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Comparing the Effects of Green tea and Peppermint Mouthwashes on Halitosis: A Single-blinded, Cross-over, Randomized Clinical Trial

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Objectives Herbal remedies can play a preventive role against oral malodor. This study aimed to investigate the clinical effects of green tea and peppermint mouthwashes on halitosis.
Methods In this cross-over, randomized clinical trial, 84 volunteers with an average organoleptic score of ≥2 were enrolled. The volunteers underwent two one-week phases of treatment with either green tea or peppermint mouthwash, divided by a one-week washout period. The main outcomes included the objective and subjective assessments of change in malodor. The organoleptic assessment was considered as the objective measure, while the participants' self-perception of the taste and smell of the mouthwash was considered as the subjective measure. The Wilcoxon signed-rank test was employed to evaluate the decrease in halitosis severity over a span of seven days for each mouthwash. This test was also used to compare the extent of halitosis reduction between the two mouthwashes.
Results Both green tea and peppermint mouthwashes significantly reduced the severity of halitosis (P<0.001). However, there was no significant difference in the reduction of the organoleptic level between the two mouthwashes (P=0.72). Additionally, there was no significant difference between the two groups in terms of self-reported satisfaction (P=0.78).
Conclusion Both green tea and peppermint mouthwashes were effective in the management of halitosis. Therefore, either of them could be prescribed for halitosis treatment based on the individual's taste preference.
Keywords Green tea; Halitosis; Malodor; Mouthwash; Peppermint

Introduction

Halitosis or bad breath is a general term used to describe an unfavorable odor in the oral cavity during exhalation and is one of the reasons for referral to dentists. [1] It can lead to concerns about one's health status and result in psychological and social problems. [2] The leading cause of halitosis is the production of volatile sulfur gas by anaerobic gram-negative microorganisms in the oral cavity. [3] It can develop as a consequence of periodontal diseases, caries, dry mouth, and tongue coating (as an intraoral source). [4] Moreover, it can be due to surgical site infections, often caused by recently identified bacterial species. [5-7]

One of the essential methods for the treatment of halitosis is the use of mechanical methods, including proper toothbrushing or the frequent use of dental floss or other auxiliary oral health equipment, such as interdental brushes, gum massagers, and tongue cleansers.[8] The use of mouthwash is considered a supplementary measure to the mechanical methods of oral hygiene, particularly for cleaning the dorsum of the tongue. Chlorhexidine digluconate is an effective mouthwash known for its anti-plaque and anti-gingivitis properties. [8, 9] Generally, complications arising from the use of chemical mouthwashes can lead to changes in oral health, which necessitate the use of supplementary mouthwashes with antibacterial and halitosis-reducing properties, but without any side effects.

Herbal drugs have both preventive and therapeutic effects in the management of halitosis. [10] It has been shown that herbs, alone or in combination, are useful, safe, and efficient agents against various oral problems, including gingival bleeding, halitosis, oral ulcers, and dental caries. [11] Herbal mouthwashes do not contain alcohol and sugar as two common components in other over-the-counter drug products. The main side effect of different alcohol- and sugar-containing mouthwashes is that they lead to the proliferation of microorganisms that are responsible for halitosis. Nevertheless, this complication can be prevented by using herbal mouthwashes. [11, 12]

The diverse geographic and climatic conditions of Iran have created an ideal environment for the growth of a wide variety of herbs and plants, used traditionally for the prevention and treatment of diseases. [13] Green tea or Camellia sinensis has various medicinal benefits due to its antibacterial and antioxidant properties. It contains high levels of polyphenol compounds with anticancer properties. [14] In an in vitro study, 1 mg/mL of catechin, as one of the green tea components, exhibited bactericidal activity

against periodontal odor-producing bacteria, such as Porphyromonas gingivalis and Prevotella. [14, 15] Catechin derivatives can reduce periodontal problems by inhibiting the collagenase and cysteine proteinase activity of P. gingivalis. [16] It can also inhibit the production of volatile sulfur compounds in the saliva. [17] Moreover, it has various therapeutic properties and can be applied in aromatherapy, mouthwashes, and toothpastes. [18] Based on previous research, its topical use can be useful in resolving itching and inflammation. [19]

