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EFFECTIVENESS OF DIFFERENT ANTIMICROBIAL MOUTHWASHES ON THE MANAGEMENT OF HALITOSIS IN PATIENTS WITH PERIODONTAL DISEASE

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ABSTRACT

Background: Halitosis is a common condition that often coexists with periodontal disease and significantly impacts patients' quality of life. Antimicrobial mouthwashes are commonly recommended to manage oral malodor, yet their comparative effectiveness in reducing volatile sulfur compounds (VSCs) and improving periodontal health is not fully established.

Objective: This study aimed to evaluate the effectiveness of different antimicrobial mouthwashes—chlorhexidine, cetylpyridinium chloride (CPC), and essential oils—compared to a placebo in reducing halitosis and improving periodontal health in patients with periodontal disease.

Methodology: This randomized controlled trial was conducted at Islam Medical and Dental College Sialkot from April 2021 to September 2021. Total 125 patients diagnosed with moderate to severe periodontitis and halitosis. Participants were randomly assigned to one of four groups: 0.12% chlorhexidine, 0.07% CPC, essential oils-based mouthwash, or placebo (saline solution). Participants used the mouthwash twice daily after brushing. Primary outcomes were reductions in VSC levels, measured with a halimeter, and organoleptic scores assessed by calibrated examiners. Secondary outcomes included improvements in probing depth, clinical attachment level, and bleeding on probing. Data were analyzed using repeated measures ANOVA, and a p-value of <0.05 was considered statistically significant.

Results: At six months, significant reductions in VSC levels were observed in the CPC (57.1%) and essential oils (54.3%) groups compared to the chlorhexidine (48.6%) and placebo (14.3%) groups ($p < 0.001$). Organoleptic scores improved significantly in the CPC (1.3 ± 0.5) and essential oils (1.4 ± 0.7) groups ($p < 0.01$). The CPC group showed the greatest improvement in probing depth and clinical attachment level, with minimal adverse effects.
Conclusion: CPC and essential oils mouthwashes demonstrated superior efficacy in reducing halitosis and improving periodontal health compared to chlorhexidine and placebo, with minimal adverse effects.

Keywords: Antimicrobial mouthwashes, cetylpyridinium chloride, chlorhexidine, essential oils, halitosis, periodontal disease, volatile sulfur compounds

Introduction

Halitosis, commonly referred to as bad breath, is a widespread oral health issue that affects individuals globally. While often considered a mere social inconvenience, halitosis can have profound effects on an individual's psychological well-being and social interactions, leading to anxiety and diminished self-esteem.[1] The condition is typically classified into two types: oral and extra-oral halitosis. Oral halitosis, which accounts for approximately 90% of cases, originates from the oral cavity and is frequently associated with periodontal diseases such as gingivitis and periodontitis.[2] Periodontal disease involves the inflammation and destruction of the supporting structures of the teeth, and it has been recognized as one of the primary contributing factors to persistent halitosis.[3]

Halitosis is mainly caused by the production of volatile sulfur compounds (VSCs) such as hydrogen sulfide, methyl mercaptan, and dimethyl sulfide, which are released by anaerobic bacteria in the oral cavity during the degradation of proteins.[4] The tongue's dorsum, periodontal pockets, and other oral surfaces provide suitable environments for bacterial colonization, particularly in patients with periodontal disease. As periodontal pockets deepen due to tissue destruction, they become a reservoir for pathogenic bacteria, exacerbating the production of VSCs and the severity of halitosis.[5]

Antimicrobial mouthwashes have long been advocated as an adjunctive treatment for halitosis management due to their ability to reduce the bacterial population and VSC production. These mouthwashes contain active agents such as chlorhexidine, cetylpyridinium chloride, essential oils, and zinc salts, which target various bacterial species responsible for VSC production.[6] Chlorhexidine, for instance, is considered the gold standard for antimicrobial mouthwashes because of its broad-spectrum antibacterial properties and its ability to reduce plaque formation and gingival inflammation.[7] However, prolonged use of chlorhexidine can lead to side effects such as tooth staining, altered taste perception, and increased calculus formation, which limits its long-term application.[8] Other agents, such as essential oils, have been shown to offer a more favorable side-effect profile while still providing antimicrobial efficacy.[9]

The use of antimicrobial mouthwashes specifically for the management of halitosis in periodontal patients has been a subject of considerable interest in recent years. While mechanical debridement, such as scaling and root planing, remains the cornerstone of periodontal therapy, adjunctive use of antimicrobial mouthwashes may enhance therapeutic outcomes by addressing the microbial aspect of halitosis.[10]

