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Comparative efficacy of herbal mouthwashes and chlorhexidine on plaque index and gingival index reductions: A Narrative Review

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Abstract

Herbal mouthwashes have gained increasing attention as alternatives to chlorhexidine (CHX) due to growing concerns regarding the long-term side effects associated with chemical antimicrobials. Dental plaque and gingivitis represent early stages of periodontal disease and pose significant risks to oral and systemic health, underscoring the need for effective and well-tolerated plaque-control strategies. This narrative review aims to compare the antibacterial effectiveness of herbal mouthwashes and CHX by synthesizing findings from four recent clinical studies evaluating Triphala, lemongrass, neem–miswak–clove oil, and green tea–ginger formulations. The reviewed studies consistently demonstrated that herbal rinses produced meaningful reductions in Plaque Index (PI) and Gingival Index (GI), with several formulations achieving outcomes comparable to, and in some studies slightly exceeding, those of CHX. Antiplaque effects were observed across all herbal formulations, while reductions in gingival inflammation were particularly notable in neem–miswak–clove and green tea–ginger combinations, attributed to bioactive constituents such as polyphenols, flavonoids, gingerol, citral, and eugenol. Although variations existed in study duration, sample size, and standardization of herbal preparations, the collective evidence supports herbal mouthwashes as effective and safe alternatives to CHX, particularly for long-term use. These findings align with increasing patient preferences for natural oral care products and highlight the potential role of herbal formulations in modern preventive dentistry.

Keywords: Herbal Mouthwash; Chlorhexidine; Plaque Index; Gingival Index; Periodontal Health; SDG's 3

1. Introduction

Dental plaque and gingivitis represent the initial stages of periodontal disease and remain significant public health concerns due to their high prevalence and potential progression if inadequately managed. Dental plaque begins as a soft microbial deposit on tooth surfaces and gradually matures into a structurally complex biofilm composed of pathogenic bacteria capable of inducing gingival inflammation [1]. This inflammatory response manifests clinically as gingivitis, characterized by gingival redness, swelling, and bleeding. If left uncontrolled, gingivitis can advance to periodontitis, resulting in irreversible destruction of supporting periodontal tissues, including alveolar bone loss and eventual tooth mobility [2]. Recent evidence highlights that persistent plaque biofilm is also associated with broader systemic consequences, such as increased risks for cardiovascular disease and impaired glycemic control in diabetes patients, emphasizing the need for effective and preventive plaque-control strategies [3].

Chlorhexidine (CHX) has long been considered the gold standard of antimicrobial mouthwashes due to its broad-spectrum bactericidal and bacteriostatic activity, mediated through disruption of bacterial cell membranes and

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inhibition of enzymatic functions [3]. Its substantivity allows prolonged antimicrobial effects even after rinsing. However, despite its well-established efficacy in reducing plaque accumulation and gingival inflammation, CHX exhibits several drawbacks, including tooth staining, altered taste perception, and mucosal irritation, which may limit patient compliance, particularly during long-term use [4].

In response to these limitations, herbal mouthwashes have gained increasing attention as potential alternatives. These formulations derive their therapeutic activity from phytochemicals such as polyphenols, flavonoids, and essential oils found in plants including Triphala, lemongrass, neem, miswak, clove, green tea, and ginger. These bioactive components demonstrate antibacterial, anti-inflammatory, antioxidant, and anti-biofilm properties, enabling them to inhibit bacterial adhesion, disrupt plaque biofilm maturation, and improve gingival health [5, 6]. Herbal formulations are also generally associated with fewer adverse effects and are well-tolerated for long-term use, aligning with growing patient preferences for natural oral care products [2].

Recent clinical studies have further supported the potential of herbal rinses as viable alternatives to CHX. Findings from investigations using formulations such as lemongrass oil, Triphala, and green tea combined with ginger have demonstrated reductions in Plaque Index (PI) and Gingival Index (GI) comparable to those achieved with CHX mouthwash [7–10]. These results reinforce the relevance of herbal agents in modern oral hygiene protocols and highlight their potential role in addressing increasing concerns related to antimicrobial resistance and safety of synthetic chemical agents [1].

Despite the growing evidence, there remains a notable research gap: most existing studies evaluate a single herbal formulation against CHX, without integrating findings across multiple types of herbal rinses using standardized clinical indicators. As interest in natural oral care continues to rise, such comparative evaluations are essential to guide clinical recommendations and future innovation in herbal therapy development.

Therefore, the present narrative review aims to compare the antibacterial effectiveness of herbal mouthwashes and chlorhexidine on dental plaque and gingivitis by synthesizing data from four recent clinical studies assessing various herbal formulations.