Peppermint (Mentha piperita) is a perennial plant, which belongs to the Lamiaceae family and is known for its strong fragrance. Due to its commercial value and fragrance, it is cultivated in many parts of the world, including Europe, Asia, United States, India, and Mediterranean countries. [20] leaves are predominantly used due to the formulation of the extracted oil. Additionally, owing to the aromatic and flavoring properties of peppermint, it is utilized in cosmetic products, food items, and medicinal products. [21] It also has different therapeutic properties and can be used topically in oral therapy, mouthwashes, and toothpastes. [22]

Since the therapeutic and antibacterial effects of green tea and peppermint have been demonstrated in previous research, the present study aimed to compare the effects of green tea and peppermint mouthwashes on halitosis.

Methods and Materials

Study design

This single-blinded, cross-over, randomized clinical trial compared the efficacy of green tea and peppermint mouthwashes in the management of halitosis. The participants were evaluated at baseline. Also, two visits were scheduled at seven and 21 days post-treatment.

Participants

The volunteer dental students of Shahid Beheshti University of Medical Sciences with a chief complaint of halitosis participated in this study. They were included in the study using the convenience sampling method. The inclusion criteria were an organoleptic score of ≥2, lack of systemic diseases, and lack of antibiotic use. [23] The organoleptic severity was assessed using the organoleptic scale [24, 25]: 0: There is no detectable odor; 1: The odor is barely detectable; 2: A slight foul smell is present; 3: The foul smell is quite noticeable; 4: A strong foul smell is present; and 5: A very strong foul smell is present.

The volunteers were instructed to avoid consuming odor-producing foods, such as garlic or onion, and to refrain from chewing gums 48 hours prior to the organoleptic assessment. Additionally, they were asked not to smoke or consume alcohol 12 hours before their scheduled appointment for the organoleptic test. They were also instructed not to use any breath fresheners or breath sprays 24 hours prior to the evaluation. Moreover, they were requested to maintain their usual oral and dental hygiene routines throughout the study. [26, 27] Likewise, they were asked not to use any other mouthwash during the study.

Sample size

The sample size calculation was conducted using G*Power software. The aim was to detect an effect size of 0.35 with a significance level (α) of 0.05 and a study power of 80% for a two-tailed test with a paired design. The calculation determined that a minimum of 67 samples were required. However, to account for a potential 20% loss at follow-up, a total of 84 participants were included in the study.

Randomization and allocation

The students participated in two separate one-week treatment phases, which were divided by a one-week washout period. The order of treatment, whether with peppermint or green tea mouthwash, was determined through randomization. The participants were assigned to the groups using permuted blocks of two and four. The random sequence was generated using the Agricolae Package in R Software (R Foundation for Statistical Computing, Vienna, Austria), with a specified seed for reproducibility. The allocation of treatments was performed by the second researcher, who was not involved in the patient assessments. For group 1, the treatment began with the peppermint mouthwash during the first week, followed by a one-week washout period during which the subjects did not use any mouthwash. In the subsequent week, the students used the green tea mouthwash. For group 2, the order of mouthwash use was reversed.

Blinding

The assessors were blinded to the type of mouthwash (peppermint or green tea) provided for the students. The mouthwashes were supplied in identical bottles of the same shape and color. However, because of their taste, it was impossible to blind the students to the type of mouthwash. Therefore, the study was single-blinded.

Interventions

Preparation of mouthwashes

One kilogram of each plant was combined with 10 L of water in specialized containers. The mixture was then heated over flame until it reached the boiling point. Once boiling, the containers were removed from the flame and allowed to cool. The cooled mixture was then filtered through a filter paper. The filtered content was subsequently reheated using a bain-marie until a soft-boiled texture was achieved. From this process, a soft-boiled syrup with a concentration of 10% was produced. Once the pH of the mouthwashes was standardized to a level of six, they were transferred into special containers. The mouthwashes were prepared with a similar color in dark containers at the Pharmacology Department of Shahid Beheshti University of Medical Sciences. The participants

were trained to gargle 15 mL of the intended herbal mouthwash for 30-60 seconds after every meal (three times a day) and to avoid eating for the subsequent 30 minutes. It should be noted again that they were aware of the type of mouthwash.

