaque itself.
[21]	PI, BOP, PD, CAL	Subgingival gel	Total subiecți = 90 A. 30 = SRP + placebo B. 30 = SRP + Alendronat 1% C. 30 = SRP + Aloe vera gel	6, 12 months	All parameters improved semi-significantly in groups B and C compared to A.
[22]	GI, BOP, PD, CAL	Subgingival gel	Total subiecți = 90 A. 30 = SRP + placebo B. 30 = SRP + Aloe vera gel C. 30 = SRP + Metformina 1%	6, 12 months	In groups B and C, the parameters show a statistically significant change, compared to group A. Metformin has the best effect on PD and CAL, but aloe vera also shows considerable improvements compared to the placebo gel.
[23]	PI, BOP, PD	Subgingival irrigation with solution	Total subjects = 30 A. 15 = Punica granatum Linn., Piper nigrum Linn B. 15 = 0,2% CHX (one month before SRP)	2, 4, 8, 12 weeks	Irrigation with plant extract solutions has a significant effect upon reducing the dental plaque. CHX has a significant effect in reduction of gingival inflammation.
[24]	PI, BOP, PD, CAL	Mouthwash	Total subjects = 40 A. 20 = SPD + plante mouthwash (Propolis, Salvia officinalis, Platango lanceolata and essential oils) B. 20 = SPD + mouthwash placebo	12 weeks	The herbal mouthwash showed a significant decrease in the bleeding score and plaque build-up.
[25]	PD, CAL	Mouthwash	Total subjects = 45 A. 15 = SPD + lemongrass mouthwash B. 15 = SPD + CHX mouthwash C. 15 = SPD	12 weeks	Mouthwash with lemongrass oil can be a good alternative in chronic periodontitis. Significantly increased effect on PD, CAL in the group that used plants and CHX compared to SPD.
[26]	PI, BOP, PD	Mouthwash	Total subjects = 50 A 25 = Herbal (hidro-alcoholic extract of Scrophularia striata) Mouthwash B. 25 = Irsha mouthwash (Listerine), without periodontal treatment	2,4 weeks	Herbal extract mouthwash has a better effect on chronic periodontitis compared to Irsha mouthwash.
[27]	GI, PI, BOP	Mouthwash	Total subiecți = 60 A. 15 = Aloe vera + ceai verde B. 15 = Matrica chamomilla C. 15 = CHX D. 15 = Placebo	2 weeks	Indices in the placebo group did not change. All other substances improved clinical parameters after administration. GI and IP significantly

Reference	Parameters	Adjuvant therapy	Subjects/Groups	Surveillance	Conclusions
					changed in groups A and C compared to B. Between A and C there are no significant differences.
[28]	PI, GI	Mouthwash	Total subjects = 50 A. 25 = SRP + triphala B. 25 = SRP + 0.2% CHX	7, 30, 45 days	Triphala mouthwash has a reduction effect upon the dental plaque, and gingival inflammation. It proved to be more efficient than SRP+CHX.
[29]	PI, GI, BOP, PD, CAL	Toothpaste	Total subjects = 30 A. 15 = SRP + green tea B. 15 = SRP + triclosan solution	4 weeks	Green tea use was associated with a higher influence in the gingival inflammation reduction and CAL.
[30]	PI, GI, BOP, PD, CAL	Mouthwash	Total subjects = 40 A. 20 = SRP + 0.05% green tea B. 20 = SRP + 0.2% CHX	7 and 21 days	Green tea was more efficient than CHX at three weeks.
[31]	PI, GI, BOP, PD, CAL	Subgingival irrigation with solution	Total subjects = 30 Nr. Periodontal pockets A. 180 = SRP + extract of S. lappa B. 180 = SRP + 0.2% CHX C. 180 = SRP	7, 14, 28, 42 days	S. lappa irrigation showed benefits compared to SRP. S. lappa and CHX showed similar results and S. lappa had a higher effect upon the 4-5 mm periodontal pockets.
[32]	PI, GI, PD, CAL	Subgingival irrigation with solution	Total subjects = 30 Nr. Periodontal pockets A. 15 = SRP + 4% Ocimum sanctum B. 15 = SRP + 0.2% CHX	30 days	Ocimum sanctum irrigation showed similar benefits as CHX upon the gingival inflammation reduction and plaque reduction.CHX had a superior effect in PD, CAL reduction.
[34]	PI, GI, BOP, PD, CAL	Mouthwash	Total subjects = 30 A. 15 = SRP + Nigella sativa B. 15 = SRP + saline solution,	2 weeks	Nigella sativa and the saline solution had beneficial effects. There were no significant differences between the 2 administered solutions.

