Effectiveness of herbal oral care products in reducing dental plaque and gingivitis: an overview of systematic reviews

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PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Herbal oral care products have attracted a lot of attention from manufacturers, researchers, clinicians, and the public.
- Some studies have shown herbal oral care products to be as effective at preventing plaque and gingivitis as conventional products, but these studies have been of lower quality, biased, and conducted for short periods only.
- Oral health care professionals should exercise caution when recommending herbal dentifrices and mouthrinses to their patients.

ABSTRACT

Introduction: Numerous clinical trials and systematic reviews have investigated the effectiveness of both herbal and conventional oral care approaches to reducing plaque and gingivitis. However, their findings vary and are inconsistent. Thus, the objective of this umbrella review is to compile data from systematic reviews and provide an overview of the effects of herbal oral care products on tooth plaque and gingivitis. **Methods**: A comprehensive search of the literature was performed in 6 databases for systematic reviews with or without meta-analyses, published up to 30 May 2023, without any language restrictions. Only clinical trials comparing herbal oral care products (in the form of mouthrinse or toothpaste) against standard oral care products or placebo were considered. **Results**: Some herbal oral care products, particularly in the form of mouthrinses, have a similar level of positive effect on plaque and gingivitis reduction and, thus, can be used as an adjunct to traditional dentifrices. However, the shorter duration of trials (<4 weeks) and reported publication bias in the clinical trials mean that these findings must be interpreted with caution. **Conclusion**: To accurately determine the impact of various herbal extracts on periodontal health, well-designed, long-term, and controlled trials that adhere to standardized protocols must be carried out.

RÉSUMÉ

Introduction : On a étudié l'efficacité d'approches de soins buccodentaires classiques et à base de plantes pour lutter contre la plaque dentaire et la gingivite dans le cadre de nombreux essais cliniques et revues systématiques. Toutefois, leurs conclusions ont été variables et incohérentes. Cette revue générale vise donc à compiler des données issues de revues systématiques et de présenter un aperçu des effets des produits de soins buccodentaires à base de plantes sur la plaque dentaire et la gingivite. **Méthodes** : On a procédé à une recherche documentaire exhaustive dans 6 bases de données pour effectuer des revues systématiques, avec ou sans méta-analyses, sans aucune restriction relative à la langue de l'étude, publiées avant le 30 mai 2023. Seuls des essais cliniques comparant des produits de soins buccodentaires à base de plantes (sous forme de rince-bouche ou de dentifrice) à des produits de soins buccodentaires classiques ou à des placebos ont été envisagés. **Résultats** : Quelques produits de soins buccodentaires à base de plantes, en particulier les rince-bouches de ce type, ont des effets positifs comparables en matière de réduction de la plaque et de la gingivite et peuvent donc être utilisés en complément des dentifrices ordinaires. Toutefois, ces résultats doivent être interprétés avec prudence du fait de la durée relativement courte des essais (moins de 4 semaines) et du biais de publication signalé dans les essais cliniques. **Conclusion** : Pour déterminer avec précision les effets de divers extraits de plantes sur la santé parodontale, il est nécessaire d'avoir recours à des essais bien conçus, à long terme et contrôlés, qui respectent des protocoles normalisés.

Keywords: dental plaque; gingivitis; herbal; oral health
CDHA Research Agenda category: risk assessment and management

BACKGROUND

Oral health is of prime importance since it has a direct impact on an individual's overall well-being. However, oral health conditions as a consequence of poor oral hygiene remain an overlooked global health concern, affecting 3.5 billion people worldwide.[1] Dental plaque and gingivitis are the most common oral health conditions that, if left untreated, could progress to tooth loss[2] and potentially other systemic disorders such as cardiovascular diseases, rheumatoid arthritis, dementia, and stroke.[3] Recently a role of epigenetic processes involving microRNAs and NT-proBNP in periodontitis was observed that could influence host response against natural agents.[4-6] Thus, effective management and control of dental plaque is an important strategy for overall well-being and quality of life. Self-care efforts or mechanical management of dental plaque with typical oral care products such as toothpaste

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and mouthwash have been demonstrated to be successful in maintaining oral hygiene and preventing plaque formation. Nevertheless, these techniques alone will not prevent gingivitis.

Another approach that might help with eliminating and preventing microbial buildup of plaque is chemical treatment of plaque.[7] Chemical agents such as chlorhexidine (CHX), essential oils, 0.454% stannous fluoride/sodium hexametaphosphate sodium monofluorophosphate, and cetylpyridinium chloride have been shown to have the highest effect on gingivitis reduction.[8,9] However, following continuous usage, these chemical mouthwashes, particularly alcohol-based, such as chlorhexidine and cetylpyridinium chloride, can cause tooth and tongue discolouration, taste disruption, and harmful effects on the oral mucosa.[8,10,11] As a result, the hunt for alternatives persists, and the focus has switched to organic or herbal agents.

In recent years, herbal oral health care products have gained popularity as a result of their perceived efficacy and effectiveness as well as possible natural and holistic advantages for oral hygiene.[2] This growing interest is predicated on the notion that certain plant extracts contain anti-inflammatory, antibacterial, and oxidative properties that may fight against the bacteria causing dental plaque while decreasing inflammation in the gums.[10,12] Thus, a number of oral care product producers and large corporations have added a variety of herbal ingredients to their products, claiming that they mimic the advantages of removal of plaque, breath freshening, and gum disease prevention.[13] These products frequently contain a blend of botanical extracts, essential oils, and other natural components with therapeutic characteristics. The most frequent herbal components mixed into oral care products are akarkara (*Anacyclus pyrethrum*), babool (*Acacia arabica*), haldi (*Curcuma longa*), sanguinarine, propolis, neem (*Azadirachta indica*), charcoal, green tea (*Camellia sinensis*), clove, and miswak.[11-13]

Herbal and conventional oral care approaches have been investigated for their reduction of plaque and gingivitis in numerous clinical trials and systematic reviews. However, the findings reported across these studies vary and are inconsistent.[7,10,13-15] As numerous systematic reviews (SR) and meta-analyses (MA) are available, an umbrella review can detect evidence uncertainty and provide a high-level summary of data, resulting in a balanced and evidence-based evaluation of the effectiveness of herbal oral care products in reducing tooth plaque and gingivitis.

Objective of the study

The objective of this umbrella review is to compile data from systematic reviews to provide an overview of the effects of herbal oral care products on tooth plaque and gingivitis. This review summarizes and synthesizes the findings from published systematic reviews and/or meta-analyses to answer the following question:

"In systemically healthy individuals, do herbal oral care products compared to conventional over-the-counter products exhibit greater efficacy in reducing dental plaque and gingivitis?"

METHODS

Review registration

This umbrella review was conducted in accordance with the *Cochrane Handbook for Systematic Reviews of Interventions*[16] and the *Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)* 2020 statement,[17] as the *Preferred Reporting Items for Overviews of Reviews (PRIOR)* is not fully developed.[18] An a priori protocol for this study was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (Registration Number CRD42022357899 dated 14 October 2022).

This overview of systematic reviews addresses the following research question: "In systemically healthy individuals (P), do herbal oral care products (I) compared to conventional over-the-counter products (C) exhibit greater efficacy in reducing dental plaque and gingivitis (O)?"