Clinical assessments

The organoleptic assessment, as the gold standard test for diagnosing halitosis, was carried out at baseline and seven days after using the mouthwashes. Two expert clinicians performed the organoleptic test. According to the assessment criteria, halitosis was graded based on the examiner's perception of halitosis. The patients exhaled into a clear tube, and the examiner smelled the odor from a 30-cm distance (Figure 1) from the other side and graded the severity of halitosis accordingly. [24] The organoleptic test was performed among 15 dental students independently by both raters to evaluate the inter-rater agreement between the two expert clinicians. Furthermore, the students' satisfaction with the mouthwashes in terms of taste and smell was evaluated in each phase, using a three-point Likert scale ('bad', 'average', and 'good').

Figure 1: Organoleptic assessment

Statistical analysis

Wilcoxon signed-rank test was employed to compare the seven-day reduction in halitosis severity for each of the mouthwashes and to compare the extent of reduction in halitosis severity between the two mouthwashes. The same test was used to compare the students' self-assessments between two phases (peppermint vs. green tea). In addition, a generalized estimating equation (GEE) ordinal logistic regression analysis was performed to compare the effects of mouthwashes on halitosis reduction by controlling for the effects of relevant variables. The significance level was considered to be $P<0.05$ for all tests. Statistical analyses were performed using SPSS Version 21 (IBM Corp., Armonk, NY, USA).

Results

In this cross-over clinical trial, of the 225 dental students, 92 were included to investigate the effects of green tea and peppermint mouthwashes on halitosis (Figure 2). Four students were excluded due to non-cooperation (not using the mouthwash regularly at the specified times). Out of 88 students, 42 (47.7%) were male, and 46 (52.3%) were female. The mean (SD) age of the participants was 21.90±2.26 years (range, 19–28 years). The CONSORT flowchart of this study is presented in Figure 2.

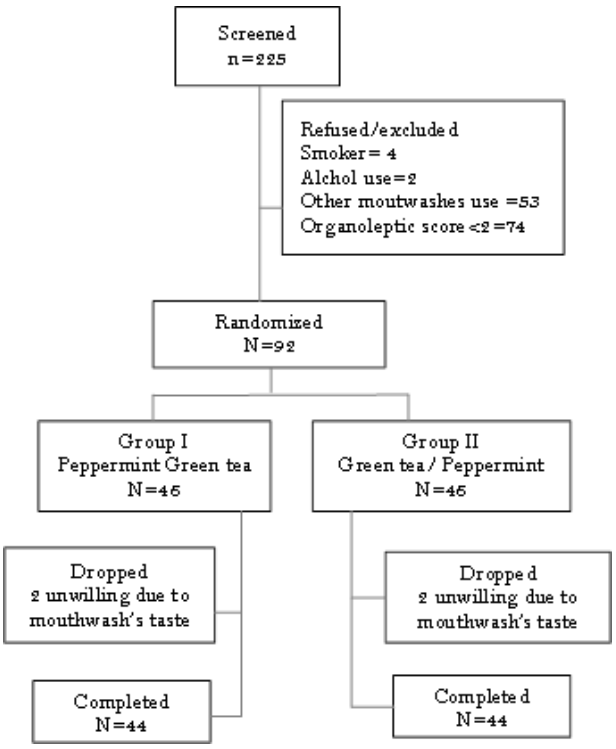

Figure 2: CONSORT participant flowchart. Disposition of subjects screened, randomized, and completing both treatment periods

At baseline, 12.5%, 39.8%, 36.4%, and 11.4% of the students' organoleptic test scores were 2, 3, 4, and 5, respectively. Table 1 shows the results of the organoleptic test for the peppermint and green tea mouthwashes on the seventh day. The degree of reduction in the halitosis severity was not significantly different between the peppermint and green tea mouthwashes after seven days ($P=0.72$). A significant reduction was observed in the severity of halitosis in both groups after seven days ($P<0.001$ and $P<0.001$).

