

Comparing the Effectiveness of Herbal and Conventional Dentifrices in Reducing Dental Plaque and Gingivitis: A Systematic Review

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ABSTRACT **Introduction:** The important cause of chronic gingivitis was proved to be dental plaque, which is a well-organized biofilm. However, self-care efforts or mechanical control of dental plaque by toothbrushing was important; these alone will not be enough to prevent gingivitis. **Aim:** The aim of the present systematic review was to compare the effectiveness of herbal and conventional toothpastes on reduction of dental plaque and gingivitis. **Materials and Methods:** Data from original scientific papers published in PubMed, Cochrane, Lilacs, and Google Scholar were taken for review up to November 2020. Randomized controlled trials and clinical trials compare the effectiveness of herbal and non-herbal toothpastes on reduction of dental plaque and gingivitis. Articles published in English language only were included. References from the identified publications were manually searched to identify additional relevant articles. Seven publications fulfilled all the inclusion criteria and were finally selected for systematic review. Outcome measurements for gingivitis were gingival index and dental plaque index. **Results:** As all the studies were randomized controlled trials, level of evidence was II. Among all studies, green tea dentifrice toothpastes showed significant reduction when compared with conventional dentifrice, and ayurvedic toothpaste and Carica papaya leaf extract were also effective. **Conclusion:** Herbal toothpaste seems to be powerful similar to non-herbal toothpaste; however, it is no longer extra superior to fluoride toothpaste. Further, long-term randomized studies of >6 months are needed to investigate the beneficial effects of intervention alone.

KEYWORDS: Dental plaque, dentifrices, gingivitis, herbal, toothpastes

INTRODUCTION

The removal of dental plaque and food debris is mandatory to maintain good oral health, which also plays a vital role in the prevention of caries and periodontal diseases.^[1] Plaque-induced chronic gingivitis is a notable oral health problem prevalent worldwide, affecting people of all ages. The important cause of chronic gingivitis was proved to be dental plaque, which is a well-organized biofilm.^[2] However, self-care efforts or mechanical control of dental plaque was important; these alone will not be enough to prevent gingivitis. Chemical manipulate of

dental plaque is a supplementary method which may additionally facilitate the elimination and save us from the accumulation of microbial plaque, potentially lowering the dependence on mechanical oral healthcare behaviors.^[3] Both mechanical and chemical removal

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methods of dental plaque are also suggested for the maintenance of good oral hygiene.^[4]

Toothbrushing with a dentifrice is the most widely practiced form of oral hygiene all over the world. In order to improve the efficacy of mechanical toothbrushing with dentifrices, antimicrobial agents have been added to produce direct inhibitory effect on dental plaque formation.^[5,6] Commercial dentifrices in market nowadays not only have antimicrobial agents but also they possess chemical agents such as triclosan, sodium lauryl sulfate (SLS), and propylparaben; allergens have also been added to dentifrices to improve the antibacterial action.^[7-9] These products have proven side effects on long-term use such as altered taste and tooth staining.^[10]

A rising shift was seen among the consumers from fluoridated dentifrices to herbal (natural) dentifrices. In recent years, natural compounds (excluding EO)-containing mouthwashes have shown a growth in demand in markets and the professional community.^[11] Many dentists also started suggesting natural agents-incorporated toothpaste for better oral health. Herbal medicines, including herbs, herbal materials, herbal preparations, finished herbal products that contain parts of plants or other plant materials as active ingredients, and various medicinal plants, individually or in combination, have been used for over 2000 years to maintain oral hygiene and to prevent inflammation.^[12-14] Herbal extracts also contain antibacterial, antioxidant, anti-inflammatory, and antiallergic properties naturally which reduce side effects too. Some of the plant extracts which have been tried incorporating in dentifrices are green tea extract,^[15] clove and *Azadirachta indica* (neem), *Rosmarinus officinalis*,^[16] *Salvadora persica*,^[17] *Scutellaria baicalensis*,^[18] etc. In the rural areas of South Asian international locations, use of natural merchandise such as neem twigs, charcoal powder, and others has been a crucial part of ordinary oral hygiene exercise for hundreds of years.^[19]