Plant-based substances acted only on some specific parameters, others not registering significant differences. However, after analyzing the groups of subjects subjected to SRP/SPD and SRP/SPD + phytotherapy, the reduction of periodontal parameters is significant in the groups in which adjuvant therapy was also administered.

The effects of the various adjunctive therapies that accompanied the basic periodontal treatment were compared in Table 4. Mainly it was aimed to record the results collected from certain groups of subjects, more precisely the groups of patients who followed SRP/SPD + chlorhexidine therapy and those in which patients underwent SRP/SPD + phytotherapy.

Most of the studies did not record significant differences between the two adjuvant therapies, at the level of the researched parameters [7,32,25,13]. Mouthwashes with extracts of Matrica chamomilla, Althea officinalis, Slix alba, Malva sylvestrais and Lemongrass oil had an influence similar to chlorhexidine on periodontal elements. As in the case of the previously exposed plant products, the gel from plants (Mimusops elegi, Acacia arabica and Punica granatum) administered subgingival, had similar results to CHX [13].

Effects of gels with subgingival administration

Subgingival delivered gel has been shown to be effective in 11 studies [11–22]. They highlighted the fact that all the parameters measured and compared between the groups of patients, treated by conventional periodontal therapy with or without the administration of placebo substances and those under conventional periodontal treatment supported by adjuvant phytotherapy, were considerably improved thanks to the plants. Four studies based on Aloe vera gel [11,16,21,22] and three on Curcuma gel [17,18,20] recorded semi-effectively increased beneficial effects, the analysis being done, after the SRP, between the group test and control group (placebo). Aloe vera gel did not cause allergic reactions. The result of the other gels was variable. Gels of Quercus barntii and the plants Mimusops elengi, Acacia arabica and Punica granatum positively influenced probing depth and loss of ligamentous attachment [12,13]. Conversely, Coriandrum sativum and Salvia officinalis did not show significant changes [14,15].

Effects of mouthwash

Herbal extract mouthwash was found in 12 studies, plants such as Matrica chamomilla (28), Althaea officinalis, Salix alba and Malva Silvestris extract [7], Triphala [28,9], green tea (30, 8), Nagilla sativa [10], Scrophularia striata [26], Liquorice [10], Propolis, Salvia officinalis, Platango lanceolata and essential oils [11], Lemongrass [25]. The measured parameters showed significantly improved values in the test patients compared to those in the patients belonging to the control group. These results being as good as those obtained following the administration of CHX mouthwashes (7, 28).

The comparison of adjuvant therapy based on green tea mouthwash and triclosan mouthwash had positive results in favor of green tea administration. Gingival index and probing bleeding were reduced, and a gain in attachment was observed in the test patient group. This may be attributed to the anti-inflammatory and antioxidant properties of green tea [29]. The previously mentioned features positively influenced the measured parameters, the results being significantly improved compared to the administration of chlorhexidine mouthwash [30,8].

The administration of liquorice mouthwash was analyzed over a short period of time and in a small sample of people. The reduction in plaque and gingival index were insignificant in the test group compared to the control group. However, it is believed that licorice mouthwash can be a safe and natural substitute for chlorhexidine. Over time, chlorhexidine caused adverse reactions, and patients did not like the taste either [10].

Effects of other pharmaceutical forms of administration

Solutions for subgingival irrigation with extract of S. lappa [31], Ocimum sactum [32], recorded positive effects on the periodontium, similar to those obtained following the administration of the CHX solution. In the case of the compound with Punica gratum Linn and Piper nigrum Linn, the results are slightly different, so that chlorhexidine registers significant changes, with statistical significance [24].

Applying Neem and Turmeric chips subgingival, more precisely inside the periodontal pocket, then stabilizing them by covering the gingiva with periodontal cement to protect postoperative wounds (coe-pak), demonstrated its effectiveness by decreasing all recorded parameters. It should be noted that the long-term effects are debatable, since the results of the parameters after one month are the same as those measured after 3 months [19].

The toothpaste showed a significant reduction in gingival inflammation and periodontal attachment loss compared to toothpaste containing triclosan. This may be attributed to the anti-inflammatory and antioxidant properties of green tea [29].

DISCUSSIONS

Periodontal disease is a major public health problem worldwide and is the most common cause of tooth loss. The success of periodontal therapy depends on the treatment of adverse environmental and behavioral factors and the elimination/reduction of pathogenic bacteria. Patients began to become aware of the adverse effects of synthetic antimicrobial products, thus increasing interest in natural substances. Natural phytochemicals can be considered good alternatives. Phytotherapy uses complexes or substances derived from plants, which are homogeneous compounds with a certain chemical structure. Phytotherapeutic agents have various bioactive components, which possess a very good medicinal value with the fewest side effects [26].