Table 1- The results of Organoleptic test for the peppermint and green tea mouthwashes

	Peppermint 7 days N (%)	Green tea 7 days N (%)
Score 0	0 (0%)	0 (0%)
Score 1	32 (36.4%)	34 (38.6%)
Score 2	39 (44.3%)	30 (34.1%)
Score 3	14 (15.9%)	23 (26.1%)

Score 4	3 (3.4%)	1 (1.1%)
Score 5	0 (0%)	0 (0%)

Additionally, a GEE ordinal logistic regression analysis was carried out to investigate the effect of mouthwash type on the severity of halitosis by controlling for the effect of variables, such as the severity of halitosis at the beginning of the study and after using the mouthwash (Table 2). The effect of peppermint on halitosis reduction was similar to that of green tea (OR=1.103, 95% CI: 0.649–1.876).

Table 2- The results of GEE logistic regression to evaluate the effect of mouthwash type on changes in halitosis severity

Variables		OR	95% confidence interval for OR	P-value
Intercept	Strong foul smell	0.002	(0, 0.034)	0.000
	Foul smell	0.027	(0.001, 0.564)	0.020
	Hard-to-discern foul smell	0.151	(0.008, 3.020)	0.216
Group	Mint	1.103	(0.649, 1.876)	0.717
	Green tea	1		
Stage	Mint (the first time)	0.902	(0.532, 1.527)	0.700
	Green tea (the first time)	1		
Gender	Female	1.337	(0.744, 2.402)	0.331
Intercept	Male	1		
Baseline halitosis severity		0.848	(0.617, 1.164)	0.306
Age		0.914	(0.798, 1.046)	0.191

In terms of the taste and smell of the mouthwash, the participants evaluated the green tea and peppermint mouthwashes as poor, moderate, or good. For the green tea mouthwash, 12% of the students rated it as poor, 49.9% as moderate, and 38.55% as good. On the other hand, the peppermint mouthwash received a poor rating from 7.10% of the students, a moderate rating from 56%, and a good rating from 36.90% (Figure 3). However, there was no significant difference between the two mouthwashes in terms of the students' self-assessment (P=0.78).

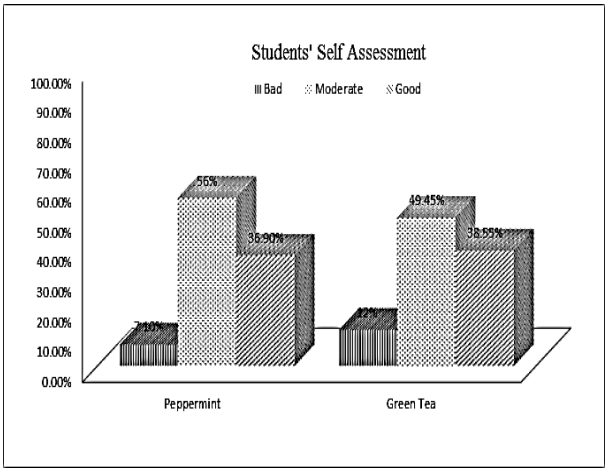

Figure 3: The relative distribution of personal satisfaction in the peppermint and green tea groups

Discussion

Considering the lack of a standard treatment for the management of halitosis [8] and in the light of the therapeutic and antibacterial effects of green tea and peppermint [18, 19, 28-30], this study evaluated and compared the effects of green tea and peppermint mouthwashes on resolving halitosis.

The majority of research conducted on green tea and peppermint has been experimental, focusing primarily on their antibacterial properties. However, there have been limited human studies investigating their effects on halitosis. [23-33] In the present study, the effectiveness of peppermint and green tea in the management of halitosis was confirmed, and a significant difference was observed in the organoleptic reduction after consuming both mouthwashes. Furthermore, a general comparison of the organoleptic reduction between the green tea and peppermint groups revealed that there was no significant difference in the reduction of halitosis severity between the two groups.

In this regard, Haghgoo et al. [34] investigated the effect of peppermint mouthwash on halitosis in high school students and reported that peppermint mouthwash effectively resolved halitosis. The results of that study was similar to the present findings regarding the effectiveness of peppermint in resolving halitosis. Similarly, in the study by Haghgoo et al., the organoleptic method was used to assess halitosis. They also asked the subjects to gargle 15-20 mL of the intended herbal mouthwash for 30 seconds after every meal (three times a day) and to avoid consuming food in the next 30 minutes for one week. After this interval, the halitosis test was performed.