Dentifrices labeled as “natural” typically do not include ingredients such as synthetic sweeteners, artificial colors, preservatives, additives, or synthetic flavors and fragrances. Manufacturers of those herbal dentifrices use a extensive variety of plant components which they claim mimic the benefits of traditional toothpastes—the ability to fight plaque, freshen breath, and prevent gum sickness. The tendency to “go herbal” has fuelled a boom in call for such merchandise through purchasers, deliver no aspect consequences, use no animal products, are vegan friendly, and so on. In some parts of the world, sale of herbal products outnumbers fluoride-primarily based toothpastes.^[20] A plethora of research exists on conventional oral care products, whereas very limited clinical research on herbal-based mouth rinses and dentifrices exists in literature.

The effectiveness of herbal and conventional dentifrices for the decrease of plaque and gingivitis was tested in trials, but results are inconclusive. The aim of the present systematic review was to compare the effectiveness of herbal and conventional toothpastes on reduction of dental plaque and gingivitis.

MATERIALS AND METHODS

PICO ANALYSIS

Population—adults above 18 years; intervention—herbal toothpastes; comparison—fluoridated and commercial toothpastes; outcome—decrease in gingival inflammation and dental plaque count.

INCLUSION CRITERIA

The inclusion criteria include the following:

- Randomized controlled trials and clinical trials comparing the effectiveness of herbal and non-herbal toothpastes on reduction of dental plaque and gingivitis;
- Adults >18 years with no other regulations on age or gender;
- The intervention part consisted of participants with the usage of natural toothpaste which had a natural ingredient.

EXCLUSION CRITERIA

The exclusion criteria are as follows:

- Quasi-randomized trials were excluded;
- Animal study and reviews;
- Literatures in other languages which cannot be translated by the reviewer were excluded;
- Participants with clinically diagnosed periodontitis, non-plaque-induced gingival lesions, leukemia-associated gingivitis, drug-influenced gingival enlargement, or experimentally induced gingivitis were excluded.

OUTCOMES

The outcomes are

- Silness–Löe plaque index (PI) or modified Quigley–Hein PI;
- Löe–Silness gingival index (GI) [Table 1].

SEARCH STRATEGY

Four electronic databases PubMed ($n = 19$), Cochrane ($n = 12$), LILACS ($n = 0$), and Google Scholar ($n = 85$) were searched till December 2020. A combination of terms “Herbal toothpaste,” “Herbal dentifrice,” “commercial dentifrice,” “conventional toothpaste,” “gingivitis,” “plaque,” “chlorhexidine toothpaste,” and “fluoridated toothpaste” was used.

DATA COLLECTION AND ANALYSIS

Screening and selection

Electronic search was carried out using the keywords in the Search engines PubMed, Science Direct, Cochrane, LILACS, and Google Scholar, which yielded a total of 116 articles. Based on the present inclusion and exclusion criteria, the titles of the studies identified from the search were assessed independently by two review authors (S. S. and I. M. A.). Conflicts concerning inclusion of the studies were resolved by discussion. Thirty-three articles titles were identified from the search after reading the titles and selected for reading abstracts. Abstracts of selected articles were reviewed independently. Sixteen were excluded after reading abstract. Seven articles were excluded for duplications. After reviewing the articles independently, finally seven articles were selected based on eligibility criteria [Flowchart 1].

The reference list of the full-text articles was reviewed for identifying additional studies. Titles of articles relevant to the review were selected for discussion. Abstracts of the two selected articles were reviewed. Difference of opinion concerning inclusion of a study was resolved by discussion, and all two articles were eliminated after reviewing abstracts. Quality Assessment criteria to evaluate the studies were decided by two review authors in accordance with CONSORT guidelines. The risk of bias for each study was independently assessed by the review authors, and conflicts concerning risk of bias were sorted by discussion using Review Manager 5.3.

Quality Assessment: Cochrane Risk of Bias Tool^[21]—Review Manager 5.3

The risk of bias assessment of the enclosed studies used the approach counseled by the Cochrane Collaboration tool.^[21]

All the included studies were assessed independently and in duplicate by two reviewers for study design characteristics and features of internal validity.

