Herbal formulations in health sector are professed to render therapeutic benefits [1]. They are preferred as it provides benefits of natural activity, safe and lesser cost. They are even safe from adverse effects. Herbal therapy is gradually gaining popularity over modern drugs to combat side effects like antibiotic resistance.

Herbs are utilised in dentistry to treat tooth ache, gingival inflammation and canker sores [2]. Literature has shown that plant extracts exhibit antiseptic, antibacterial, antimicrobial, antifungal, antioxidant, antiviral and analgesic properties [3]. Various plant extracts like propolis, noni fruit, burdock root, neem extract, tulsi extract and curcumin have been tested in dentistry showing promising results [4].

The mildest form of periodontal disease is gingivitis seen as plaque accumulation on tissues of the oral cavity [5]. Dental plaque accumulation is the prime reason of all dental diseases [6]. It is described as a reversible condition, but can progress to periodontitis if not treated, resulting in bone loss and connective tissue [7]. Ideal method to remove plaque and prevent gingivitis is through mechanical plaque control such as tooth brushing and flossing. Additional oral health aides are also used like chlorhexidine, essential oils as mouthwashes which are approved by American Dental Association as antiseptic formulations [8]. Cases of hypersensitivity, formation of stains, irritation to oral mucosa and dysguesia are reported with these usage [9]. Multiple drug resistant organisms with the use of antibiotic formulations are also increasing in the oral cavity.

Studies have demonstrated that gingivitis is associated with various systemic diseases [10]. Hence, prevention and control of gingival inflammation is imperative to maintain overall health through oral health [11].

Herbal formulations used as dentifrice or mouth rinses can be used as a single ingredient or as a combination of different medicinal plants. The aim of the review was to comprehensively present an overview on the efficacy, safety and utilization of herbal products on periodontal diseases.

**Materials and Methods**

A hypothesis of “Are herbal formulations effective in influencing periodontal health” was framed to be tested through this review. Literature search began by scrutinizing search engines of PubMed, Medline data base, Scopus and Journal of Web, from 2000 to 2019. Articles testing the efficacy of herbal dentifrice formul-
tions of periodontal health, Randomized Controlled trials testing the herbal formulation with either a placebo or a gold standard agent were included, irrespective of the ages tested on. Review articles, unpublished data, articles without open access, dissertations and articles published in any other language apart from English were excluded. An independent researcher looked into the data base using the MeSH terms herbs, herbal dentifrice, herbal formulation, periodontitis and gingivitis.

Each selected article was reviewed for the risk of any bias by using the Cochrane Collaboration’s tool for risk assessment. The search obtained was carefully scanned by the reviewer initially. Papers were chosen to be fully read only if the MeSH terms appeared in the title or abstract. The abstracts of the selected articles were then scrutinized for eligibility criteria.

Only those trials or studies which tested the herbal formulation along with a test group and subjects above 18 years of age were included for the review. Only if they fulfilled the eligibility criteria, then full text articles were read. Parameters evaluated were study design, sample size, indices recorded, herbs used and results obtained.

The search yielded a total of 327 articles, out of which 127 had to be excluded because of duplicate results, 8 articles investigated other oral diseases like premalignant lesions and dental caries and thus had to be excluded. 18 articles were included for the review finally which fulfilled the eligibility criteria (Figure 1). Outcomes in terms of disease reduction or change in indices scores was compared between the herbal component (mentioned as test group) and control group (gold standard formulation) or placebo. Risk of bias was assessed on the basis of Cochrane Collaboration's tool for risk assessment. Each selected article was reviewed for the risk of any bias by using the Cochrane Collaboration’s tool for risk assessment. The search obtained was carefully scanned by the reviewer initially. Papers were chosen to be fully read only if the MeSH terms appeared in the title or abstract. The abstracts of the selected articles were then scrutinized for eligibility criteria.

Out of 18 studies reviewed, 16 were randomised controlled trial of parallel design while 2 were randomised controlled experiments of cross over type. All the included studies were double blinded. While all studies assessed periodontal disease by GI and PI, Pradeep AR et al [14] and Waghmare PF et al [25] in addition evaluated microbial colony count and George Jacob et al recorded salivary pH. All included studies recruited individuals with gingivitis and were above 13 years. There were 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.

Study conducted by Kalyana Chakravarty [12] mentioned hyper-sensitivity in one subject using herbal dentifrice. No other adverse effects or gingival desquamation was noted in any studies.