Moreover, Lodhia et al. [17] examined the effects of green tea and sulfur compounds in the oral cavity. They demonstrated that in comparison to toothpaste, mint, parsley, and chewing gum, green tea was more effective in temporarily reducing halitosis, which can be attributed to its anti-infective properties and aromatic activity. The oral odor measurement method in their study was chromatographic, which is different from the organoleptic

method used in the present study. The authors of that study found green tea to be superior to other substances, including mint, apparently contradicting the present results. The discrepancy could be potentially attributed to differences in the characteristics of the study samples.

Additionally, Farina et al. [35] examined the effects of Curcuma and Camellia sinensis (green tea) on halitosis. They concluded that these herbs could be used in combination as a mouthwash. In this study, the assessment of halitosis was performed before using the mouthwashes, after one minute, and 90 minutes after their use, and the authors used an objective method for the assessments (a Halimeter). Despite some discrepancies regarding the effectiveness of mint in addressing halitosis, the results of the two aforementioned studies concerning green tea align with the findings of the present study. Furthermore, Moghbel et al. [36] assessed the effect of green tea extract on the oral bacterial activity in the presence of propylene glycol. They found that green tea could prevent plaque formation and the resulting halitosis. Given its abundance, availability, and widespread consumption in society, along with its significant anti-caries properties, the incorporation of this plant into the composition of mouthwashes is suggested.

A randomized clinical trial in 2013 evaluated the relationship between the daily reduction of halitosis and the use of mucoadhesive tablets with an herbal formula. That study showed the positive effect of the mucoadhesive tablets on preventing and resolving halitosis on a daily basis. Their results confirmed the present findings regarding the effectiveness of herbal mouthwashes. [37] Moreover, Rassameemasmaung et al. [38] reported that green tea mouthwash positively affected halitosis, dental plaque, and gingivitis. Their results were in line with the present findings, even when the authors used a mixture of green tea with propylene glycol, paraben, and saccharin. In addition, Hur et al. [39] reported that using an herbal oil containing tea, mint, and lime effectively reduced halitosis and volatile sulfur compounds in patients hospitalized in the intensive care unit. In that study, the herbs were used in combination, which made it difficult to accurately assess the individual effect of each herb.

Generally, in the symptomatic treatment of halitosis, it is essential to identify the oral factors inducing the disease in order to address their resolution. [40] The use of mechanical methods for oral hygiene, such as the proper use of a toothbrush, dental floss, and tongue cleaner, should be taught to patients. [41] Also, consuming fiber-rich foods, drinking ample amounts of water, and maintaining the cleanliness of dentures are crucial steps in addressing halitosis. Moreover, the use of herbal mouthwashes can serve as an effective supplement to these mechanical methods in alleviating halitosis. [8]

Overall, the present study revealed that both peppermint and green tea mouthwashes were effective in alleviating halitosis. The majority of participants expressed average to above-average satisfaction with these mouthwashes. Given their effectiveness in treating halitosis, the use of these mouthwashes can be encouraged for managing this condition.

This is the first study to compare the effects of green tea and peppermint on halitosis with a sample size of this magnitude. Since halitosis is primarily caused by poor oral hygiene, it is crucial to raise awareness among individuals, particularly those with halitosis. This will underscore the importance of oral health and its role in both preventing and treating halitosis.

The limitations of this study included the absence of simple and cost-effective access to precise and specific measures for the quantitative measurement of halitosis. Additionally, it is important to note that non-intraoral causes of halitosis, such as systemic causes, cannot be addressed through the use of these mouthwashes.

Conclusion

Based on the present results, there was no significant difference between peppermint and green tea mouthwashes in resolving halitosis. Considering the participants' satisfaction with both of these mouthwashes, they can be prescribed for the treatment of halitosis.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was registered on the Clinical Trials website under the code NCT03053882.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The authors declare that they have no conflict of interest.

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