Assessment was done within and across the studies. The first step was writing a description of the results of each included study. Next involved was the assessment of the risk of bias where a score of low, high, or unclear was assigned for each included study. The overall quality of each study was then assessed by grading the six bias categories [Figure 1]. A score of 3, 1, and 0 were considered as low, unclear, and high risk of bias, respectively for each of the seven categories of biases. The ratings have been averaged for each enclosed examine and outcomes are shown in Figure 2 as risk of bias summary. Reviewers were not blinded to author and source institution. Any disagreement was resolved by discussion or by third party adjudication.

The AHRQ classifies studies in seven levels according to the level of evidence: (I) systematic review or meta-analysis; (II) randomized controlled trials; (III) controlled trials without randomization; (IV) case-control and cohort studies; (V) systematic reviews of descriptive and qualitative studies; (VI) single descriptive or qualitative study; and (VII) opinion of authorities and/or report of expert committees.

RESULT

A systematic literature search yielded 116 publications from various databases. Fifty-four articles were excluded after reading titles and 62 articles are identified for further procedures. Forty-five articles were excluded after reading the abstract which did not fit into our inclusion criteria. Finally, 17 articles are selected eligible for reading the full text. After removing 7 duplicates, 10 articles were finally selected for full text reading. Finally, after excluding three articles for different outcomes and no free full text, seven^[18,22-27] articles were included in this systematic review.

The studies were characterized based on factors such as the study location, type of study design, study setting, year of publication, age of the study population,

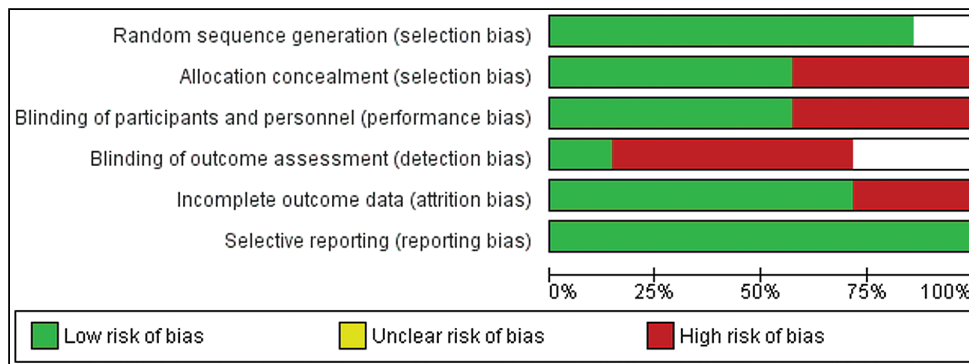


Figure 1: Risk of bias—included studies

measurement tool, and the duration of the study. Only randomized controlled trials were included in the review. Tables 3 describes the general characteristics and data of all the included studies. Among the seven included studies, two studies were from Germany,^[18,22] two studies were from Brazil,^[23-27] one study from India,^[23-27] one from Sri Lanka,^[23-27] and one from Spain.^[23-27] No studies were available from African and Australian continents.

Among the seven studies, two studies used Parodontax as herbal intervention,^[23-27] one study used miswak toothpaste (*S. persica*),^[22] one study used green tea dentifrice,^[23-27] one used *S. baicalensis* extract toothpaste,^[18] and one used Carica papaya leaf extract toothpaste.^[23-27] For assessing PI among seven included studies, four studies used Turesky modification of the Quigley and Hein PI,^[23-27] two studies used the Silness and Løe PI,^[18,23-27] and one study used API.^[22] For assessing GI, four studies used GI by Løe and Silness,^[18,23-27] one study used SBI,^[22] one study used bleeding on probing and probing pocket depth,^[23-27] and

one study used Bleeding on Interdental Brushing Index (BOIP).^[23-27]

The included studies were assessed for quality by Cochrane Risk of Bias Tool.^[21] The overall quality of each study was then assessed by grading the six bias categories. A score of 3, 1, and 0 was considered as low, unclear, and high risk of bias, respectively, for each of the seven categories of biases. The scores were averaged for each included study and results are provided in Table 3.^[18] It is the highest quality of study with score 16. The level of evidence is given in Table 2 according to the AHRQ guidelines. As all the studies are randomized controlled trials, all were given level of evidence II [Table 2].

