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COMPARATIVE EVALUATION OF EFFECTIVENESS OF GREEN TEA MOUTH RINSE WITH PROBIOTIC MOUTH RINSE ON ORAL HALITOSIS AND GINGIVITIS

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ABSTRACT

Aim: To assess and compare the efficacy of Green tea mouth rinse and Probiotic mouth rinse on oral halitosis and gingivitis. **Materials and Methods:** The present study was a double blinded, parallel, randomized clinical trial. 54 patients were included in the study and were divided into three groups: Group 1 (n=18) were advised to use Green tea mouth rinse, Group II (n=18) with Probiotic mouth rinse and Group III (n=18) with distilled water mouth rinse. Presence of plaque and gingival inflammation was assessed by Turesky Gilmore Glickman modification of Quigley Hein Plaque index and gingival index at baseline, 2 weeks and 4 weeks. Oral halitosis was assessed by Winkles tongue coating index and Rosenberg Organoleptic scoring index at baseline and 4 weeks. **Results:** The mean gingival index, mean plaque index at post intervention in all three groups is statistically significant at p value 0.05. The mean gingival index, plaque index at post intervention was lowest in Group I followed by Group II and Group III in the descending order and is statistically significant at p value 0.05. The mean oral halitosis scores were lowest in Group I followed by Group II and Group III in the descending order. The mean tongue coating scores were lowest in Group I followed by Group II and Group III in the descending order. **Conclusion:** The study suggests that both rinses have a positive effect on reducing oral malodor and gingival inflammation, with green tea showing a more pronounced effect over the study period.

KEYWORDS: Halitosis, Oral Health, Dental Plaque, Volatile Sulfur Compounds, Mouth rinse.

INTRODUCTION

Oral health plays a pivotal role in an individual's overall well-being, with conditions such as halitosis and gingivitis affecting both physical health and social interactions. Oral halitosis, commonly referred to as bad breath, is often caused by the accumulation of volatile sulfur compounds produced by oral bacteria, while gingivitis, the inflammation of the gingiva, is a precursor to more serious periodontal disease. Addressing these issues is not only essential for improving quality of life but also for preventing further oral and systemic complications.[1]

In recent years, natural and alternative treatments have gained attention in the management of oral health conditions. Natural extracts has been studied for its potential benefits in reducing oral bacteria and promoting gingival health because of their rich antioxidant content and anti-inflammatory properties.[2] Similarly, probiotics have been shown promising results in restoring balance with beneficial microorganisms potentially reducing the presence of harmful bacteria that contribute to oral halitosis and gingivitis.[3]

Among these natural extracts, green tea has gained particular attention due to its favorable properties, such as anti-collagenase and cysteine protease activity against *Porphyromonas gingivalis*, as well as its anti-inflammatory and anti-mutagenic effects. Green tea contains polyphenols, notably four major catechins like epicatechin gallate, epigallocatechin gallate, epicatechin, and epigallocatechin. These catechins exhibit bactericidal properties and inhibit the adhesion of *Porphyromonas gingivalis* to oral epithelial cells. Additionally, these polyphenols reduce the production of pro-inflammatory cytokines, such as interleukin-6 and interleukin-8, and have been shown to inhibit volatile sulphur compounds (VSC) production, further reducing halitosis.[4]

Probiotis especially lactobacillus reuteri (L.reuteri), represent a novel approach in maintaining oral health by leveraging the body's natural defenses against harmful bacteria. Mouth is considered as the first part of the gastrointestinal tract and it is plausible that probiotic mechanisms of action in the gut could similarly impact oral health. Oral care probiotics are believed to modulate the oral microbiome through mechanisms such as competitive inhibition of pathogen adhesion and growth, direct antimicrobial effects by altering metabolic activity and environmental pH, and the production of antimicrobial compounds. Probiotics have also been shown to reduce VSC production by targeting intraoral biofilms.[5]

Despite of promising individual effects of both green tea and probiotics, there is limited research comparing their effectiveness in a clinical setting. Thus this study aimed to address this gap by conducting a comparative evaluation of green tea mouth rinse and probiotic mouth rinse in the management of oral halitosis and gingivitis, providing insights into their relative efficacy and potential for inclusion in routine oral care practices.