Results

Total 18 articles were included after full text was read independently by the reviewer. The most commonly used herbal formulations in oral health were dentifrices and mouthwashes. Hence, both of these were included in the review. The review of the trials included is presented in Table 1.

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Discussion

The main culprit in both dental caries and gingival inflammation is dental plaque. Gingival inflammation of chronic type leads to tissue destruction which if not treated, progresses to the destroy periodontium [30]. Hence, maintaining proper oral health can control plaque and subsequently gingivitis. This is attained by efficient mechanical plaque control through toothbrushes and therapeutic toothpastes.

The use of an adjunctive antimicrobial agent in treating patients with chronic periodontitis along with scaling and root planning enhances patient outcomes when scaling alone is done [31]. Though the recent chemotherapeutic agents’ project marked efficiency in bettering periodontal health, adverse effects like discoloration of teeth and mucosal surfaces, alteration of taste and increased cost cannot be overlooked. In this context herbal products are used increasingly in the recent times particularly benefitting the lower socio-economic strata across the globe [32]. Chlorhexidine, the gold standard drug, was developed way back in 1950 which still remains the most effective plaque cessation agent. But the long term usage gets restricted due its adverse effects.

Figure 1. Flow chart representing the number of articles screened and evaluated.
| Authors / Year          | Study design                  | Sample Size | Age     | Tested formulation                                      | Study duration | Index used                                      | Findings                                                                 |
|------------------------|-------------------------------|-------------|---------|--------------------------------------------------------|----------------|-----------------------------------------------|--------------------------------------------------------------------------|
| Kalyana Chakravarthy et al [12], 2019 | RCT, double blind parallel arm          | 75          | >18 years | Clove, cinnamon, black pepper, bakul and camphor extract dentifrice | 30 days        | Turesky Gilmore Glickman modification of plaque index, Tablott Mandel Chilton modification of Loe and Silness Gingival index | No significant difference in clinical indices between test and control group |
| Shahabe Saquib, 2017 [13] | RCT parallel group, blinded study | 112         | 21-40 years | Babul, Vajradanti and bakul                           | 4 weeks        | Gingival Index                                | Redact on in gingival inflammation was similar in test and control group   |
| Pradeep AR et al, 2016 [14] | RCT double blind parallel study | 90          |         | Triphala mouthwash                                    | 60 days        | PI, GI, OHI –S, Microbiologic colony count | No significant differences was noticed in reduction of PLG1, OHI-S and microbiology of colony count |
| Devandan Gupta et al 2015 [15] | RCT, blinded parallel study | 60          | 20 – 25 years | Cinnamon and T.Chebula extract mouthrinse            | 3 days         | Turesky et al modification of Quigley Hein Plaque Index | Herbal extract inhibited plaque formation though not as comparable as chlorhexidine mouthrinse. |
| Bhat N et al, 2015 [16] | RCT double blind cross over study | 30          | 18-22 years | Propolis and Miswak mouthwash (separate test groups) | 24 hours       | MGPI plaque index                             | MGPI plaque score was lesser in propolis followed by miswak and control group |
| Aravind Tatikonda et al, 2014 [17] | RCT double blind parallel study | 30          | 35-43 years | Dabur red                                            | 30 days        | GI, PI                                        | Reduction of plaque and gingivitis was similar in both test and control groups |
| Chinani et al 2014 [18] | RCT                            | 120         | 13-16 years | Herbal mouthwash                                     | 30 days        | GI, PI                                        | A significant reduction in GI and PI scores was noted in test group as effective as the control group |
| Shivanand Aspalli et al 2014 [19] | RCT parallel double blind study | 100         | 20 – 45 years | Herbal mouthwash                                     | 21 days        | Gingival Index, Plaque Index, Gingival Bleeding Index | Test group effectively reduced plaque induced gingivitis and statistically significant reduction was observed in GI, BI, GBI scores |
| Ajmera et al 2013 [20] | RCT                            | 45          | 18-65 years | Herbal mouthwash                                     |                |                     | A significant reduction in gingival inflammation |
| Makaram et al 2013 [21] | RCT parallel study            | 45          | 11-12 years | Herbal dentifrice (Barberry gel)                     | 20 days        | GI, PI                                        | The test group was effective in reducing gingivitis similar to the control group |
| Chandradas B, 2012 [22] | RCT double blind              | 120         | 18-25 years | Herbal mouthrinse Aloevera 100%                      | 22 days        | Modified Gingival Index, PI, Bleeding Index    | Reduction in gingival inflammation was noted |
| Mali et al, 2012 [23] | RCT parallel double blind study | 60          | >15 years | Turmeric mouthwash                            | 20 days        | GI, PI                                        | No statistical difference between test and control groups |
| Tange PS et al 2012 [24] | RCT, double blind cross over study | 60          |         | Herbal dentifrice                                    | 28 days        | GI, QHI, BOP                                  | Significant reduction in indices was noted in test group |
| Waghamare PF et al, 2011 [25] | RCT, double blind parallel study | 100         | 25-35 years | Turmeric mouthwash                               | 21 days        | GI, PI, Total microbial count                 | No significant difference in mean GI, PI and total microbial count between test and control group |
| Amoian B et al, 2010 [26] | RCT, double blind parallel study | 40          |         | Calendula officinalis Dentifrice                   | 28 days        | PI,GI, BOP                                   | Decrease in PI, GI, BOP in both test and control groups |
| George Jacob et al, 2009 [27] | RCT double blind parallel study | 30          | 18-65 years | Colgate herbal                                        | 30 days        | Turesky modification of Quigley Hein Plaque Index, GI, salivary pH | Significant reduction in PI and GI, chang in salivary pH was not statistically significant |
| Ozaki et al, 2006 [28] | RCT, double blind parallel study | 42          | 18-69 years | Paradontax                                            | 28 days        | Turesky modification of Quigley Hein Index, Gingival Index | Significant reduction in PI and GI in test group |
| Pannuri et al, 2003 [29] | RCT parallel double blind study | 31          | 18-35 years | Paradontax                                            | 3 weeks        | Turesky modification of Quigley Hein Plaque Index, GI | No statistically significant difference was observed between test and control groups after study duration. |
Out of the 18 articles reviewed, 16 followed the parallel design while two studies were of cross over study design. All the studies the trials were double blinded ensuring non discrepancy of study results. While the effect of herbal extract was evaluated for 24 hours by Bhat N et al [16] which formed the least time frame in the review, Pradeep et al [14] assessed the efficacy of Triphala formulation over 60 days on plaque. It also assessed microbiological counts in plaque. But the subjects in the study of Bhat N et al [16] were instructed to refrain from oral hygiene practices completely, which might have been the reason for such a short time period as obtaining patient compliance will be difficult. In both the trials mentioned, gingival inflammation reduced significantly in the test group which was as comparable to that of control group.