- P (Population): Participants of any age group (free from any systemic illnesses)
- I (Intervention): Herbal oral care products (either toothpaste or mouthrinse)
- C (Comparison): Over-the-counter (OTC) non-herbal oral care products (fluoride toothpaste, non-fluoride/non-herbal toothpaste, CHX mouthrinse or non-herbal mouthrinse)
- O (Outcomes): Reduction in dental plaque levels or gingival inflammation

Data source and search strategy

The following online databases were searched to retrieve systematic reviews irrespective of meta-analyses: Scopus, PubMed, Embase, Allied and Complementary Medicine Database, Complementary and Alternative Medicine (CAM), and Cochrane Central Register of Controlled Trials. Two independent reviewers (VM and AM) searched the repositories using medical subject heading (MeSH) terms and keywords. Articles published up to May 30, 2023, were retrieved; there were no language restrictions. Boolean operators were used for combining the following search terms:

1. "herbal" OR "herb*"
2. "Hygiene, Oral" OR "Dental Hygiene" OR "Hygiene, Dental" OR "Dentifrice" OR "Mouth Rinse" OR "Mouth Rinses" OR "Rinse, Mouth" OR "Rinses, Mouth" OR "Mouth Bath" OR "Bath, Mouth" OR "Mouth Baths" OR "Mouth Wash" OR "Wash, Mouth"
3. "Indices, Dental Plaque" OR "Dental Plaque Indexes" OR "Dental Plaque Indices" OR "Index, Dental Plaque"
4. "Gingival Index" OR "Gingival Indices" OR "Index, Gingival" OR "Indices, Gingival" OR "Gingival Indexes" OR "Indexes, Gingival"
5. Systematic review OR Meta-analysis

Inclusion and exclusion criteria

The retrieved citations were evaluated; duplicates were removed from the database. Two reviewers (VM and AM) separately examined the titles and abstracts of all the systematic reviews with or without meta-analyses discovered via the electronic search. The full texts were then studied and examined for additional inclusion/exclusion criteria. Studies that did not match the inclusion criteria were omitted (Table 1). Any disagreements were settled through conversation among reviewers and consulting a third subject expert. Additionally, the included studies were carefully searched to identify further potentially relevant systematic reviews with or without meta-analyses. In the case of inadequate or missing information, contact was made with the authors.

Study selection and data extraction

The citations found during the search and full-text publications from possibly relevant SRs were evaluated independently by 2 reviewers. Using a standardized form, one reviewer extracted the information in question. Any discrepancies were resolved with a third reviewer after a second reviewer independently assessed the retrieved data. The following information was sought: author(s), year of publication, participants, intervention, comparator, outcome, quality assessment technique, meta-analysis, sample size, SR quality, and findings.

Methodological quality assessment

The Joanna Briggs Institute (JBI) critical assessment checklist for systematic reviews[19] was used to assess the methodological quality of the SRs with or without meta-analysis. There are 11 items on the checklist; each one is worth 1 point. Consequently, a review's overall quality score might range from 0 to 11. The articles in this umbrella review that had scores of 0 to 4, 5 to 7, and 8 to 11 were classified as low-, medium-, and high-quality research, respectively, based on independent evaluation by 2 authors (ST and AM). Discussion and agreement were employed to settle any disputes.

Data synthesis and analysis

The characteristics and methodological integrity of the included SRs were compiled in table form and presented narratively. Moreover, a narrative summary of the results of the natural product intervention was also provided.

Table 1. Eligibility criteria concerning sources, design, and characteristics of the studies

Systematic reviews		
Sources	**Inclusion criteria**	**Exclusion criteria**
Databases	Electronic and manual	None
Language	No restrictions	None
Publication status	Published	None
Publication date	Up to 30 May 2023	No restrictions
Design		
	Systematic reviews exclusively, including RCTs with or without a meta-analysis	Prospective, retrospective, case-control, preclinical in vivo, in vitro studies, as well as conference communications, books and chapters, oral presentations
Characteristics of the studies		
RCTs population	Healthy participants	Participants with systemic disorders
Study sample size	No restrictions	No restrictions
Age	No restrictions	No restrictions
Gender	No restrictions	No restrictions
Intervention		
Route of administration	Either brushed or rinsed	Application of toothpowder
Type of products	Herbal oral care products (either toothpaste or mouthrinse) which had an active herbal ingredient or a natural or plant extract as claimed by the manufacturer	Ayurvedic or proprietary medicine formulation without manufacturers' instructions or absence of active ingredient
Comparison	Active controls using formulations containing non-herbal active ingredients in toothpaste and mouthrinse that were commercially available OTC or manufactured as placebos for the study	Combination of herbal and non-herbal oral care products
Outcome(s)	Reduction in dental plaque and gingivitis	Periodontitis, bleeding on probing

OTC: over the counter; RCTs: randomized controlled trials

RESULTS

Literature search

In total, 371 citations were found through electronic searches across all sources, 48 of which were deleted for being duplicates. The remaining 323 titles and abstracts were located and screened for eligibility (Figure 1). Only 28 of those sources were identified as potentially eligible for full-text screening. Following the review of all 28 full-text articles, 16 studies[7,10,13-15,20-30] met the inclusion criteria.

Study characteristics

Of these 16 studies, 7 were systematic reviews and 9 were systematic reviews with meta-analyses. Table 2 lists the PICO characteristics of the included studies. Moreover, Tables 3, 4, and 5 provide details of demographic characteristics, qualitative and quantitative syntheses of the studies, respectively. The included studies were published between 2014 and 2023, and drew their conclusions from primary research ranging from 2 to 47 randomized controlled trials (RCTs). The average number of databases referenced by the included papers was 3.63±2.00, with PubMed, Cochrane clinical trial registry, and Embase being the most common.

Participants in 8 reviews were healthy people[7,13,14,20,24,25,27,29] while those in 7 studies[10,15,21-23,28,30] had plaque or clinically confirmed gingivitis or biofilm related periodontal conditions in the absence of any other systemic illnesses. Only one study included individuals having fixed orthodontic therapy (OT).[26] The number of participants involved in the included research ranged from 120 to over 3600. Only one study did not disclose the number of participants.[7] The length of the follow-up period in the research ranged greatly, from the shortest duration of 1 hour to the greatest duration of 63 weeks. Manipal et al.[27] didn't report the duration of follow up in included studies.