DISCUSSION

Despite the fact that most individuals practice brushing their teeth at least twice a day, the prevalence of gingivitis and chronic periodontitis remains high in most populations around the world.^[28] The upkeep of a useful stage of plaque manipulate is utmost tough because of the usage of conventional mechanical methods and dentifrices; yet, from a therapeutic angle, it is presently the only realistic way of enhancing the periodontal status of populations.^[29,30] Herbal dentifrices are available globally as “over-the-counter” oral hygiene products to help remove food debris and

| | Random sequence generation (selection bias) | Allocation concealment (selection bias) | Blinding of participants and personnel (performance bias) | Blinding of outcome assessment (detection bias) | Incomplete outcome data (attrition bias) | Selective reporting (reporting bias) |
|----------------------|---|---|---|---|--|--------------------------------------|
| Azaripour et al 2015 | + | - | - | - | + | + |
| Claudio et al 2003 | | - | - | - | + | + |
| Fabiana et al 2006 | + | + | + | - | - | + |
| Howshigan et al 2015 | + | + | + | + | - | + |
| Hrishi et al 2014 | + | + | + | - | + | + |
| Nicole et al 2011 | + | + | + | | + | + |
| Saliasi et al 2018 | + | - | - | | + | + |

Figure 2: Risk of bias summary

Table 1: Variables of interest

| Sl. No. | Variables of interest |
|---------|--|
| 1. | Plaque index—PI by Silness and Løe Turesky modification of the Quigley and Hein PI Approximal PI |
| 2. | Gingival index—GI by Løe and Silness |

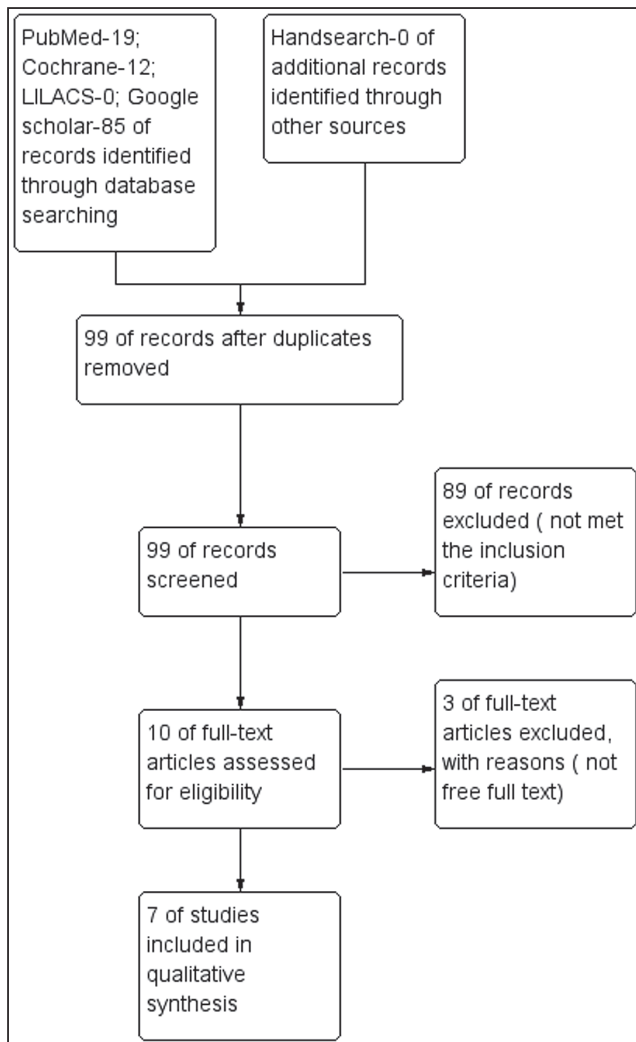
Table 2: Level of evidence according to the Agency for Health Research and Quality (AHRQ) guidelines (2016)

| Sl. No. | Author and year | Study design | Level of evidence |
|---------|--------------------------------|----------------|-------------------|
| 1 | Azaripour <i>et al.</i> , 2015 | Clinical trial | II |
| 2 | Claudio <i>et al.</i> , 2003 | Clinical trial | II |
| 3 | Fabiana <i>et al.</i> , 2006 | Clinical trial | II |
| 4 | Howshigan <i>et al.</i> , 2015 | Clinical trial | II |
| 5 | Hrishi <i>et al.</i> , 2014 | Clinical trial | II |
| 6 | Nicole <i>et al.</i> , 2011 | Clinical trial | II |
| 7 | Saliasi <i>et al.</i> , 2018 | Clinical trial | II |