MATERIALS AND METHODS

The participants were randomly selected from outpatient Department and informed consent was obtained from all participants

The case record performa containing demographic data, gingival clinical findings, diagnosis along with format for recording indices at baseline, 2 weeks, and 4 weeks were prepared. The primary investigator was trained and calibrated for ten participants. Internal reliability was assessed using Cronbach’s alpha for Winkels tongue coating index (WTCI), Rosenberg Organoleptic scoring index (ROSI), Turesky Gilmore Glickman modification of Quigley Hein Plaque index (TQHPI) and gingival index (GI).

Sample size was calculated using G. Power software 3.1.9.2 with sample size of 60 with 20 patients in each group at 0.5 % level of significance with 90% power.

Inclusion and exclusion criteria

Participants aged 18–25 years of both genders with oral halitosis and gingivitis, possessing a minimum of 20 natural teeth, and who were systemically healthy without any physical or mental disabilities were included in the study. Participants who had taken antibiotics within the previous month, who had adverse reactions to lactose or fermented milk products, associated with systemic diseases known to cause halitosis, who were currently undergoing dental treatment were excluded.

Clinical procedure

60 participants were included in the study and were divided into three groups with 20 patients in each group. Out of which 6 participants were excluded as they are not willing to participate for fallow up. At baseline oral halitosis was assessed by Winkles tongue coating index.[6] (WTCI) and Rosenberg Organoleptic scoring index.[7] (ROSI). Presence of plaque and gingival inflammation were assessed by Turesky Gilmore Glickman modification of Quigley Hein Plaque index.[8] (TQHPI) and gingival index.[9] (GI). After recording indices patients received preintervention prophylaxis (scaling and polishing) and thorough oral hygiene instructions were given. Later group 1 (n=18) advised to use green tea mouth rinse, group II with probiotic mouth rinse (n= 18) and Group III advised to use distilled water mouth rinse (n = 18). Plaque and gingival indices were recorded at fallow up visits at 2 weeks and 4 weeks where as Winkles tongue coating index and Rosenberg organoleptic scoring index were recorded at 4 weeks fallow up. Figure 1 shows CONSORT study flow chart.

Mouthrinse Dispensation: Group allocation and dispensing of the mouth rinses were independently conducted by a separate investigator, ensuring that both the investigator and the participants were blinded in the study. Each participant was assigned with unique identification code and all participants were advised to take a 10 ml mouth rinse twice daily. Green tea and distilled water mouthwashes were dispensed in pre-sealed containers. Each container with 150 ml of mouthrinse is given every week week for up to 4 weeks. To maintain potency and efficacy, 14 probiotic capsules (containing *L. reuteri,* $2x10^9$ CFU) were also dispensed in pre-sealed containers every week for up to 4 weeks. Participants were instructed to freshly mix one capsule in 10 ml of water twice daily.

The mouthrinse and probiotic capsules were distributed to participants during each weekly visit. The quantity of mouthrinse provided at each visit was pre-calculated. Written instructions on mouthrinse usage were provided. All participants were instructed to rinse with 10ml undiluted mouthrinse for 30 seconds, 30 minutes after tooth brushing. They were not allowed to rinse with water for at least 20 minutes after using the mouthrinse. Participants were also advised to brush their teeth with a soft nylon toothbrush and a low-abrasive dentifrice. Mouth rinsing was performed at home. To ensure compliance, participants were asked to record the times of day when they used the mouthwash.

Plaque and gingival indices were recorded at baseline, 2 weeks, and 4 weeks after intervention whereas tongue coating and organoleptic ratings were assessed at baseline and 4 weeks post-intervention. Any subjective side effects like taste acceptability, burning sensation, dryness, or soreness of the mouth and objective side effects like staining of teeth or tongue, ulcer formation, or allergic reactions were recorded. Participants were instructed to maintain routine plaque control measures, including the use of mouthwash.