All the studies showed no difference between herbal extract formulations and control group in treating gingival health, excepting for the study done by Devanand et al [15] in which the herbal extract mouthrinse reduced plaque formation in slightly lesser proportion as compared to the control group.

Herbal formulations form natural photochemical which can be substituted to antibiotics and is an important alternative approach to manage oral and periodontal infections [33, 34].

Herbal components were delivered in various formulations and modes. While turmeric mouth wash was tested in studies conducted by Mali et al [23] and Waghmore et al [25], Paradontax was tested in the studies of George Jacob [27], Ozaki [28] and Pannuti et al [29]. Barberry and Aloe vera gel was tested by Makarem [20] and Chandras et al [22] respectively.

Study conducted by Pannuti et al [29] and Devanand et al [15] was done on dental students. Hawthorne effect could have influenced the outcome of this study as mere participation in the trial could have improved the scores by motivating participants to adopt better oral hygiene behaviours irrespective of whichever group they were in.

The main mechanism by which herbal formulations resulted in decreasing gingival inflammation was by reducing markers of inflammation like IL-1β, IL-6, IL-10, IFN-γ and also reduces the pathogenic bacteria count in the oral cavity.

The review results suggest that herbal formulations in any mode improved gingival health in all the studies included and also reduced the bacterial count in the plaque as seen in the study done by Pradeep et al [14]. None of the studies had followed proper sample size calculation in recruiting study participants. Also, the fact that patient compliance determined the study results must not be overlooked in any study. None of the studies were conducted for a long term, so no data regarding adverse effect of any herbal formulation related to its long term usage is available till now. Clinical trials designed with larger sample size and for a longer time frame are recommended.

**Conclusion**

Based on the existing clinical evidence available, the review supports the effectiveness of herbal formulations in treating gingivitis. Studies involving amalgamation of various herbs to optimise their anti-plaque potential efficacy is needed to overcome the adverse side effects associated with the conventional plaque control formulations.

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