Summary of intervention

Of the 16 included studies, 11 examined the use of herbal toothpastes or mouthwashes as interventions.[7,10,13-15,20,23,24,26-28] There was significant variability in the herbal constituents of the toothpastes under study. However, some commonly reported herbal ingredients include chamomile (*Matricaria recutita*), neem (*Azadirachta indica*), aloe vera (*Aloe barbadensis*), *Salvoadora persica*, chitosan, *Sanguinaria canadensis L.* extracts, rosmarinus officinalis, triphala, lemon grass (*Cymbopogan citratus*), *Terminalia chebula*, green tea (*Camellia sinensis*), *Zingiber officinale*, *Curcuma longa*, and miswak.[7,10,13-15,20,24,26-28]

Five studies investigated a single herbal ingredient as an intervention.[21,22,25,29,30] Triphala was mentioned as an adjuvant by Aljameel and Almalki.[30] Terby et al.[29] reported

Figure 1. Study selection process

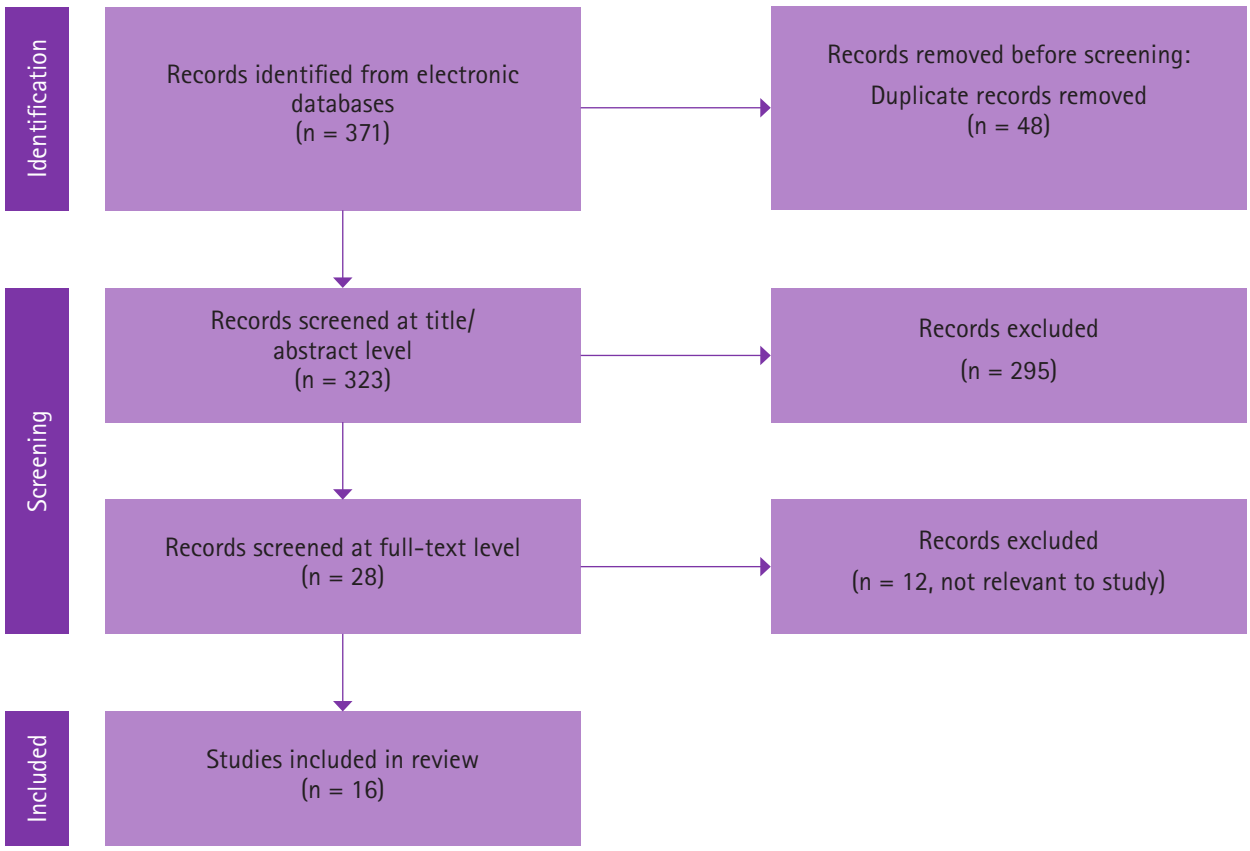

Table 2. PICO of included studies

Study No.	Authors	Participants	Intervention	Comparison	Outcome
1	AlJameel and Almalki (2020)[30]	Humans clinically diagnosed with plaque-induced gingivitis	Triphala mouthrinse	CHX	Primary: GI and/or secondary: PI
2	Cai et al. (2020)[10]	Systematically healthy participants with gingivitis	Application of herbal mouthrinses from botanical sources	Placebo and CHX	Clinical effects of mouthrinses as a supplement to daily oral hygiene (i.e., toothbrushing) on plaque and inflammation control
3	Chen et al. (2014)[20]	Adults with good general health	NCCM used either alone (as a monotherapy) or as an adjunct to another therapeutic agent	Placebo or conventional mouthrinse	PI and/or GI
4	Dhingra (2014)[21]	Patients with gingivitis	Aloe vera herbal dentifrices	Placebo/conventional dentifrices	Effectiveness of aloe vera containing herbal dentifrices in improving plaque control and gingival health
5	Dhingra and Vandana (2017)[22]	Patients with gingivitis	Neem mouthrinses	CHX	Effectiveness of *Azadirachta indica* (neem)-based herbal mouthrinse in improving plaque control and gingival health
6	Furquim Dos Santos Cardoso et al. (2021)[23]	Patients presenting dental plaque, gingivitis, and/or periodontal-associated biofilm disorders, without any physiological restrictions were included	Plant-derived extracts (tinctures, essential oils, hydroalcoholic extracts) incorporated in appropriated pharmaceutical formulations (gels, toothpastes, chewing gums, tablets, powders, mouthwashes, etc.)	CHX, antibiotics, other similar substances or placebo	Changes in PI, gingival bleeding index, GI, volume modified gingival index, bleeding on probing, papillary bleeding index, plaque accumulation, periodontal probing depth, clinical attachment level, microbial colonization, gingival crevicular fluid parameters
7	Ingle (2021)[24]	Healthy adults	Herbal formulation	Conventional mouthwashes or CHX	PI and/or GI
8	Janakiram et al. (2020)[13]	Healthy adults	Herbal toothpastes or mouth rinses; chamomile (*Matricaria recutita*), neem (*Azadirachta indica*), Aloe vera (*Aloe barbadensis*), calendula (*Calendula officinalis*), *Salvoadora persica*, chitosan, ajamoda satva (*Apium graveolens*), pepper-rosmarin (*Lippia sidoides*), and vaikrantha bhasma (*Dolichos biflorus*)	OTC non-herbal oral care products (fluoride toothpaste, non-fluoride/non-herbal toothpaste, CHX mouthrinse or non-herbal mouthrinse)	1. Mean reduction in plaque measured by Silness and Loe plaque index or modified Quigley Hein plaque index; 2. Mean reduction of gingival inflammation by Loe and Silness gingival index; 3. Short-term effects (studies with 4-week follow-up acceptability range ±3 days) 4. Long-term effects (studies with 12-weeks follow-up acceptability range ±3 days)
9	Jassoma et al. (2019)[25]	Healthy individuals	*Salvoadora persica* mouthrinse	CHX	Decrease in the mean plaque score and cariogenic bacterial counts
10	Javed et al. (2023)[15]	Patients diagnosed with established gingivitis and otherwise having no oral or systemic disease	Herbal or ayurvedic toothpaste, toothpowder, gel, mouthrinse with or without mechanical use of the toothbrush, floss, etc.	Negative placebo, control having CHX or any other antiseptic compound, and conventional toothpaste or mouthrinse not containing any herbal or botanical component as a constituent	PI, GI
11	Kommuri et al. (2022)[26]	Patients undergoing fixed OT	Herbal mouthrinses	CHX mouthrinses	Efficacy of herbal versus CHX mouthrinses in oral hygiene maintenance in patients undergoing fixed OT remains debatable