Table 3: Summation table of the included studies

| Author | Year | Evaluation period | Outcome | Inference | Quality of study [#] | Limitations/ future scope |
|-------------------------|------|-------------------|---|--|-------------------------------|--|
| Howshigan <i>et al.</i> | 2015 | 6 months | Quigley and Hein PI, bleeding on probing, probing pocket depth (N=80) | This trial provides evidence for the therapeutic benefits of the ayurvedic medicinal test toothpaste through its anti-inflammatory effects and confirms anti-inflammatory and antibacterial properties of the herbs used in this formula. | 15 | Sample size small |
| Hrishi <i>et al.</i> | 2016 | 4 weeks | GI, PI, percentage of sites with bleeding on probing (BOP), probing depth (PD), and clinical attachment level (CAL) N=30 | On comparison with fluoride-triclosan dentifrice, green tea showed greater reduction of gingival inflammation and improved periodontal parameters. Green tea dentifrice may serve as a beneficial adjunct to non-surgical periodontal therapy. | 15 | Long-term clinical trials should be conducted to validate the results of this pilot study. |
| Azaripour <i>et al.</i> | 2017 | 21 days | Approximal plaque index (API), sulcus bleeding index (SBI) N=66 | The use of each of the three tested toothpastes caused a significant reduction in gingival inflammation and amount of plaque. The miswak extract-containing toothpaste showed a similar effect as the herbal toothpaste and can be safely used for domestic oral hygiene in patients with gingivitis. | 9 | Further long-term studies are needed to confirm long-lasting benefits of miswak extract-containing toothpastes. |
| Saliasi <i>et al.</i> | 2018 | 4 weeks | N= 100 Bleeding on Interdental Brushing Index (BOIP) on the interdental space. Turesky modification of the Quigley-Hein PI | Carica papaya leaf extract dentifrice is effective when compared with SLS-free enzyme-containing dentifrice in the reduction of gingival bleeding and inflammation and could constitute a valid parallel alternative to classical commercial dentifrices. | 10 | Findings require confirmation in a less selected population or in patients with periodontitis. Further comparisons against classical dentifrices and with other periodontitis outcomes are also desirable. |
| Nicole <i>et al.</i> | 2011 | 21 days | N= 40 Löe and Silness GI, Silness and Löe PI | Herbal dentifrice group has reduced GI score when compared with the placebo group at 14th day and 21st day which suggests that the new toothpaste formulation was able to significantly reduce the extent of gingivitis, plaque development, and vital flora. | 16 | Limitation of the study is less sample size. |
| Claudio <i>et al.</i> | 2003 | 21 days | N = 30 Quigley and Hein PI and GI | There was no significant difference between groups in relation to the PI and GI medians, at baseline and at the end of the 21-day period. There was no significant reduction in PI in either the test or control groups. There was a significant decrease in GI in the test group. The authors concluded that there was no difference between the dentifrices in the reduction of plaque and gingivitis. | 6 | Long-term follow-up needed for future studies Very less sample size |
| Fabiana <i>et al.</i> | 2006 | 28 days | N = 42 Quigley and Hein PI and GI | There was a significant reduction in plaque levels in both the test and control groups. However, there was no significant difference between the groups. A significant reduction in gingivitis was observed in both groups, although there was no significant difference between them. | 12 | Long-term follow-up needed for future studies Very less sample size |

[#]Quality of score assessment: no risk—3, unclear risk—1, high risk—0 (sum of each of the six biases were taken)



Flowchart 1: Prisma flowchart of included studies

dental plaque. One would expect a consensus on which dentifrice to choose as there is evidence that herbal dentifrice can be effective against dental plaque and gingivitis. Thus, this systematic review included seven randomized controlled trials eligible for the outcome measurement of gingivitis and dental plaque reduction.