Statistical analysis: Data were analysed using Statistical Package for Social Sciences software version 20. (IBM Corporation, IBM, Armonk, NY, USA) The demographic characteristics of the study population were analyzed to assess baseline comparability. Gender distribution was evaluated using the Chi-square test, and age was analyzed using one-way ANOVA. Intragroup and intergroup comparison of plaque and gingivitis scores was done using one-way analysis of variance (ANOVA) test and repeated measures.

RESULTS

Male participants were more prevalent in the Green Tea group (61.1%), whereas female participants were more in the Probiotic (55.6%) and Distilled Water (55.6%) groups. However, no statistically significant differences was observed for gender ($P = 0.503$) or age ($P = 0.695$). The mean age of participants across all three groups was 22±2 years. Table 1 presents the demographic characteristics of gender and age.

The gingival index scores in green tea group decreased from 2.27 ± 0.46 at baseline to 1.66 ± 0.41 by the 2nd week and further to 1.48 ± 0.39 by the 4th week ($p<0.001$). Similarly, the Probiotic group showed a significant decline, with scores dropping from 2.31 ± 0.47 at baseline to 1.99 ± 0.40 at the 2nd week and 1.78 ± 0.37 at the 4th week ($p<0.001$). In contrast, the distilled water group exhibited the least reduction, with scores ranging from 2.31 ± 0.47 at baseline to 2.08 ± 0.54 at the 2nd week and 1.93 ± 0.55 at the 4th week ($p<0.001$). The plaque index scores in green tea group decreased from 4.20 ± 0.67 at baseline to 2.38 ± 0.20 at the 2nd week and further to 2.13 ± 0.20 at the 4th week. The Probiotic group also showed a notable reduction, with scores decreasing from 4.30 ± 0.47 to 2.67 ± 0.16 and then to 2.54 ± 0.14 ($p<0.001$). In contrast, the distilled water group exhibited the least improvement, with scores decreasing from 4.50 ± 0.26 to 3.60 ± 0.19 and then to 3.44 ± 0.19 ($p<0.001$). Table 2 presents the intragroup comparison of mean gingival index and mean plaque index scores across three timelines within the three study groups.

The gingival index scores at baseline were similar across all groups, with Green Tea (2.27 ± 0.46), Probiotics (2.31 ± 0.47), and Distilled Water (2.31 ± 0.47) ($P = 0.957$). By the 2nd week, gingival inflammation reduced in all groups, with the lowest score in the Green Tea group (1.66 ± 0.41), followed by Probiotics (1.99 ± 0.40) and Distilled Water (2.08 ± 0.54) ($P = 0.013$). By the 4th week, the trend continued, with Green Tea (1.48 ± 0.39) showing the greatest reduction, followed by Probiotics (1.78 ± 0.37) and Distilled Water (1.93 ± 0.55) ($P = 0.005$). The plaque index scores were similar in all three groups with Green Tea of 4.20 ± 0.67, Probiotics of 4.30 ± 0.47, and Distilled Water of 4.50 ± 0.26 ($P = 0.199$). By the 2nd week, plaque levels significantly decreased, with Green Tea of 2.38 ± 0.20 showing the lowest score, followed by Probiotics of 2.67 ± 0.16 and Distilled Water of 3.60 ± 0.19 ($P < 0.001$). By the 4th week, plaque reduction was most pronounced in Green Tea of 2.13 ± 0.20, followed by Probiotic of 2.54 ± 0.14 and Distilled Water of 3.44 ± 0.19 ($P < 0.001$). These findings indicate that Green Tea was the most effective in reducing both gingival inflammation and plaque accumulation, followed by Probiotics, while Distilled Water showed minimal improvement.Table 3 show intergroup comparison of mean gingival index scores, mean plaque index scores between three groups over three timelines.

Graph 1 show intergroup comparison of mean oral halitosis scores between three groups over two timelines. Three groups demonstrated a significant reduction in OLP scores at 4 weeks post intervention. Graph 2 show intergroup comparison of mean tongue coating scores between three groups over two timelines. Three groups demonstrated a significant reduction in tongue coating scores at 4 weeks post intervention.