In addition to reducing VSC levels, some mouthwashes also work by neutralizing sulfur compounds or forming complexes with them, rendering them non-volatile. Zinc salts, for instance, have been shown to neutralize VSCs effectively and are often included in formulations for patients with chronic halitosis.[11]

The rationale for this study is to evaluate the effectiveness of various antimicrobial mouthwashes in reducing halitosis among patients with periodontal disease, a common condition linked to bad breath. Current treatments often lack standardized approaches, and comparing different mouthwashes could help identify the most effective options. This could lead to better clinical outcomes and improved patient quality of life.

METHODOLOGY

This study was designed as a randomized controlled trial. The trial was conducted at Islam Medical and Dental College Sialkot from April 2021 to September 2021. Ethical approval was obtained from the institutional review board, and all participants provided written informed consent.

The sample size was determined using Open epi software (version 3.1.9.7), with a power of 80%, an alpha level of 0.05, and an effect size of 0.5, based on prior studies evaluating the effectiveness of mouthwashes in managing halitosis. This calculation resulted in a total sample size of 125 patients, allowing for a 10% potential dropout rate.

A total of 125 patients diagnosed with periodontal disease and suffering from halitosis were included in the study. Participants were selected according to the following inclusion criteria: adults aged 25 to 65 years, with clinically diagnosed moderate to severe periodontitis, and exhibiting oral halitosis confirmed by halimeter readings (volatile sulfur compound levels above 150 parts per billion). Additionally, participants had not used antimicrobial mouthwashes in the past month and did not have systemic conditions known to cause halitosis, such as gastrointestinal disorders or sinus infections. Patients were excluded if they had known allergies to mouthwash ingredients, were smokers, or were undergoing antibiotic therapy.

Patients were randomly assigned to one of four treatment groups using a computer-generated randomization table. The first group was assigned to use a 0.12% chlorhexidine mouthwash, the second group used a 0.07% cetylpyridinium chloride (CPC) mouthwash, the third group used an essential oils-based mouthwash, and the fourth group was assigned a placebo saline solution. Each group consisted of 31 participants, ensuring balance across the groups.

Participants were instructed to use their assigned mouthwash twice daily, once in the morning and once in the evening, following tooth brushing. Each mouthwash rinse was to last for 30 seconds, and participants were advised to avoid eating or drinking for at least 30 minutes after using the mouthwash. All participants received standardized oral hygiene instructions, which included the use of a soft-bristled toothbrush and non-abrasive toothpaste. Additionally, professional dental cleanings were provided to all participants at the start of the study to ensure a consistent baseline in oral health.

The primary outcome of this study was the reduction of halitosis, which was measured using two key methods. First, a halimeter (Interscan Corp., Chatsworth, CA) was used to measure volatile sulfur compounds in parts per billion at baseline, and then again at 1, 3, and 6 months. Second, an organoleptic assessment was performed by two calibrated examiners, who assigned scores on a scale of 0 to 5 based on the intensity of the breath odor, with 0 indicating no detectable odor and 5 indicating extremely strong malodor. Additional outcomes included improvements in periodontal health, which were assessed by measuring probing depth, clinical attachment level, and bleeding on probing at both the baseline and the end of the study using a standard periodontal probe (UNC-15, Hu-Friedy).

The statistical analysis was performed using SPSS software (version 25.0). Baseline characteristics between groups were compared using one-way analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. The changes in volatile sulfur compound levels, organoleptic scores, and periodontal health indicators were analyzed using repeated measures ANOVA to assess the effectiveness of each mouthwash over time. A p-value of less than 0.05 was considered statistically significant throughout the analysis.

RESULT

Table 1 presents the demographics and baseline characteristics of the study participants. The mean age of the participants was 45.3 ± 10.2 years. Gender distribution was fairly balanced, with 60 participants (48.0%) being male and 65 (52.0%) being female. The mean baseline volatile sulfur compound (VSC) level, which measures the concentration of compounds contributing to halitosis, was 175 ± 22 parts per billion (ppb). The baseline organoleptic score, which assesses the severity of breath odor, was 4.1 ± 0.6.

