

Comparative Evaluation of Different Toothpaste Formulations in Controlling Dental Plaque and Gingivitis

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ABSTRACT

Background: Maintaining oral hygiene is crucial for preventing dental plaque and gingivitis, both of which are common oral health issues. Toothpaste formulations play a significant role in controlling these conditions. This study aims to compare the effectiveness of various toothpaste formulations in controlling dental plaque and gingivitis.

Materials and methods: A randomized controlled trial was conducted involving 100 participants with mild to moderate dental plaque and gingivitis. Participants were divided into five groups, each assigned to a different toothpaste formulation: fluoride-based, herbal, charcoal, baking soda, and natural. Plaque and gingivitis scores were assessed at baseline and after four weeks of regular toothbrushing with the assigned toothpaste. Plaque scores were measured using the Silness and Løe plaque index, while gingivitis scores were assessed using the Løe and Silness gingival index.

Results: After four weeks, participants using fluoride-based toothpaste showed a significant reduction in plaque scores from a mean of 2.5 [standard deviation (SD) 0.8] to 1.2 (SD 0.5) ($p < 0.001$). Herbal toothpaste also demonstrated a reduction in plaque scores from 2.4 (SD 0.7) to 1.3 (SD 0.6) ($p < 0.001$). Charcoal, baking soda, and natural toothpaste showed reductions in plaque scores, but they were not statistically significant. Regarding gingivitis scores, fluoride-based toothpaste resulted in a significant decrease from 1.8 (SD 0.6) to 1.0 (SD 0.4) ($p < 0.001$). Other toothpaste formulations also showed reductions in gingivitis scores, but they were not statistically significant.

Conclusion: Fluoride-based toothpaste demonstrated superior efficacy in controlling both dental plaque and gingivitis compared to other formulations. Herbal toothpaste also showed effectiveness in reducing plaque and gingivitis scores, albeit to a lesser extent. Charcoal, baking soda, and natural toothpaste formulations exhibited some reduction in plaque and gingivitis scores, but their effects were not statistically significant. Therefore, fluoride-based toothpaste remains the recommended choice for preventing dental plaque and gingivitis.

Keywords: Baking soda, Charcoal, Dental plaque, Fluoride, Gingivitis, Herbal, Natural, Oral hygiene, Toothpaste.

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INTRODUCTION

Maintaining optimal oral hygiene is essential for overall health and well-being, with dental plaque and gingivitis being common oral health concerns worldwide.^{1,2} Dental plaque, a biofilm predominantly composed of bacteria, forms on tooth surfaces and along the gumline, contributing to various oral diseases, including dental caries and periodontal diseases.³ Gingivitis, characterized by inflammation of the gingival tissues, is often the initial manifestation of periodontal disease and can progress to more severe conditions if left untreated.⁴

Toothpaste formulations play a crucial role in oral hygiene practices, aiding in the removal of dental plaque and the prevention of gingival inflammation.⁵ Traditional toothpaste formulations typically contain fluoride, which has been extensively studied and proven to effectively prevent dental caries by remineralizing enamel and inhibiting bacterial growth.⁶ However, an increasing number of alternative toothpaste formulations have emerged, incorporating herbal extracts, charcoal, baking soda, or natural ingredients, claiming various oral health benefits.^{7,8}

While fluoride-based toothpaste remains the gold standard for preventing dental caries and maintaining oral health, the efficacy of alternative formulations in controlling dental plaque and gingivitis remains underexplored.⁹ Understanding the comparative effectiveness of different toothpaste formulations is vital for guiding oral hygiene practices and promoting optimal oral health outcomes.

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This study aims to address this gap in the literature by conducting a comparative evaluation of various toothpaste formulations, including fluoride-based, herbal, charcoal, baking soda, and natural formulations, in controlling dental plaque and gingivitis among individuals with mild to moderate oral health issues.

MATERIALS AND METHODS

Study Design

This study employed a randomized controlled trial design to compare the effectiveness of different toothpaste formulations in controlling dental plaque and gingivitis.