Table 2. *Continued*

Study No.	Authors	Participants	Intervention	Comparison	Outcome
12	Manipal et al. (2016)[27]	Healthy human subjects	Herbal mouthrinse	CHX	Effect of 2 broad categories of mouthrinses: CHX and herbal
13	Mehta et al. (2018)[14]	Healthy adults	Herbal dentifrices	Conventional dentifrices	PI and/or GI
14	Santi et al. (2021)[28]	Systemically healthy adults, ≥18 years, with a diagnosis of gingivitis	Mouthrinse with herbal products (*Camellia sinensis, Azadirachta indica, Anacardium occidentale Linn, Schinus terebinthifolius,* and *Curcuma longa*)	Conventional mouthrinses	Dental plaque and/or gingival inflammation reductions as measured by plaque score and bleeding on probing Potential side/adverse effects
15	Suresh et al. (2021)[7]	Healthy adults	Herbal toothpastes	CHX or fluoride toothpaste	PI and/or GI
16	Terby et al. (2021)[29]	Adults >18 years	Curcumin topical gels, local delivery gels, chips, mouthrinses, and subgingival irrigation	CHX mouthrinse, CHX chips, CHX gel, saline, ornidazole gel, metronidazole gel	Reduction in gingival inflammation, plaque scores, and periodontal pocket depth

CHX: chlorhexidine; GI: gingival index; NCCM: natural component containing mouthrinses; PI: plaque index

using curcumin as an intervention in a variety of ways (gel, subgingival irrigants, chips or mouthwash). Dhingra[21] reported on herbal dentifrices with aloe vera as an active component. *Azadirachta indica* (neem) mouthrinses were studied by Dhingra and Vandana.[22] *Salvoadora persica* mouthwash was also mentioned as an intervention by Jassoma et al.[25]

Summary of findings

Systematic reviews

The main findings of the systematic reviews varied due to differences in the intervention investigated. Participants in half of the studies were healthy people, while those in the other half had plaque or clinically confirmed gingivitis or biofilm-related periodontal conditions in the absence of any other systemic illnesses. Dhingra[21] showed that in patients with gingivitis, aloe vera herbal dentifrices are just as effective—if not more so—than a placebo or traditional dentifrices at reducing plaque and gingival irritation. However, reliable inferences cannot be drawn due to the data's intrinsic poor quality and significant bias likelihood. Another comprehensive analysis of the effectiveness of neem mouthrinse discovered no notable difference in the reduction of plaque and gingival inflammation in gingivitis patients when administered as an alternative to toothbrushing over the course of 4 weeks.[22] Similarly, Chen et al.[20] and Ingle[24] found that there were no appreciable differences in plaque or gingival inflammation between the test and control groups, proving that the efficacy of herbal formulations is comparable to that of the best available non-herbal formulations.

In contrast, Suresh et al.[7] reported green tea, miswak, *Carica* papaya leaf extract, and *S. baicalensis* toothpastes as effective in reducing plaque, gingivitis, and gingival bleeding. Similarly, Santi et al.[28] found that certain mouthrinses containing herbs such as *Camellia sinensis, Anacardium occidentale Linn, Azadirachta indica, Curcuma longa,* and *Schinus terebinthifolius* reduced dental plaque and gingival irritation more effectively than CHX. Furthermore, in another study, *Camellia sinensis* was found to have the greatest positive results in lowering both plaque and gingival indices, and *Azadirachta indica* extracts showed effectiveness similar to CHX.[23] *Ricinus communis* oil decreased microbiological counts and gingival index (GI) scores but failed to surpass the hypochlorite solution, which was used as a replacement therapy for dentures. *Melaleuca alternifolia* oil, in contrast, demonstrated a low reduction in plaque index (PI) scores but no effect on GI scores. Overall, herbal products demonstrated positive effects in reducing plaque and gingival inflammation, although the specific efficacy varied depending on the herb used.

However, due to non-adherence to established scientific protocols for RCTs (e.g., Consolidated Standards of Reporting Trials [CONSORT] guidelines) and the short time of trial evaluation, all of these systematic reviews revealed uncertainty in their results. As a result, future clinical trials should follow rigorous methodological approaches including blinding, parallel study design, and appropriate sample sizes to enable accurate evaluation of treatment differences in order to achieve more consistent results across investigations.

Systematic reviews and meta-analyses

A majority of the systematic reviews and meta-analyses reported similar efficacy of herbal and

Table 3. Demographic characteristics of the included studies

Study ID	No. of trials	Total sample size (N)	Country	Sources	Duration	Follow-up period
AlJameel and Almalki (2020)[30]	7	1270	India, Saudi Arabia	MEDLINE/PubMed, EMBASE, and Cochrane Central Register of Controlled Trials (CENTRAL)	Up to April 2020	2 to 63 weeks
Cai et al. (2020)[10]	11	959	China, Africa, Tibet, Mongolia, Japan, India, Korea, Iran, Myanmar	PubMed, EMBASE, Cochrane Database of Systematic Reviews (CDSR), and CENTRAL	From inception to 22 February 2019	10 days to 24 weeks
Chen et al. (2014)[20]	11	474	India, Germany, Iran	MEDLINE/PubMed, CENTRAL, and EMBASE	Up to Feb 2013	4 to 12 weeks
Dhingra (2014)[21]	2	120 120	Brazil, India	A manual and electronic literature search (MEDLINE and CENTRAL)	Up to July 2012	4 weeks to 24 weeks
Dhingra and Vandana (2017)[22]	3	129	Brazil, India	PubMed, CENTRAL, EMBASE, and manual searching	Search up to February 2015	3 to 4 weeks
Furquim Dos Santos Cardoso et al. (2021)[23]	47	2914	USA, Brazil, Japan, Italy, Australia, India, Germany, Sweden, Thailand, China, Malaysia	MEDLINE, Scopus, Web of Science	1988 to August 30, 2020	7 days to 18 months
Ingle (2021)[24]	18	1190	India, Saudi Arabia	MEDLINE/PubMed, Scopus and Journal of Web	2000 to 2019	3 days to 30 days
Janakiram et al. (2020)[13]	24	1597	India, Iran, USA, Jordan, Brazil, Netherlands	MEDLINE Ovid, EMBASE Ovid, WHO clinical trial register, ClinicalTrials.gov, and Cochrane Library	Inception to June 2018	4-12 weeks
Jassoma et al. (2019)[25]	19	1139	Iraq, Iran, India, Saudi Arabia	MEDLINE/PubMed, CENTRAL, Wiley Online Library, ScienceDirect, and Google Scholar	Up to December 2018	1 day to 2 months
Javed et al. (2023)[15]	41	2810	India, Brazil, Saudi Arabia	PubMed/MEDLINE, CAM-QUEST, and CENTRAL	Up to August 2021	1 hour to 84 days
Kommuri et al. (2022)[26]	8	>400	Not mentioned	MEDLINE/PubMed, EMBASE, OVID Medline, Scopus, ISI Web of Science	Up to August 2021	3 days to 8 weeks
Manipal et al. (2016)[27]	11	445	India	PubMed Central listed studies	2003 to 2014	Not mentioned
Mehta et al. (2018)[14]	10	459	Brazil, India, Yemen, Iran	MEDLINE, CENTRAL, and major journals	Up to September 30, 2017	2 weeks to 6 months
Santi et al. (2021)[28]	20	1887	USA, India, Brazil, Egypt	PubMed/MEDLINE, CENTRAL, EMBASE, Web of Science, Latin American and Caribbean Center on Health Sciences (LILACS/BIREME), Clinical Trials Registry, PROSPERO, The National Dental Trial Registry, US Clinical Trials Registry and grey literature (OpenGrey, CAPES thesis bank and reference lists of the selected studies)	Up to April 2018	14 days to 6 months
Suresh et al. (2021)[7]	7	NA	Germany, Brazil, India, Spain, Sri Lanka	PubMed, Cochrane, LILACS, and Google Scholar	Up to December 2020	21 days to 6 months
Terby et al. (2021)[29]	27	>3600	India	PubMed/MEDLINE, Cochrane Library, and hand searching	Inception to June 2019	2 to 4 weeks