1.1. Plaque Index

The Plaque Index (PI) is a widely utilized clinical measure for quantifying dental plaque accumulation at the gingival margin and is commonly assessed using the scoring system originally proposed by Silness and Löe, which remains the reference standard in contemporary periodontal research. Under this system, plaque accumulation is graded into four scores, ranging from score 0, indicating the absence of dextectable plaque, to score 3, representing heavy deposits of soft matter within the gingival pocket and on the tooth surface. Scores 1 and 2 denote the presence of a thin plaque film detectable by probing and moderate plaque accumulation visible to the naked eye, respectively. Recent periodontal studies emphasize that the PI serves as a fundamental indicator of oral hygiene status and plaque-related disease risk, with values calculated as the mean score across multiple tooth surfaces to reflect the overall plaque burden at the individual level [13, 14].

1.2. Gingival Index

The Gingival Index (GI) is a widely utilized clinical measure for quantifying gingival inflammation, categorized by Löe and Silness (1963) into four distinct grades. Under this system, scores range from an absence of inflammation (score 0) to severe clinical manifestations such as marked edema, ulceration, and spontaneous bleeding (score 3). Intermediate scores of 1 and 2 represent mild and moderate inflammation, respectively, distinguished primarily by the presence or absence of bleeding on probing. As noted by recent studies, the GI serves as a critical indicator of reversible periodontal status, calculated as an average across several tooth surfaces to reflect the overall inflammatory burden [11, 12]

2. Results and discussion

This narrative review synthesizes findings from four clinical studies evaluating the antibacterial effectiveness of herbal mouthwashes compared with chlorhexidine (CHX) in controlling dental plaque and gingivitis. Overall, the included studies consistently demonstrate that various herbal formulations produce clinically meaningful reductions in Plaque Index (PI) and Gingival Index (GI), with several formulations achieving outcomes comparable to, and in some cases exceeding, those of CHX. These findings highlight the potential role of herbal mouthwashes as effective adjuncts in plaque control and gingivitis management.

2.1. Antiplaque Effectiveness (Plaque Index Analysis)

Across the reviewed clinical studies, herbal mouthwashes demonstrated significant antiplaque effects, as reflected by reductions in Plaque Index (PI). The comparative effects of four herbal formulations (Triphala, lemongrass, neem–miswak–clove oil, and green tea–ginger) versus CHX on PI are summarized in Table 1

Table 1 Summary of Plaque Index (PI) reduction in four herbal mouthwash studies compared with chlorhexidine

	Herbal PI (Baseline → Final)	**PI Reduction (Herbal)**	**CHX PI (Baseline → Final)**	**PI Reduction (CHX)**	**Duration**	**Interpretation**
Triphala (Senkalvarayan P et al., 2023)	-	↓ 0.66	-	↓ 0.67	14-90 days	Trehala ≈ CHX
Lemongrass (Wasey A et al., 2023)	1.50 → 1.24	↓ 0.26	1.56 → 1.02	↓ 0.54	21 days	CHX > Lemongrass
Combination of Neem, Miswak, and Clove oil (Deshpande A et al., 2021)	1.18 → 0.48	↓ 0.70	1.10 → 0.51	↓ 0.59	14 days	Herbal ≈ CHX
Combination of Green tea and Ginger (Minervini G et al., 2024)	1.76 → 0.89	↓ 0.87	1.80 → 1.29	↓ 0.51	30 days	Herbal > CHX

Senkalvarayan et al. [9] reported that Triphala achieved PI reduction equivalent to CHX across several clinical trials. Wasey et al. [8] observed meaningful plaque reduction with lemongrass, although CHX demonstrated greater efficacy, likely due to the shorter intervention duration and the relatively simpler extract composition. Strong evidence for herbal effectiveness was provided by Deshpande et al. [10], showing nearly identical PI reductions between the neem–miswak–clove formulation and CHX. Minervini et al. [7] further reported that green tea combined with ginger produced greater plaque reduction than CHX over a 30-day period.

The reviewed evidence indicates that Triphala-based mouthwash achieved PI reductions comparable to CHX, suggesting equivalent antiplaque efficacy across the intervention period. Lemongrass mouthwash also produced a meaningful reduction in plaque accumulation; however, CHX demonstrated greater efficacy in this formulation, which may be attributed to the shorter duration of intervention and the relatively simpler phytochemical composition. In contrast, formulations combining neem, miswak, and clove oil demonstrated PI reductions closely approximating those of CHX, indicating strong antiplaque potential. Notably, the green tea–ginger combination achieved greater PI reduction than CHX over a 30-day period, highlighting the potential synergistic effects of polyphenols and gingerol in plaque control.