Table 1: **Demographic study characteristics.**

Characteristics	Green tea (n=1[8])	Probiotics (n=18)	Distilled Water (n=18)	P value
Gender **Male** **Female**	 11 (61.1%) 07 (38.9%)	 08 (44.4%) 10 (55.6%)	 08 (44.4%) 10 (55.6%)	 0.503 (Chi-square)
Age (Mean ± SD)	22±2	22±2	22±2	0.695 (ANOVA)

Table 2: Intragroup comparison of mean gingival index scores, mean plaque index scores within the three groups over three timelines.

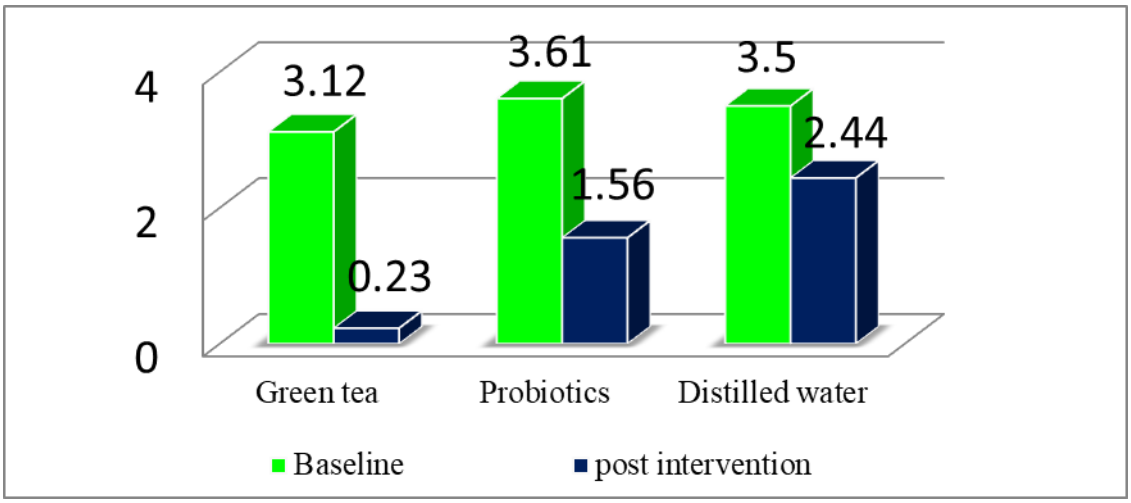
parameter	Groups	Baseline	2nd week	4th week	F*	P Value
Gingival Index	Green Tea	2.27 ± 0.46	1.66 ± 0.41	1.48 ± 0.39	66.385	0.000
	Probiotics	2.31 ± 0.47	1.99 ± 0.40	1.78 ± 0.37	127.206	0.000
	Distilled Water	2.31 ± 0.47	2.08 ± 0.54	1.93 ± 0.55	274.957	0.000
Plaque Index	Green Tea	4.20 ± 0.67	2.38 ± 0.20	2.13 ± 0.20	115.654	0.000
	Probiotics	4.30 ± 0.47	2.67 ± 0.16	2.54 ± 0.14	234.963	0.000
	Distilled Water	4.50 ± 0.26	3.60 ± 0.19	3.44 ± 0.19	213.463	0.000