LILACS: Latin American and Caribbean Center on Health Sciences; NA: not applicable

Table 4. Qualitative synthesis

Study Authors	Methodology quality assessment	Quality appraisal	Heterogeneity	Findings
AlJameel and Almalki (2020)[30]	CONSORT statement	4 studies: moderate risk of overall bias 3 studies: overall high risk of bias High risk of bias in the included studies was mainly due to lack of reporting sequence generation and selective reporting. All studies reported the completion of the trial and clear explanation of withdrawals	Significant heterogeneity for both GI and PI was observed between both TRP-MW and CHX-MW groups	All studies showed that TRP administration was significantly effective as compared to CHX in the treatment of plaque-induced gingivitis
Cai et al. (2020)[10]	Cochrane Collaboration's tool	11 studies: low and unclear risk of bias and 2 studies included high risk of bias (failure to blind participants & personnel) 6 studies had a low risk of bias for random sequence generation, 5 provided clear information in terms of allocation concealment	Substantial heterogeneity was observed in those meta-analyses. For herbal vs CHX it was unable to detect the exact sources of heterogeneity within the review due to the limited number of included studies	Significant differences were observed in favour of herbal mouthwashes compared with placebos in both plaque- and inflammation-related indices No significant difference was found between herbal and CHX mouthwashes
Chen et al. (2014)[20]	Center of Evidence-Based Medicine and the Jadad scale	5 studies: low quality, having Jadad scale scores of 2 or less Remaining studies were of relatively high quality, having Jadad scale scores of 3 or more For the "level of evidence" assessment, all of the selected studies were ranked in Level 2b because of their small sample size (no study justified their sample size determination) and low level of study design	Considerable heterogeneity was observed in the demographic background of the participants and in the interventions, regimens, duration, clinical indices, and outcomes of the studies	The clinical outcome parameters included plaque and/or gingival bleeding and/or gingivitis scores
Dhingra (2014)[21]	Cochrane Collaboration's tool	The overall risk of bias was estimated to be "high" for both RCTs as the proportion of information from studies at high risk of bias was sufficient to affect the interpretation of the results	A marked heterogeneity was evident in study characteristics (populations, interventions, outcomes, design, quality, and results), meta-analysis was not performed, and synthesis of data was determined from the evidence tables	The clinical effectiveness of aloe vera herbal dentifrices is not sufficiently defined at present and warrants further investigations based on reporting guidelines of herbal CONSORT statement
Dhingra and Vandana (2017)[22]	Cochrane Collaboration's tool	The overall risk of bias was estimated to be "unclear" across all RCTs.	A marked heterogeneity was evident in study characteristics (population, intervention, regimen and comparison, outcomes, evaluation period, design, quality, and results)	Although the included RCTs showed statistically significant results with respect to efficacy of neem-based mouthrinses, the inherent methodological limitations of these studies warrant their conclusions to be interpreted with great caution
Furquim Dos Santos Cardoso et al. (2021)[23]	Cochrane Collaboration's tools evaluation system	For the trials, 42.5% of the manuscripts had a final score of 3 (n = 20), 31.9% had a score of 4 (n = 15), while 21.3% had a score of 5 (n = 10) and 4.3% a score of 6 (n = 2 trials)	Heterogeneity in drug administration forms (mouthrinse, toothpaste, gel, chewing gum, and powder), patient collection data, standardization of plant extracts, associations among plant extracts, and randomization in every trial	*Camellia sinensis* was the most commonly used species (8 studies), with positive results in reducing both the PI and GI in the form of mouthrinse, toothpaste, and gel. The *Melaleuca alternifolia* oil (5 studies) demonstrated low reduction in PI but important effects on GI scores. *Azadirachta indica* (4 studies) extracts presented efficacy similar to CHX to improve the periodontal parameters, including PI and GI. *Ricinus communis* oil (3 studies), despite reducing microbiological counts and GI, did not prove to be better than the hypochlorite solution, used as an alternative treatment for dentures

Table 4. *Continued*

Study Authors	Methodology quality assessment	Quality appraisal	Heterogeneity	Findings
Ingle (2021)[24]	Cochrane Risk of Bias Tool	Studies were included only if they had low risk of bias, which was independently reviewed by the author	Not mentioned	No significant differences in the outcome parameters evaluated between the test and control group in all studies, proving the efficacy of herbal formulation as similar to that of a gold standard formulation
Janakiram et al. (2020)[13]	Cochrane Collaboration's tool	Among all, allocation concealment or selection bias and blinding of the participants had higher proportions of bias across the studies. Three studies showed low risk of bias, 7 studies had unclear risk and the remainder were high risk	Substantial heterogeneity across the studies	Participants using HTP were more likely to experience a reduction in dental plaque scores during a 4-week period compared to those using NHTP. HTP reduced dental plaque over non-fluoride toothpaste. There was substantial evidence of mean reduction of dental plaque by users of NHMR compared to HMR in 6 studies
Jassoma et al. (2019)[25]	CONSORT 2010 checklist	Studies with scores of 9 or less were considered to be of low quality; studies with scores of 10 to 18 were considered to be of moderate quality; studies with a score of 19 or more were considered to be of high quality. Seven papers were regarded as high quality while the remaining papers were of moderate quality	The heterogeneity observed between studies might have resulted from different methodologies followed, study designs, and small sample sizes in the individual studies. Heterogeneity was overcome using random effects instead of fixed effects analysis	*Salvoadora persica* rinses exhibited strong antiplaque effects
Javed et al. (2022)[15]	Cochrane Collaboration	Most studies had a low risk of bias. Random sequence generation had a low risk of selection bias in 77.2% of trials; allocation concealment had low risk in 65.8% of studies. In 65.8% of trials, blinding of participants and personnel (performance bias) was determined to be low risk. In 62% of trials, blinding of outcome assessment (detection bias) was a low risk. In the reviewed studies, incomplete outcome data (attrition bias) was 77.2%, while selective reporting (reporting bias) was 82.2% low risk. In these studies, the risk of other bias was only 12.65%.	Heterogeneous composition of the ayurvedic preparations	Ayurvedic and herbal dentifrices may help in plaque reduction, gingival inflammation, and bacterial growth
Kommuri et al. (2022)[26]	Cochrane ROB	4 studies: low risk of bias 2 studies: moderate risk 2 studies: high risk	Heterogeneity of I^2= 0% to 65% was identified between CFU, GI, and PI parameters on comparing the parameters before the use of CHX and herbal mouthrinses	Of 8 RCTs, results from 1 RCT favoured CHX and the results from a second RCT favoured herbal mouthrinses. Results from 3 RCTs showed comparable effects for the respective investigated OHM-related parameters. CHX demonstrated higher antimicrobial efficacy against *Streptococcus mutans* (*S. mutans*) in 2 studies; 1 RCT found comparable antimicrobial efficacies
Manipal et al. (2016)[27]	NR	NR	Heterogeneity: χ^2 = 369.01, I^2 =97%; df = 10 ($p < 0.00001$)	Of 11 studies analysed, 4 favoured the use of CHX in comparison with only 2 studies that favoured the effect of herbal extract. The rest of the 5 studies were neutral agreeing to the null hypothesis that there is no difference in the effect of both the mouthrinses