Table 1: Demographics and Baseline Characteristics of Study Participants

Characteristic	Total (N = 125)
Age (years), mean ± SD	45.3 ± 10.2
Gender, n (%)	
Male	60 (48.0%)
Female	65 (52.0%)
Baseline VSC (ppb), mean ± SD	175 ± 22
Baseline Organoleptic Score, mean ± SD	4.1 ± 0.6

Table 2 shows that participants across all treatment groups were similar at baseline. The mean age ranged from 44.8 to 46.1 years with no significant difference (p = 0.72). Gender distribution was balanced across groups, with p = 0.88. Baseline VSC levels and organoleptic scores were also comparable among groups, with p-values of 0.81 and 0.67, respectively, indicating no significant differences in initial halitosis severity or demographic characteristics between the treatment groups**.**

Table 2: Baseline Characteristics of Participants by Treatment Group

Characteristic	Chlorhexidine (n=31)	CPC (n=31)	Essential Oils (n=31)	Placebo (n=32)	p-value
Age (years), mean ± SD	45.6 ± 10.4	44.8 ± 10.1	46.1 ± 9.9	45.0 ± 10.5	0.72
Gender, n (%)					
Male	15 (48.4%)	14 (45.2%)	14 (45.2%)	17 (53.1%)	0.88
Female	16 (51.6%)	17 (54.8%)	17 (54.8%)	15 (46.9%)	0.88
Baseline VSC (ppb), mean ± SD	176 ± 20	174 ± 21	177 ± 23	173 ± 25	0.81
Baseline Organoleptic Score, mean ± SD	4.1 ± 0.6	4.0 ± 0.7	4.2 ± 0.5	4.1 ± 0.7	0.67

Table 3 presents the primary outcomes for the reduction in halitosis across different treatment groups. At 6 months, the mean VSC levels were significantly lower in the CPC (75 ± 18 ppb) and essential oils (80 ± 20 ppb) groups compared to the chlorhexidine (90 ± 15 ppb) and placebo (150 ± 25 ppb) groups, with a p-value of <0.001, indicating a significant difference. The percentage reduction in VSC was highest in the CPC group (57.1%), followed by the essential oils group (54.3%), chlorhexidine group (48.6%), and placebo group (14.3%), with a p-value of <0.001, showing significant effectiveness of the CPC and essential oils treatments. The organoleptic score at 6 months also demonstrated significant improvements in the CPC (1.3 ± 0.5) and essential oils (1.4 ± 0.7) groups compared to the placebo group (3.5 ± 0.8), with a p-value of <0.01, indicating that both treatments were more effective in reducing breath odor compared to the placebo.

Table 3: Primary Outcomes - Reduction in Halitosis

Outcome Measure	Chlorhexidine (n=31)	CPC (n=31)	Essential Oils (n=31)	Placebo (n=32)	p-value
VSC Levels at 6 Months (ppb)	90 ± 15	75 ± 18	80 ± 20	150 ± 25	<0.001
% Reduction in VSC	48.6%	57.1%	54.3%	14.3%	<0.001
Organoleptic Score at 6 Months	1.5 ± 0.6	1.3 ± 0.5	1.4 ± 0.7	3.5 ± 0.8	<0.01

Table 4 displays the improvements in periodontal health across the different treatment groups. The mean reduction in probing depth was greatest in the CPC group (1.4 mm), followed by the chlorhexidine group (1.2 mm). The essential oils group showed a reduction of 0.9 mm, while the

placebo group had a minimal reduction of 0.2 mm. The p-value of <0.001 indicates significant differences, with CPC and chlorhexidine showing superior improvements over the placebo. The CPC group demonstrated the most significant improvement in clinical attachment level (1.2 ± 0.3 mm), followed by the chlorhexidine group (1.0 ± 0.4 mm). The essential oils group had a lesser improvement (0.8 ± 0.5 mm), and the placebo group showed a minimal improvement (0.1 ± 0.4 mm). The p-value of <0.01 indicates significant differences, favoring CPC and chlorhexidine. The CPC group had the highest reduction in bleeding on probing (65%), followed by the chlorhexidine group (60%). The essential oils group showed a 55% reduction, while the placebo group had a much lower reduction of 10%. The p-value of <0.01 reflects significant differences, with CPC and chlorhexidine showing more effective results compared to the placebo.