*****Repeated measures ANOVA test* with significance level ($p<0.05$)

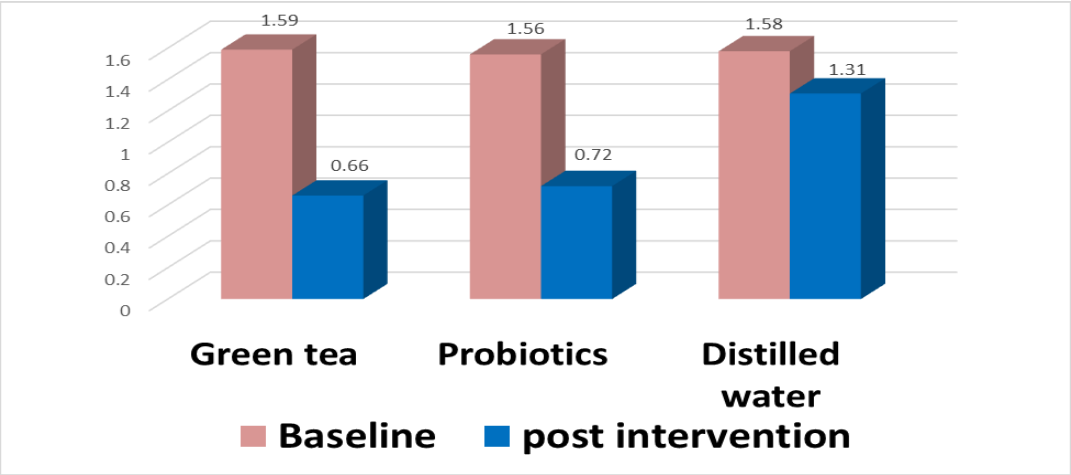
Table 3: Intergroup comparison of mean gingival index scores, mean plaque index scores in between the three groups over three timelines.

Parameter	Timelines	Green Tea	Probiotics	Distilled Water	F	P Value
Gingival Index	Baseline	2.27 ± 0.46	2.31 ± 0.47	2.31 ± 0.47	0.044	0.957
	2nd week	1.66 ± 0.41	1.99 ± 0.40	2.08 ± 0.54	4.741	0.013
	4th week	1.48 ± 0.39	1.78 ± 0.37	1.93 ± 0.55	5.975	0.005
Plaque Index	Baseline	4.20 ± 0.67	4.30 ± 0.47	4.50 ± 0.26	1.665	0.199
	2nd week	2.38 ± 0.20	2.67 ± 0.16	3.60 ± 0.19	202.718	0.000
	4th week	2.13 ± 0.20	2.54 ± 0.14	3.44 ± 0.19	236.890	0.000

*****Repeated measures ANOVA test* with significance level ($p<0.05$)



Graph 1: Comparison of mean oral halitosis scores among three groups over two timelines.



Graph 2: Comparison of mean tongue coating scores among three groups over two timelines.