Table 4. *Continued*

Study Authors	Methodology quality assessment	Quality appraisal	Heterogeneity	Findings
Mehta et al. (2018)[14]	Cochrane Collaboration's tool	Random sequence generation, blinding of participants and personnel, and other bias showed more than 50% low risk of bias. Blinding of outcome assessment and incomplete outcome data showed more than 75% low risk of bias. No bias was seen for selective reporting. Allocation concealment showed 50% unclear risk of bias	Plaque intervention test for heterogeneity: $p < 0.00001$, $I^2 = 96\%$; gingivitis test for heterogeneity: $p < 0.00001$, $I^2 = 94\%$	Subgroup analysis for plaque intervention and gingival inflammation in case of long-term (more than 4 weeks and up to 6 months) and short-term effects (minimum of 4 weeks) of herbal dentifrice showed no difference when compared to conventional dentifrice
Santi et al. (2021)[28]	The criteria were adapted and divided into 7 domains	Estimated potential risk of bias was uncertain in most studies. More than 75% of the studies exhibited an uncertain risk with regard to allocation concealment and selective reporting of the outcome. Taking the high and uncertain risk of bias together, 40% to 50% of studies presented selection, performance, and attrition biases	Considerable clinical heterogeneity was found in the interventions. The herbal products used as an intervention involved 17 different types of plants.	Five studies found percent reductions higher than CHX, favouring the herbal product for the outcome of dental plaque. All studies found significant differences favouring the herbal products when compared to placebos in both outcome, plaque index, and gingival inflammation
Suresh et al. (2021)[7]	Cochrane Risk of Bias tool	3 studies: low risk 3 studies: medium risk 1 study: high risk	Due to lack of more clinical studies comparing conventional and herbal dentifrices, the study found heterogeneous outcome variables	As all the studies were RCTs, level of evidence was I. Among all studies, green tea dentifrice showed significant reduction when compared with conventional dentifrice, and ayurvedic toothpaste and Carica papaya leaf extract were also effective
Terby et al. (2021)[29]	Cochrane Collaboration's tool	Allocation concealment and blinding of participants had higher proportions of bias across the studies	Clinical heterogeneity was observed with regard to concentrations and forms of curcumin used in the included studies. Few studies had small sample sizes which could be the reason for the high statistical heterogeneity	For a long-term evaluation of probing pocket depth in 9 studies each with 400 participants, there was a statistically significant difference in the reduction when curcumin topical gel was used as compared with the control

NA: not applicable; NR: not reported; SMD: standard mean difference; CI: confidence interval; PI: plaque index; GI: gingival index; MD: mean difference; TRP: triphala; CHX: chlorhexidine; HTP: herbal toothpaste; HMR: herbal mouthrinses; NHTP: non-herbal toothpaste; HMR: non-herbal mouthrinses; BOP: bleeding on probing; CFU: colony forming unit; CPI: Community Periodontal Index; PPD: probing pocket depth; MW: mouthwash; RCTs: randomized controlled trials; ROB: risk of bias; CONSORT: Consolidated Standards of Reporting Trials; OT: orthodontic treatment; OHM: oral hygiene maintenance

Table 5. Quantitative synthesis

Study authors	Meta-analysis	Statistical analysis	Subgroup analysis	Sensitivity analysis	Significance/Direction
AlJameel and Almalki (2020)[30]	yes	If the test showed substantial heterogeneity ($I^2 > 75\%$), a random effects model was applied, or else ($I^2 \leq 75\%$), a fixed effects model was used. Forest plots were produced describing WMD of outcomes and 95% CI.	NA	NA	TRP mouthrinses seem to significantly improve the clinical gingival inflammatory parameters in plaque-induced gingivitis with equal clinical efficacy as CHX. The overall mean difference for both GI (WMD = −0.29, 95% CI: −0.40 to −0.17, $p < 0.001$) and PI (WMD = −0.43, 95% CI: −0.54 to −0.31, $p < 0.001$) were statistically significant between TRP and CHX at follow-up, respectively.

Table 5. *Continued*

Study authors	Meta-analysis	Statistical analysis	Subgroup analysis	Sensitivity analysis	Significance/Direction
Cai et al. (2020)[10]	yes	Considering the sample size of individual studies and the heterogeneity across trials, either a fixed effects model or a random effect model was applied.	NA	NA	Significant differences were observed in all analyses in favour of herbal mouthrinses rather than placebo. Herbal to placebo: QHPI: WMD = −0.61, 95% CI: −0.80 to −0.42), $p < 0.001$). Herbal mouthrinses had a significantly higher decrease in GI (−0.28 [−0.51 to −0.06], $p > 0.01$), MGI (−0.59 [−1.08 to − 0.11], $p < 0.02$), and GBI (−0.06 [−0.09 to −0.04], $p < 0.001$) compared to placebos. No significant difference was found between herbal and CHX mouthrinses.
Dhingra and Vandana (2017)[22]	yes	Difference in mean values of parameters (clinical and/or microbiological/immunological outcomes) measured at baseline and at the end of evaluation period.	NA	NA	The RCTs showed that there was no statistically significant difference between neem and CHX mouthrinses. However, the short study duration (up to 4 weeks), inherent poor quality of reporting, and unclear risk of bias of these RCTs precludes the drawing of firm conclusions.
Janakiram et al. (2020)[13]	yes	Subgroup analyses were performed to assess the impact of the HTP on duration of intervention (4 vs 12 weeks). Heterogeneity of the data using Cochrane's Q statistic, a chi-square test, a threshold p value of less than 0.10	Yes	NA	HTP was superior to NHTP (SMD: 1.95, 95% CI: 0.97–2.93) in plaque reduction. The long-term use of NHMR was superior in reduction of dental plaque over HMR (SMD −2.61, 95% CI: 4.42–0.80)
Jassoma et al. (2019)[25]	yes	Odd ratios with a fixed effect model were used for homogenous studies, while a random effect model was used for the heterogeneous studies. Forest plots were used to display MD and their 95% CI of individual studies and a summary estimate of effect.	Yes	Yes	The meta-analysis showed that *Salvadora persica* rinses exhibited strong antiplaque effects ($p < 0.00001$, MD: 0.46, 95% CI: 0.29 to 0.63). In addition, it had statistically significant antistreptococcal ($p < 0.0001$, MD: −1.42, 95% CI: −2.08 to −0.76) and antilactobacilli effects ($p < 0.00001$, MD: −1.12, 95% CI: −1.45 to −0.79) when compared to placebo.
Javed et al. (2022)[15]	yes	MD and standard deviations (±SD). The SMDs were calculated for outcomes (measured by different scales or indices) for each study. Random effect models were used to calculate a pooled estimate of effect and its 95% CI.	NA	Yes	Significant differences in these analyses in favour of herbal and ayurvedic dentifrices as compared to control or placebo.
Kommuri et al. (2022)[26]	yes	Mean and standard deviations (SD), mean differences (MD) [GI, HI, BOP, PPD, and CPI] and SMD [CFU and PI] were calculated. In addition to 95% CI, random effect models were used to estimate pooled and non-pooled effect. Subgroup analysis for each OHM-related parameter was performed across studies before and after the use of CHX and herbal mouthwashes in the control and intervention groups. To identify consistency between studies, heterogeneity was calculated using the I^2 statistic; forest plotting was used.	NA	NA	3 studies show OHM properties of CHX are superior, 4 show both herbal and CHX as equal. CHX and herbal mouthrinses seem to be effective towards OHM in patients undergoing fixed OT. However, based on the high risk of bias and methodological variations, the reported outcomes should be interpreted with caution.
Manipal et al. (2016)[27]	yes	The fixed effects model was used for analysis when compared to the random effects model as the data were more heterogeneous. Chi square was used to compute heterogeneity based on the standard deviation and confidence levels of all the selected studies. Meta-analysis was performed for 11 studies.	NA	NA	The present situation supports the use of CHX, labelled as the "gold standard." The widespread usage of herbal products now needs to be advocated and prescribed only with substantial documented and scientific studies. Hence more clinical trials and RCTs on a larger scale to continue their development and usage.