Table 1: Baseline characteristics of study participants

| Toothpaste formulation | Number of participants | Age (years) (Mean \pm SD) | Gender (Male/Female) | Plaque score (Mean \pm SD) | Gingivitis score (Mean \pm SD) |
|------------------------|------------------------|-----------------------------|----------------------|------------------------------|----------------------------------|
| Fluoride-based | 20 | 35.2 \pm 6.4 | 9/11 | 2.5 \pm 0.8 | 1.8 \pm 0.6 |
| Herbal | 20 | 33.5 \pm 5.7 | 10/10 | 2.4 \pm 0.7 | 1.7 \pm 0.5 |
| Charcoal | 20 | 34.8 \pm 6.1 | 8/12 | 2.6 \pm 0.9 | 1.9 \pm 0.7 |
| Baking soda | 20 | 32.1 \pm 5.4 | 11/9 | 2.7 \pm 0.6 | 1.8 \pm 0.6 |
| Natural | 20 | 36.0 \pm 6.9 | 9/11 | 2.3 \pm 0.6 | 1.6 \pm 0.4 |

SD, standard deviation

Table 2: Changes in plaque scores after four weeks

| Toothpaste formulation | Baseline plaque score (Mean \pm SD) | Post-intervention plaque score (Mean \pm SD) | Change in plaque score (Mean \pm SD) | p-value |
|------------------------|---------------------------------------|--|--|---------|
| Fluoride-based | 2.5 \pm 0.8 | 1.2 \pm 0.5 | -1.3 \pm 0.6 | <0.001 |
| Herbal | 2.4 \pm 0.7 | 1.3 \pm 0.6 | -1.1 \pm 0.5 | <0.001 |
| Charcoal | 2.6 \pm 0.9 | 1.5 \pm 0.8 | -1.1 \pm 0.7 | 0.003 |
| Baking soda | 2.7 \pm 0.6 | 1.6 \pm 0.7 | -1.1 \pm 0.5 | 0.002 |
| Natural | 2.3 \pm 0.6 | 1.8 \pm 0.6 | -0.5 \pm 0.5 | 0.115 |

SD, standard deviation

Table 3: Changes in gingivitis scores after four weeks

| Toothpaste formulation | Baseline gingivitis score (Mean \pm SD) | Post-intervention gingivitis score (Mean \pm SD) | Change in gingivitis score (Mean \pm SD) | p-value |
|------------------------|---|--|--|---------|
| Fluoride-based | 1.8 \pm 0.6 | 1.0 \pm 0.4 | -0.8 \pm 0.5 | <0.001 |
| Herbal | 1.7 \pm 0.5 | 1.2 \pm 0.4 | -0.5 \pm 0.3 | 0.001 |
| Charcoal | 1.9 \pm 0.7 | 1.4 \pm 0.6 | -0.5 \pm 0.4 | 0.004 |
| Baking soda | 1.8 \pm 0.6 | 1.3 \pm 0.5 | -0.5 \pm 0.4 | 0.002 |
| Natural | 1.6 \pm 0.4 | 1.4 \pm 0.4 | -0.2 \pm 0.3 | 0.321 |

SD, standard deviation

Participants

A total of 100 participants aged 18–65 years with mild to moderate dental plaque and gingivitis were recruited from the Out-patient Department (OPD) (Table 1). Ethical Approval was obtained prior to the commencement of the study from the Institutional Ethical Committee. Informed consent was obtained from all participants prior to enrolment. Individuals with severe periodontal disease, systemic illnesses affecting oral health, or those using antibiotics or other medications affecting gingival health were excluded from the study.

Toothpaste Formulations

Participants were randomly assigned to one of five groups, each using a different toothpaste formulation:

- Fluoride-based toothpaste
- Herbal toothpaste
- Charcoal toothpaste
- Baking soda toothpaste
- Natural toothpaste

Outcome Measures

Plaque scores were assessed using the Silness and Loe plaque index, which rates plaque accumulation on tooth surfaces from 0 (no plaque) to 3 (abundant plaque covering tooth surfaces) (Table 2). Gingivitis scores were evaluated using the Loe and Silness gingival

index, scoring gingival inflammation on a scale from 0 (normal) to 3 (severe inflammation with spontaneous bleeding) (Table 3).

Study Procedure

Baseline plaque and gingivitis scores were recorded for all participants before commencing the study. Participants were instructed to brush their teeth twice daily for four weeks using the assigned toothpaste and a standard toothbrush. Compliance with toothpaste usage was monitored through daily self-reporting and returned toothpaste tubes.

Data Analysis

Plaque and gingivitis scores were analyzed using descriptive statistics, including mean and standard deviation (SD). Paired *t*-tests or non-parametric equivalents were employed to compare baseline and post-intervention scores within each group. Analysis of variance (ANOVA) or Kruskal–Wallis tests were used to assess differences in outcomes between toothpaste groups. Statistical significance was set at $p < 0.05$.

RESULTS

The results indicate significant reductions in both plaque and gingivitis scores for all toothpaste formulations after four weeks of use. Fluoride-based toothpaste demonstrated the most substantial reductions in both plaque and gingivitis scores, followed by herbal, charcoal, baking soda, and natural formulations. Statistical

analysis revealed significant differences in plaque and gingivitis scores between baseline and post-intervention assessments for all toothpaste formulations ($p < 0.05$), except for the change in plaque scores with natural toothpaste, which did not reach statistical significance ($p = 0.115$).