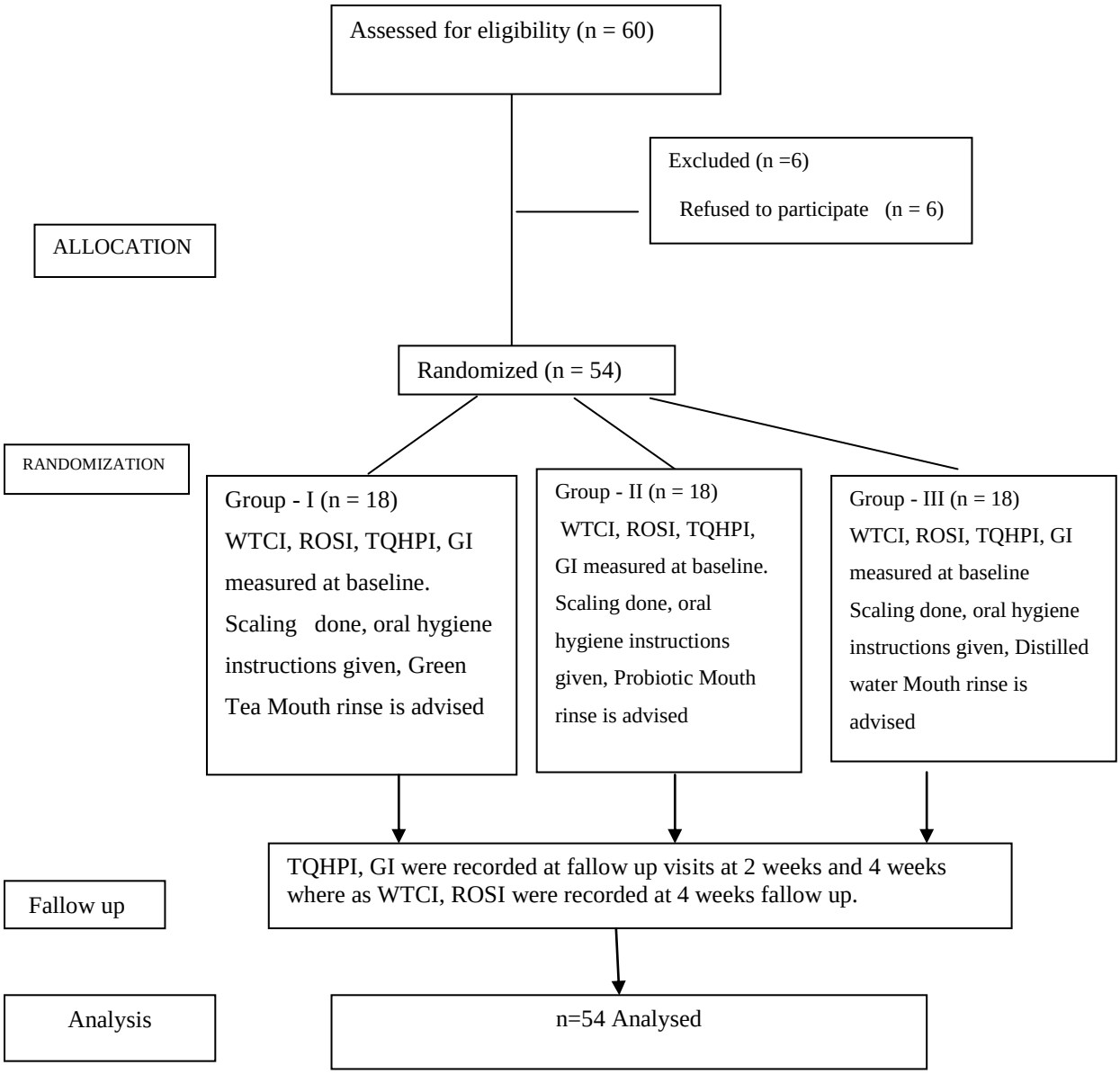


Figure 1: CONSORT Flow Diagram.

DISCUSSION

Oral malodor widely known as halitosis is a problem, which occurs in large proportion of the adult population, and it is one of the major reason why many people are motivated to persist with regular oral hygiene. Halitosis is a general term used to describe a foul odor emanating from the oral cavity in which proteolysis, metabolic products of the desquamating cells, and bacterial purifications are involved. Vast majority of the causes of oral halitosis relate to the oral cavity with gingivitis, periodontitis, and tongue coating as the predominant factors. Plaque control is a critical component of dental practice, permitting long-term success of periodontal and dental care. There is a growing interest throughout the oral health-care profession using therapeutic agents that complement and enhance the mechanical removal of biofilms in the oral cavity.[10]

Most of the mouth rinses, which contain modern chemicals such as chlorhexidine, have undesirable side effects, such as staining of teeth and taste alteration. Hence, there has been increased interest in Green tea and probiotic mouth rinses which appear to be effective in leveraging the body's natural defenses against pathogenic bacteria**,** promoting oral health by reducing both gingival inflammation and plaque accumulation.[11, 12]

Of the numerous herbal extracts, green tea (*C. sinensis*) has numerous medicinal benefits, mainly due to their antibacterial and antioxidant properties. Green tea has been widely used in topical and oral applications for disease treatment. The phenolic compounds in green tea may block the growth of bacteria responsible for tooth cavity and plaque formation.[13] Probiotics mouth rinse is believed to modulate oral microflora via a mechanism similar to intestinal probiotics which include competitive inhibition of adhesion and growth of pathogens, direct antimicrobial effect mediated by lowering metabolism and environmental pH and inhibit volatile sulfur compounds (VSC) production adherent to intra oral structures. The present study evaluated the effect of mouth rinse containing green tea or probiotic in reducing oral halitosis and gingivitis.[14]

Vivekananda et al in 2010 conducted study on effect of *Lactobacilli reuteri* (Prodentis) alone and in combination with scaling and root planing (SRP) in a double blind, randomized, placebo-controlled clinical trial of volunteers with siginificant reduction in gingival index and plaque index and results are in accordance with the present study.[15]