Table 4: Outcomes - Periodontal Health Improvements

Parameter	Chlorhexidine (n=31)	CPC (n=31)	Essential Oils (n=31)	Placebo (n=32)	p-value
Probing Depth Reduction (mm)	1.2	1.4	0.9	0.2	<0.001
Clinical Attachment Level Improvement (mm)	1.0 ± 0.4	1.2 ± 0.3	0.8 ± 0.5	0.1 ± 0.4	<0.01
Bleeding on Probing (% reduction)	60%	65%	55%	10%	<0.01

Table 5 summarizes the adverse events reported across the different treatment groups: Temporary Burning Sensation: This adverse effect was reported by 5 participants (16.1%) in the chlorhexidine group and 4 participants (12.9%) in the essential oils group. No cases were reported in the CPC and placebo groups. Six participants (19.4%) in the chlorhexidine group experienced altered taste, compared to 3 participants (9.7%) in the essential oils group. No cases of altered taste were reported in the CPC and placebo groups. None of the participants in any of the groups (chlorhexidine, CPC, essential oils, or placebo) discontinued the study due to adverse events.

Table 5: Adverse Events Reported

Adverse Event	Chlorhexidine (n=31)	CPC (n=31)	Essential Oils (n=31)	Placebo (n=32)
Temporary Burning Sensation, n (%)	5 (16.1%)	0 (0%)	4 (12.9%)	0 (0%)
Altered Taste, n (%)	6 (19.4%)	0 (0%)	3 (9.7%)	0 (0%)
Discontinuation Due to Adverse Events, n (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

DISCUSSION:

Halitosis, often associated with periodontal disease, is a widespread condition that can significantly affect quality of life. The major contributors to halitosis are volatile sulfur compounds (VSCs) produced by bacterial metabolism, making antimicrobial mouthwashes a key component of its management. Several types of mouthwashes are available, such as chlorhexidine, cetylpyridinium chloride (CPC), and essential oils, each with varying effectiveness in reducing oral malodor and improving periodontal health. This study aimed to compare the effectiveness of different antimicrobial mouthwashes on halitosis in patients with periodontal disease.[12,13]

The findings of this study align with previous research showing the efficacy of antimicrobial agents like CPC and essential oils in reducing VSC levels and improving breath odor. For instance, a study by Quirynen et al. (2002) found that mouthwashes containing essential oils and CPC were significantly more effective in reducing VSC levels compared to chlorhexidine, which is consistent with the current results where CPC showed a 57.1% reduction in VSC levels.[14] Similarly, Winkel et al. (2003) demonstrated that essential oils were effective in managing oral malodor, corroborating

the significant improvements observed in our study for both VSC reduction and organoleptic scores.[15]

However, our study differed slightly from others in terms of periodontal health improvements. While chlorhexidine has been traditionally regarded as the gold standard for periodontal treatment, this study found that CPC was superior in reducing probing depth and clinical attachment loss. This contrasts with the study by Faveri et al. (2006), which reported that chlorhexidine performed better in periodontal parameters. One possible explanation for this discrepancy could be the duration of treatment and patient compliance, as prolonged use of chlorhexidine can lead to side effects like altered taste and mucosal irritation, which may affect adherence.[16]

In terms of organoleptic scores, our study supports the findings of Bernardi et al. (2012), where essential oils and CPC led to a significant reduction in breath odor.[17] However, chlorhexidine, while effective, was associated with adverse effects such as burning sensations and altered taste, which are consistent with other studies such as by Addy et al. (2006), who reported similar side effects limiting its long-term use.[18]

While placebo-controlled studies like the one by Sanz et al. (2013) & Slots et al. highlight the minimal effect of placebo mouthwashes on halitosis and periodontal health, our findings reinforce the superiority of antimicrobial treatments. The placebo group in our study showed only a 14.3% reduction in VSC levels and minimal improvement in periodontal parameters, underscoring the necessity of using active ingredients to manage halitosis effectively.[19,20]

The major strength of this study lies in its randomized controlled trial design, which ensures high internal validity and minimizes bias. Additionally, the comparison between multiple active agents and a placebo adds to the robustness of the findings. However, the study's limitations include the relatively short duration (6 months), which may not capture the long-term effects and compliance challenges, particularly with agents like chlorhexidine. The sample size, though adequate, may not be representative of broader populations with varying severities of periodontal disease, limiting generalizability

Conclusion:

This study demonstrates that CPC and essential oils mouthwashes are significantly more effective than chlorhexidine and placebo in reducing halitosis and improving periodontal health. CPC showed the highest percentage reduction in VSC levels and the greatest improvements in clinical parameters with minimal adverse effects. These findings support the use of CPC and essential oils as superior options for managing halitosis in patients with periodontal disease.

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