The results of the clinical trials included for review compared herbal and non-herbal toothpastes in reduction of dental plaque and gingivitis.

A study conducted by Hrishi *et al.*^[23-27] compared green tea toothpaste with commercially available fluoride and triclosan-containing dentifrice and concluded that green tea showed greater reduction of gingival inflammation and improved periodontal parameters. Another study^[22] compared miswak extract-containing toothpaste with conventional fluoride-containing toothpaste and concluded that use of tested toothpastes caused a significant reduction in gingival inflammation

and amount of plaque. The miswak extract-containing toothpaste showed a similar effect to the conventional toothpaste and can be safely used for domestic oral hygiene in patients with gingivitis but without significant differences between the groups.

Another randomized controlled trial^[23-27] compared ayurvedic medicinal toothpaste with placebo toothpaste and finally concluded that the test group shows a significant reduction in plaque score, bleeding on probing, and probing pocket depth when compared with placebo toothpaste and reduction increased overtime. Another randomized controlled trial^[23-27] compared Carica papaya leaf extract dentifrice with SLS-free enzyme-containing dentifrice and concluded that the Carica papaya leaf extract dentifrice is effective when compared with an SLS-free enzyme-containing dentifrice in the reduction of gingival bleeding and inflammation and could constitute a valid parallel alternative to classical commercial dentifrices.

Another study conducted by Arweiler *et al.*^[18] compared *S. baicalensis* extract-containing toothpaste with placebo toothpaste and the authors concluded that gingival score and plaque score were low after 21 days for test toothpaste when compared with control; the results suggest that the new toothpaste formulation was able to significantly reduce the extent of gingivitis, plaque development, and vital flora. Next two studies done^[23-27] compared Parodontax toothpaste with fluoridated toothpaste. According to Claudio *et al.*, the Parodontax dentifrice presented no significant clinical advantage over the conventional toothpaste with fluoride. Nevertheless, it did produce a decrease in plaque and gingivitis, and according to Ozaki *et al.*, there was no additional benefit of the test dentifrice over the positive control toothpaste (Colgate Total) and concluded that both dentifrices were able to reduce plaque and gingivitis, although no additional benefit of the test dentifrice over the positive control toothpaste could be observed.

The objective was to estimate the efficacy of removal of dental plaque following use of the herbal toothpaste when compared with conventional toothpaste. Varied indices were used for dental plaque and gingivitis. Based on this systematic review, whether the indices analyzed are sensitive enough cannot be determined; however, all of them are commonly used in dentistry. Most commonly used indices in this review are Turesky's modification of the Quigley and Hein PI and GI by Loe and Silness. Although these were insufficient data to assess the introduction of a bias, most of the studies did not provide any information on sample size

calculation. Herbal toothpaste which includes herbal ingredients act naturally in our oral cavity, whereas commercial toothpaste available in the market contains chemicals which might lead to side effects after long-term use which left unnoticed often.

The present systematic review limits the studies in English language only. This systematic review includes only the published data or researches for interpretation. This limited the number of studies assessing the aim of this review. Due to lack of more clinical studies comparing the conventional and herbal dentifrices, heterogeneous outcome variables are included in the study.

CONCLUSION

Herbal toothpaste seems to be powerful similar to non-herbal toothpaste; however, it is no longer extra superior to fluoride toothpaste. It can be used as an alternative to conventional dentifrices without any adverse effects. Further long-term randomized studies of >6 months are needed to investigate the beneficial effects of intervention alone.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHORS CONTRIBUTIONS

All my co authors Dr. Srisakthi, Dr. Meignana Arumugham, Dr. Pradeep Kumar, Dr. Jayashri, and Dr. Arthi contributed equally to the concept, design, literature search, manuscript preparation, manuscript editing, manuscript review, and are guarantors.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable.

PATIENT DECLARATION OF CONSENT

Not applicable.

DATA AVAILABILITY STATEMENT

Not applicable.

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