Keller et al in 2012 conducted a study to evaluate the effect of chewing gum containing *Lactobacills reuteri* probiotic bacteria on oral malodour and found statistically significant improvement in organoleptic score. The results of the present study are in accordance with the observations of the Keller et al study.[16]

Rassameemasmaung et al. in 2013 investigated the effects of green tea mouthwash on oral malodor, plaque, and gingival inflammation. Participants used the mouthwash twice daily for four weeks, and volatile sulfur compounds(VSC), plaque index, and papillary bleeding index levels were assessed. Their findings showed a 38.61% reduction in VSC levels in the green tea group, compared to 10.86% in the placebo group**,** highlighting the superior efficacy of green tea in controlling oral malodor. These results align with our study, supporting the potential use of green mouth rise helps in reduction of volatile sulfur compounds in gingivitis patients.[17]

Priya BM et al in 2015 compared the efficacy of the mouthwash containing green tea and chlorhexidine in the management of dental plaque-induced gingivitis and found that green tea-containing mouthwash is as equally effective

as chlorhexidine in reducing the gingival inflammation and plaque . The results of the present study are similar to Priya BM et al study.[18]

Morin et al. in 2015 conducted a study in 2015 provided evidence that green tea extract and its active component, EGCG, possess properties that effectively reduce *S. moorei*-related halitosis. These findings align with our study's results, suggesting that natural compounds like green tea extract could be valuable as supplements in oral healthcare products aimed at managing halitosis.[19]

Gizem İnce et al in 2015 conducted a study to evaluate the effect on clinical and biochemical parameters of Lactobacillus reuteri-containing probiotic supplementation adjunctive to initial periodontal therapy in patients with chronic periodontitis. Lozenges containin L. reuteri may be a useful supplement in moderately deep pockets of patients with chronic periodontitis. Low MMP-8 and high TIMP-1 levels may indicate the role of the lozenges in reduction of inflammation-associated markers up to day 180. The results of Gizem İnce et al study are in accordance to present study.[20]

Penala S et al in 2016 conducted a study to evaluate the efficacy of local use of probiotics as an adjunct to scaling and root planing (SRP) in the treatment of patients with chronic periodontitis and halitosis and showed statistically significant improvement in plaque index in probiotic group. The results of the present study are similar to penala S et al study.[21]

Singh O et al in 2019 compared and evaluated the effects of commercially available green tea mouthwash with chlorhexidine mouthwash on gingivitis and showed that green tea mouthwash was found to be more effective than the chlorhexidine mouthwash in reducing extensive levels of gingivitis. The results of the present study are similar to Singh O et al study.[22]

Sharma P et al in 2023 conducted a study to asses effectiveness of green tea extracts in reducing oral halitosis and tongue coating on Indian population and concluded that green tea mouth rinse is as effective as commercially available 0.2% chlorhexidine mouthwash in reducing plaque deposition, tongue coating, and oral halitosis. The present study results are in accordance to Sharma P et al study.[23]

A key limitation of the study is its short duration. Furthermore, a longer duration of the study could through light on the long-term advantages and disadvantages of the green tea mouthwash. Further research is needed to establish the level of substantivity, plaque inhibition, safety, and microbial parameters for daily plaque removal.

CONCLUSION

The present study showed that green tea mouthwash was found to be more effective than the probiotic mouthwash, in order to reduce gingivitis and halitosis. Both green tea mouthwash and probiotic mouth wash can be effectively used as an adjunct to mechanical plaque control in the prevention of halitosis and gingivitis. However well acceptance of green tea mouthwash by the participants is more than probiotic mouth wash because of altered taste sensation of probiotc. Both can be effectively used as adjunctive to scaling in patients with gingivitis and halitosis.

INSTITUTION AND ETHICAL APPROVAL

The participants were randomly selected from outpatient Department of Periodontology, SIBAR Institute of Dental Sciences, Guntur, Andhra pradesh, India. The present study was a double blinded, parallel, randomized clinical trial. Institutional Ethical Committee approval (Pr.254/IEC/SIBAR/2023) by the institution was obtained and informed consent was obtained from all participants.

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