Table 5. *Continued*

Study authors	Meta-analysis	Statistical analysis	Subgroup analysis	Sensitivity analysis	Significance/Direction
Mehta et al. (2018)[13]	yes	Primary outcome variables from each study were combined for continuous data using a random effects model.	Yes	NA	MA with a subgroup of herbal dentifrice compared to conventional dentifrice (fluoridated or nonfluoridated) revealed that that efficacy of conventional dentifrice was significantly higher for plaque intervention (SMD: 7.34; 95% CI: 4.05–10.64, $p = 0.0001$).
Terby et al. (2021)[29]	yes	Heterogeneity of the data was evaluated using the Cochran's Q statistic, with the threshold p value of less than 0.10 and I^2 statistic). Forest plots were generated for visual interpretation.	NA	NA	There was a statistically significant difference in the reduction when curcumin topical gel was used as compared with the control (SMD: 0.87, 95% CI: 1.31 to 0.43). However, in the evaluation of short-term plaque and gingival scores, there were no statistically significant differences in the reduction when curcumin mouthrinse was used (SMD: 0.76, 95% CI: 2.25 to 0.73).

NA: not applicable; SMD: standard mean difference; CI: confidence interval; PI: plaque index; GI: gingival index; WMD: weighted mean difference; NCCM: natural compound containing mouthwashes; TRP: triphala; CHX: chlorhexidine; SD: standard deviation; BOP: bleeding on probing; CFU: colony forming unit; CPI: Community Periodontal Index; PPD: probing pocket depth; MD: mean differences; MW: mouthwash; NHMR: non-herbal mouthrinse; HTP: herbal toothpaste; HMR: herbal mouthrinse; NHTP: non-herbal toothpaste; RCTs: randomized controlled trials; OT: orthodontic treatment; OHM: oral hygiene maintenance

conventional dentifrices in reducing plaque and gingival inflammation.[10,13-15,27,30] Janakiram et al.[13] compared fluoridated and non-fluoridated dentifrices with herbal dentifrice and reported that herbal toothpaste is just as effective as conventional toothpaste (standardized mean difference [SMD]: 4.64, 95% confidence interval [CI]: 2.23, 7.05] at removing plaque, but less effective than fluoride toothpaste (SMD: 0.99, 95% CI: 0.14 to 2.13) at 4 weeks and CHX mouthwashes (SMD: −2.61, 95% CI: 4.42 to 0.80) after 12 weeks.[13] Cai et al.[10] also found that herbal mouthwashes were effective in reducing plaque and gingivitis, comparable to chlorhexidine mouthwashes (CHX-MW). Similarly, a study by Aljameel and Almalki[30] reported that triphala mouthrinses are as effective in improving plaque-induced gingivitis as CHX-MW. The overall mean differences for both GI (weighted mean difference [WMD] = −0.29, 95% CI: −0.40 to −0.17, $p < 0.001$) and PI (WMD = −0.43, 95% CI: −0.54 to −0.31, $p < 0.001$) were statistically significant between tripahala and CHX-MW at follow-up.[30]

However, few studies reported conventional dentifrices or CHX mouthwashes as superior in efficacy to herbal dentifrices. For instance, Mehta et al.,[14] in their meta-analysis found that conventional dentifrice had a significantly higher efficacy for PI (SMD: 7.34; 95% CI: 4.05 to 10.64) whereas there was a similar effect of herbal and conventional dentifrices on gingival inflammation (SMD: 1.48; 95% CI: −0.59 to 3.55, $p = 0.16$; test for heterogeneity: $p < 0.00001$, $I^2 = 96\%$). Another meta-analysis of *Salvadora persica* results showed a significant inhibitory plaque formation effect ($p < 0.00001$, MD: 0.46; 95% CI: 0.29 to 0.63), anti-streptococcal ($p < 0.0001$, MD: −1.42; 95% CI: −2.08 to −0.76), and anti-lactobacilli effects ($p < 0.00001$, MD: −1.12; 95% CI: −1.45 to −0.79). However, its effectiveness was found to be inferior to CHX formulations.[25] Kommuri et al.[26] revealed that approximately 40% of studies found that CHX is superior to herbal mouthrinses. Findings of the Janakiram et al.[13] study also showed that conventional mouthrinses were significantly better than herbal mouthrinses for either short-term (SMD: −0.15; 95% CI: 0.32 to 0.01) or long-term (SMD: −0.09; 95% CI: 0.25 to 0.08) impacts on gingival inflammation.

One article reported a positive effect of the herbal product, curcumin, in dental treatment.[29] The effectiveness of curcumin in various forms for the treatment of periodontitis was evaluated and the findings showed that over the long term, there was a statistically significant decrease in probing pocket depth when compared to the control group (SMD: 0.87; 95% CI: 1.31 to 0.43). The short- and long-term plaque scores or gingival inflammation were better treated by curcumin topical gel (SMD: 0.87; 95% CI: 1.31 to 0.43) than by curcumin mouthrinse (SMD: 0.76; 95% CI: 2.25 to 0.73).

All studies, however, acknowledged that their results were equivocal because of heterogeneity in several parameters, variations in individual elements, and the chemical composition of the components in mouthwashes used in the control and intervention groups.