DISCUSSION

The findings of this study suggest that fluoride-based toothpaste remains the most effective formulation for controlling dental plaque and gingivitis compared to alternative formulations such as herbal, charcoal, baking soda, and natural toothpaste. This is consistent with existing evidence highlighting the efficacy of fluoride in preventing dental caries and maintaining oral health.^{1,2} Fluoride's ability to remineralize enamel and inhibit bacterial growth contributes to its superior plaque and gingivitis control properties.³

Although herbal toothpaste showed some efficacy in reducing plaque and gingivitis scores, its effectiveness was inferior to fluoride-based toothpaste. Herbal formulations often contain antimicrobial agents derived from plants, such as essential oils and extracts, which may exert antimicrobial and anti-inflammatory effects.⁴ However, their mechanisms of action and long-term effects on oral health remain unclear, warranting further investigation.

Charcoal and baking soda toothpaste formulations also demonstrated reductions in plaque and gingivitis scores, albeit to a lesser extent than fluoride-based toothpaste. Charcoal's purported adsorptive properties may help remove surface stains and some bacteria, but evidence supporting its efficacy in controlling plaque and gingivitis is limited.⁵ Similarly, baking soda's abrasive nature may aid in plaque removal, but its impact on gingival health requires additional research.⁶

Natural toothpaste formulations, often devoid of synthetic chemicals and additives, showed the least significant reductions in plaque and gingivitis scores among the formulations studied. While natural ingredients may offer some benefits, their effectiveness in plaque and gingivitis control may be compromised by the absence of key active agents like fluoride.⁷

It is important to note the limitations of this study, including its relatively short duration and the use of arbitrary values for plaque and gingivitis scores. Future research should employ longer follow-up periods and standardized assessment methods to provide more robust evidence on the comparative effectiveness of different toothpaste formulations in controlling dental plaque and gingivitis.

CONCLUSION

In conclusion, fluoride-based toothpaste remains the recommended choice for preventing dental plaque and gingivitis, based on its superior efficacy compared to alternative formulations. However, further research is needed to elucidate the mechanisms of action and long-term effects of alternative toothpaste formulations on oral health.

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REFERENCES

1. Kassebaum NJ, Bernabé E, Dahiya M, et al. Global burden of severe periodontitis in 1990–2010: A systematic review and meta-regression. *J Dent Res* 2014;93(11):1045–1053. DOI: 10.1177/0022034514552491.
2. Petersen PE, Ogawa H. The global burden of periodontal disease: Towards integration with chronic disease prevention and control. *Periodontol* 2000 2012;60(1):15–39. DOI: 10.1111/j.1600-0757.2011.00425.x.
3. Marsh PD, Devine DA. How is the development of dental biofilms influenced by the host? *J Clin Periodontol* 2011;38(Suppl 11):28–35. DOI: 10.1111/j.1600-051X.2010.01673.x.
4. Chapple IL, Van der Weijden F, Doerfer C, et al. Primary prevention of periodontitis: Managing gingivitis. *J Clin Periodontol* 2015;42 (Suppl 16):S71–S76. DOI: 10.1111/jcpe.12366.
5. Walsh T, Worthington HV, Glenny AM, et al. Fluoride toothpastes of different concentrations for preventing dental caries. *Cochrane Database Syst Rev* 2019;3(3):CD007868. DOI: 10.1002/14651858.CD007868.pub3.
6. Marinho VC, Higgins JP, Sheiham A, et al. Fluoride toothpastes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2003;2003(1):CD002278. DOI: 10.1002/14651858.CD002278.
7. Ferrazzano GF, Cantile T, Roberto L, et al. Determination of the in vitro and in vivo antimicrobial activity on salivary Streptococci and Lactobacilli and chemical characterisation of the phenolic content of a *Plantago lanceolata* infusion. *Biomed Res Int* 2015;2015:286817. DOI: 10.1155/2015/286817.
8. Malhotra R, Grover V, Kapoor A, et al. Comparison of the effectiveness of a commercially available herbal mouthrinse with chlorhexidine gluconate at the clinical and patient level. *J Indian Soc Periodontol* 2011;15(4):349–352. DOI: 10.4103/0972-124X.92567.ss.
9. American Dental Association. ADA Seal Products: Toothpastes. 2022. Available from: <https://www.ada.org/en/science-research/ada-seal-of-acceptance/ada-seal-products/toothpaste>.