The main objective of periodontal therapy is to reduce the microbial load, thus improving clinical parameters. Scaling and root planing have remained the gold standard of periodontal therapy, with numerous other agents currently being used as adjunctive therapeutic modalities [16].

The use of plant extracts in the form of toothpaste, mouthwash, gels, solutions, chips with local administration at the level of the periodontal pockets, has been considered effective for the prevention/treatment of the disease, but also for the periodontal maintenance after SRP/SPD (26).

In the case of using the gel with subgingival administration containing extract of Quercus bratii and Coriandrum sativum, a notable improvement was observed only at the probing depth level. Polyphenols and tannins are the main substances in oak and coriander. They have hemostatic, antibacterial, anti-inflammatory and analgesic activities. Although the use of the herbal gel containing oak and coriander resulted in more improvements in clinical parameters than the placebo gel, these were not considered significant benefits. Thus, emphasis is placed on the major role of SRP as the main method of periodontal treatment. It is possible that by increasing the concentration of the gel, its sustainability or repeated consumption, some significant benefits can be observed [14].

A very good combination that can successfully replace mouthwash with CHX is Aloe Vera with Green Tea. Mouthwash with these plant components showed similar effects to CHX on periodontal structures. Anti-inflammatory, anti-plaque properties and lack of side effects contributed to these conclusions [27]. The antimicrobial property of Emblica offcinalis (Indian gooseberry) fruit is mainly supported by flavoids, phenols and tannins. Phenolic compounds contribute to the relief of acute and chronic inflammation. The test group showed significant results such that probing depth and clinical attachment loss were significantly improved compared to the placebo control group [12].

Another form of productive administration of plants following SRP/SPD is mouthwash. Outcomes among patients who also received adjunctive therapy with green tea or lemongrass extract mouthwash were significantly improved. All monitored parameters were positively influenced by these plant substances [8,25]. The results of the study suggest that lemongrass mouthwash, used as an adjunctive treatment following periodontal treatment, significantly reduced clinical signs. A significant reduction in probing depth and periodontal attachment loss was observed, as were systemic markers of infection. In the study, both antimicrobial and antioxidant activities were achieved with 0.25% lemongrass essential oil. This mouthwash has been shown to be a good herbal alternative to 0.12% chlorhexidine mouthwash, with no significant changes in parameters between the two [25].

Green tea extract mouthwash significantly influenced all periodontal variables compared to chlorhexidine solution [30,8]. Green tea was much more effective, this fact was demonstrated in a control performed three weeks after periodontal therapy [30].

Chamomile mouthwash is used to manage chronic periodontitis due to its antimicrobial, superior healing, anti-inflammatory and immunomodulatory properties. The main mechanism of action is given by the anti-inflammatory property due to apigenin. Chamomilla matrix improves the clinical and microbiological picture of chronic periodontitis [7].

Curcuma, the main yellow bioactive component of turmeric, has been shown to have a broad spectrum of biological actions, such as anti-inflammatory and antibacterial, suggesting its potential for use as a subgingival agent [18]. Studies evaluate the effectiveness of turmeric gel when used with SRP as a topical gel, compared to SRP alone. The results indicated the effect by improving the plaque index, bleeding on probing and probing depth in patients with chronic periodontitis [17,18,20]. There was a slight, but not statistically significant, reduction in the average level of attachment in the test group compared to the control group. This may be due to increased levels of growth factors in the healing tissues; thus re-epithelialization occurs earlier, stimulating neovascularization and collagen production [17,18]. Within the limits of clinical trials, it can be concluded that curcumin gel administered subgingival was effective in reducing plaque, gingival inflammation and subsequently, probing depth. However, longer-term studies are needed to determine the effect of topical application of curcumin gel in improving periodontal attachment [17,18,20].

The presented studies confirmed that plant materials could be successfully used in the management of periodontal diseases. Herbal therapy has a favorable safety profile, with few, if any, side effects compared to conventional agents such as chlorhexidine or the drug substances alendronate and metformin. Adverse reactions are a negative factor on patient adherence to periodontal therapy.

CONCLUSIONS

Herbal extract mouthwashes and gels have been shown to be the most widely used phytotherapeutic pharmaceutical forms in the management of periodontal diseases. They are affordable and easy to integrate into patients' routines. Even after the first month of administration, the gels significantly changed the evaluated periodontal parameters, and the results continued to improve during the follow-up period. Although the effects of the mouthwashes were analyzed after the first week of treatment, statistically significant results were recorded after longer administration.

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