Adverse effects

Studies on herbal compounds have documented a range of adverse consequences. Several reviews[0,14,20,23,28] discovered that both herbal and conventional dentifrices

cause side effects such as mouth ulceration, a burning sensation, tissue sensitivity, dryness, tooth discoloration, hypogeusia, lightheadedness, and an unpleasant taste. Contrarily, *Camellia sinensis* (green tea) mouthrinse had no adverse effects.[28] According to Ingle,[24] herbal dentifrice caused hypersensitivity in one individual, but no other side effects or gingival desquamation were seen. Other studies did not find any negative events connected to the interventions.[7,13,15,21,22,26,27,29,30]

Quality assessment findings

Based on the scoring system, it was determined that the methodological quality of one study[24] was low, 4 studies[7,21,23,27] were of medium quality, and the remaining 2 were high quality.[10,13-15,20,22,25,26,28-30] According to the PICO structure, all research had explicitly and clearly stated their systematic review question The majority of studies obtained scores for appropriate inclusion criteria, assessment criteria, independently conducted critical appraisal, appropriate data synthesis, and defined research directions. All studies except for one[27] reported performing risk of bias assessment, with the majority using the Cochrane risk of bias assessment method to evaluate studies. Only 7 of the 16 reviews mentioned the possibility of publication bias.[10,14,15,20,25,26,30] Six reviews did not explicitly mention the procedures applied for reducing errors in data extraction.[7,20,21,24,26,27] Just over half of the studies made policy and practice recommendations based on their research findings (Supplementary Table S1).[13-15,22,25,26,27,29,30]

DISCUSSION

The present umbrella review has collated the available systematic reviews with and without meta-analyses of randomized controlled trials. The results show that some herbal oral health care products, particularly in the form of mouthrinse, such as curcumin, green tea, miswak, *Carica* papaya leaf extract, *S. baicalensis, Azadirachta indica, Curcuma longa*, *Anacardium occidentale Linn,* and *Schinus terebinthifolius* have a similar positive effect on plaque and gingivitis reduction and, thus, can be used as an adjunct to traditional dentifrices. However, the short duration of the trials (<4 weeks) and reported publication bias mean that the findings must be interpreted with caution. Further long-term clinical trials in this area are necessary.

Periodontal disease is the world's second-most prevalent oral health condition, affecting approximately 1 billion people.[1] Despite tremendous advances in clinical oral health care technologies and interventions in recent years, there remain major concerns about the availability, accessibility, and affordability of such services. Addressing these factors is crucial to reducing health disparities because they directly influence proper oral health care as well as appropriate health behaviours.[33] When oral health is compromised, eating patterns are significantly impacted, which may consequently lead to metabolic disorders such as diabetes mellitus where nutrition plays a significant role. An affordable approach is therefore extremely needed.[34]

CHX is widely considered the cost effective and benchmark standard in periodontal antiseptic treatment. However, because of its negative effects and the rise in antibiotic resistance, people are seeking alternatives that are organic.[35] Herbs contain unique physicochemical and therapeutic properties. Secondary metabolites, found in herbs, are effective in treating infections and other medical conditions. Identifying and characterizing these metabolites, as well as their independent and collaborative modes of action, is a significant challenge for contemporary pharmacology. Although numerous studies[7,10,13-15,20-30] have demonstrated the efficacy of some herbal plants in plaque and gingivitis reduction, it is critical to comprehend the interactions of plant compounds (metabolites) with the human system as well as other medications. Based on that, appropriate guidelines for herbal products usage must be created, which may subsequently require modification depending on unique biological profiles. Furthermore, there is a risk of improper utilization or adulteration. Thus, despite their therapeutic potential, precautions must be taken when promoting herbal treatments. It is critical to maximize the therapeutic effect of herbal medicine by paying close attention to both plant origin and quality control.[36]

Weaknesses and strengths of the umbrella review

This umbrella review has several strengths. First, it explored 6 major electronic research databases using a comprehensive and rigorous search method to discover potentially suitable publications for review. Second, no language constraints were imposed on the inclusion of studies. Third, 2 authors worked independently on the screening of search results, data extraction, and quality appraisal. Lastly, differences were settled at each stage by involving a third reviewer who was an expert in the subject matter.

However, the analysis undertaken has some inherent limitations. These include not exploring grey literature, which could have resulted in the loss of potentially relevant literature. Second, while the investigation included both systematic reviews and meta-analyses, there was variability in the composition, concentrations, and therapeutic properties of herbal ingredients utilized in the included studies. As a result, it was not possible to pool and analyse the data to reach a conclusive decision.

Reporting gaps in the clinical studies and included systematic reviews

While reviewing the included studies, several methodological limitations of the clinical trials as well as the systematic reviews were identified. Therefore, the following recommendations are made to enhance the standard of subsequent research on herbal oral care products.

Recommendations

For clinical trials

Choosing a sample size that produces a certain level of

statistical power has been an established method to conducting trials. Ingle,[24] in their systematic review, reported on studies that lacked sufficient sample size. Trials with either too small or too large samples are referred to as "underpowered" or "overpowered," respectively, as they cannot capture true effect and are, thus, frequently criticized as being scientifically pointless and unethical from a medical standpoint.[37] Before beginning a trial, a thorough sample size calculation based on earlier studies must be made.

In addition, because all studies that included RCTs were carried out for a brief period (<6 months), there is currently no information available on the potential negative effects of any herbal formulation when used over an extended period. Therefore, it is advised to conduct RCTs with established protocols, defined population parameters with a bigger sample size, and over a longer period. For instance, the minimum length of the research intervention should be taken into account so that a reduction in gingival inflammation may be shown. The American Dental Association (ADA) specifies that long-term studies must be carried out over ≥6 months for a seal of acceptance, with an intermediate evaluation at 3 months to determine the efficacy and safety of chemical agents and patient compliance.[38]

Although numerous studies have found that herbal formulations work well as dentifrices, further rigorous and high-quality research involving trials at different concentrations and compositions is recommended to improve the documentation of findings.[15]

Finally, 3 systematic reviews and meta-analyses indicated uncertain risk of bias and methodological issues in included RCTs, which prevents drawing reliable inferences.[14,26,28] Therefore, additional clinical trials with a clear risk of bias assessment and following CONSORT guidelines is required to offer trustworthy and conclusive results.

For systematic reviews and meta-analyses

To avoid bias in study outcomes, SRs should seek to synthesize all relevant material, regardless of language of publication.[39]

The tool used for appraising included studies must be reported and its outcomes must be taken into account for drawing conclusions and making recommendations.

Two or more authors must independently appraise the quality of included studies and extract data to reduce bias and improve accuracy of information.

To bridge the gap between research evidence and clinical decision making, all SRs and SR with meta-analyses must give policy and practice implications, supporting evidence-based clinical practice and guiding future research endeavours.

CONCLUSION

This umbrella review highlights the fact that some herbal oral health care products produce results comparable to those of traditional products. Consequently, herbal care products can be utilised as an alternative to treat plaque and gingivitis. Nevertheless, inferences cannot be drawn from the existing studies because of their poor methodological quality, short duration of trials, and significant potential for bias. Therefore, clinicians should use caution when incorporating herbal products into the treatment plan for plaque and gingivitis, weighing the potential benefits and unanticipated events. Furthermore, to accurately determine the impact of various herbal extracts on periodontal health, subsequent well-designed, long-term, controlled trials which adhere to standardized protocols must be carried out.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

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