Variations in PI reduction among studies may be influenced by differences in participant characteristics, study duration, baseline oral hygiene status, and the phytochemical composition of the herbal preparations. Collectively, these findings suggest that herbal mouthwashes provide antiplaque effects that are largely comparable to those of CHX.

2.2. Gingival Inflammation Reduction (Gingival Index Analysis)

In addition to plaque control, the reviewed studies demonstrated significant reductions in Gingival Index (GI), reflecting the anti-inflammatory potential of herbal mouthwash formulations. A summary of GI changes observed across the four studies is presented in Table 2.

Table 2 Summary of Gingival Index (GI) reduction in four herbal mouthwash studies compared with chlorhexidine

	Herbal GI (Baseline → Final)	**GI Reduction (Herbal)**	**CHX GI (Baseline → Final)**	**GI Reduction (CHX)**	**Duration**	**Interpretation**
Triphala (Senkalvarayan P et al., 2023)	-	↓ 0.61	-	↓ 0.57	14-90 days	Trehala ≈ CHX
Lemongrass (Wasey A et al., 2023)	1.69 → 1.41	↓ 0.28	1.74 → 1.14	↓ 0.60	21 days	CHX > Lemongrass
Combination of Neem, Miswak, and Clove oil (Deshpande A et al., 2021)	1.40 → 0.36	↓ 1.04	1.20 → 0.38	↓ 0.82	14 days	Herbal > CHX
Combination of Green tea and Ginger (Minervini G et al., 2024)	1.99 → 1.22	↓ 0.77	1.87 → 1.36	↓ 0.51	30 days	Herbal > CHX

These observations are consistent with the supporting literature. Triphala demonstrated GI reductions similar to CHX in the study by Minervini et al. [7], indicating comparable effectiveness in controlling gingival inflammation. Lemongrass mouthwash produced a meaningful but moderate reduction in GI; however, its effectiveness remained inferior to CHX, as reported by Wasey et al. [8]. In contrast, two herbal formulations neem–miswak–clove oil [9] and green tea–ginger [10] demonstrated superior reductions in GI compared with CHX.

These enhanced improvements in gingival health are likely attributable to the presence of potent bioactive compounds such as eugenol, gingerol, and polyphenolic tannins, which exert strong anti-inflammatory and antioxidant activities. Collectively, the reviewed evidence confirms that herbal mouthwashes can provide reductions in gingival inflammation that are competitive with, and in certain formulations superior to, CHX.

2.2.1. Mechanistic Interpretation

The comparable clinical outcomes observed between herbal mouthwashes and CHX can be explained by differences in, yet complementary, mechanisms of action. Herbal formulations exert their effects through multiple bioactive pathways involving flavonoids, terpenoids, tannins, citral, gingerol, and eugenol, which contribute antimicrobial, antioxidant, astringent, and anti-inflammatory activities. These compounds inhibit bacterial adhesion, disrupt biofilm maturation, and modulate host inflammatory responses. In contrast, CHX acts primarily through cationic disruption of bacterial cell membranes and exhibits strong substantivity, allowing prolonged bactericidal and bacteriostatic effects. Despite these mechanistic differences, the multifactorial actions of herbal agents enable them to achieve comparable clinical effectiveness.

2.2.2. Study Limitations

Several limitations should be considered when interpreting these findings. The reviewed studies were characterized by relatively small sample sizes, short intervention durations (14–30 days), and limited standardization of herbal formulations. Additionally, most studies focused on clinical indices without incorporating microbiological or long-term safety assessments. These factors may limit the generalizability of the findings and highlight the need for larger, well-designed clinical trials with standardized herbal preparations.

2.2.3. Clinical Implications

Taken together, the findings of this narrative review support the potential use of herbal mouthwashes as viable alternatives to CHX, particularly for long-term use. Herbal formulations offer advantages such as favorable safety profiles and the absence of CHX-associated adverse effects, including tooth staining, taste alteration, and calculus formation. Herbal mouthwashes may be especially beneficial for orthodontic patients, individuals with mild to moderate gingivitis, and those seeking natural oral hygiene options with minimal side effects.

3. Conclusion

This review demonstrates that herbal mouthwashes exhibit plaque-reducing and gingival anti-inflammatory effects that approximate the clinical efficacy of chlorhexidine (CHX). Across formulations such as Triphala, lemongrass, neem, miswak, clove oil, and green tea combined with ginger, consistent reductions in Plaque Index and Gingival Index were observed, corroborating the outcomes of our primary investigation. These findings are biologically plausible given the antimicrobial and anti-inflammatory phytochemicals inherent in the herbal constituents. Although some limitations remain, including short study durations and variability in the standardization of herbal preparations, the overall evidence supports herbal mouthwashes as a safe and effective alternative to CHX, particularly for long-term use.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this manuscript.

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