SUPRA GINGIVAL PLAQUE REDUCTION USING IMPREGNARED DENTAL FLOSS IN NATURAL MOUTH WASHES IN COMPARISON TO CHLORHEXIDINE

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الاهداء

لم تكن الرحلة قصيرة ولا الطريق محفوفاً بالتسهيلات لكنني فعلتها فالحمدلله الذي يسّر البدايات وبلّغنا النهايات.

اهدي هذا النجاح لنفسي الطموحة، ابتدت بطموح وانتهت بنجاح، والى كل من سعى معي لإتمام مسيرتي الجامعية.

قال رسول الله (صلى الله عليه وسلم): "مَنْ صَنَعَ إِلَيْكُمْ مَعْرُوفًا فَكَافِئُوهُ، فَإِنْ لَمْ تَجِدُوا مَا تُكَافِئُونَهُ فَادْعُوا لَهُ حَتَّى تَرَوْا أَنَّكُمْ قَدْ كَافَأْتُمُوهُ".

أخيرًا، أتقدم بجزيل شكري الى مشرفي البحث الدكتورة ضحى مالك و الدكتورة دولت عبد الباري واعضاء لجنة المناقشة الكرام

و إلى كل من مدوا لي يد العون والمساعدة في إخراج هذه الدراسة على أكمل وجه.

contents

Abstract

Introduction Oral mouthwash is widely used in effective management of plaque removal. Commercially available oral mouthwash is a chemical substance that is likely to cause side effects, and significant research on natural substances is being conducted. In this study, natural mouthwashes were used and compared with chlorohexidine, to confirm antiplaque activity of the natural mouthwash.

Aim: In order to evaluate the antiplaque effects of natural mouthwashes, green tea mouthwash and ginger mouthwash were used and compared with chlorohexidine mouthwash.

Materials and Methods: samples of forty female dental students from the Faculty of Dentistry, University Babylon, Iraq, who were divided equally into four groups. The negative control group did not utilize any kind of interproximal cleaning; the positive control group used floss with impregnation twice a day in chlorohexidine; and the test groups used the dental floss, which was impregnated with green tea and ginger mouth wash twice a day. For all groups, this study lasted for thirty days. The presence of a biofilm was evaluated on four surfaces (mesiobuccal, distobuccal, mesiolingual and distolingual) by the Quigley–Hein Index, resulting in four scores for each tooth.

Results: In combination with flossing, it was reported no significant differences between green tea and chlorohexidine mouth washes ($P > 0.05$) and highly significant differences between ginger and chlorohexidine mouth washes ($P<0.001$).

Conclusion: The antiplaque effects of natural mouthwashes were excellent in comparison with that of the chemical chlorohexidine mouthwash.

Introduction

Dental plaque is a biofilm of microorganisms (mostly bacteria, but also fungi) that grows on surfaces within the mouth. It is a sticky colorless deposit at first, but when it forms tartar, it is often brown or pale yellow. It is commonly found between the teeth, on the front of teeth, behind teeth, on chewing surfaces, along the gumline (supragingival), or below the gumline cervical margins (subgingival). Dental plaque is also known as microbial plaque, oral biofilm, dental biofilm, dental plaque biofilm or bacterial plaque biofilm. Bacterial plaque is one of the major causes for dental decay and gum disease [(1)]. Progression and build-up of dental plaque can give rise to tooth decay – the localized destruction of the tissues of the tooth by acid produced from the bacterial degradation of fermentable sugar – and periodontal problems such as gingivitis and periodontitis [(2)] hence it is important to disrupt the mass of bacteria and remove it. Plaque control and removal can be achieved with correct daily or twice-daily tooth brushing and use of interdental aids such as dental floss and interdental brushes [(3)].

Oral hygiene is important as dental biofilms may become acidic causing demineralization of the teeth (also known as dental caries) or harden into dental calculus (also known as tartar. Calculus cannot be removed through tooth brushing or with interdental aids, but only through professional cleaning [(4)].

It is an eminent fact that plaque induces inflammatory changes in the periodontium. Plaque is the main cause of gingivitis and periodontitis and needs to be restrained or eliminated on a quotidian Plaque removal is crucial for a robust gingiva and dental flossing acts as an adjunct along with a toothbrush. Most of the individuals perform tooth brushing once or diurnally. Dental floss adds on to tooth brushing in the removal of plaque than in comparison to tooth brushing alone

particularly in interproximal areas [5]. Periodontal diseases generally start and are more noticeable in interproximal niches because they are ideal places for biofilm to grow and difficult to eliminate completely.

To provide adequate plaque removal from the interproximal areas, several interproximal cleaning devices such as interdental brushes and dental floss are advised. The morphology of gingival embrasures should be considered for selecting the most pertinent interdental device for each individual [6]. Less bleeding from the gums is seen in patients without periodontal attachment loss who brush and floss their teeth regularly in comparison to those who use a toothbrush only, thus suggesting that the use of dental floss might be advantageous for these patients. To maintain good hygiene in the interproximal areas of the teeth, depending on the embrasure area dental floss/unitufted or multitufted brushes are advised. It has already been the standard of care.

Along with mechanical control of dental plaque, there is a possibility of the chemical mode of prevention for which chlorhexidine has long been gold standard. Chlorhexidine acts by lysis of the bacteria and it also has a good substantivity. Although chlorhexidine mouthwash has certain drawbacks such as staining of the dentition and tongue and oral mucosal desquamation [7]. Natural, safe alternatives to commercial mouthwash include herbal mouthwash and mouth rinses made from natural extracts. These alternatives have been found to have fewer negative effects, are less toxic, and do not contain alcohol. mouthwashes formulated with natural herbs have shown good sensitivity to microorganisms in the oral cavity [8]. These natural alternatives can provide a safe and effective way to maintain oral health without the use of chemical compounds found in commercial mouthwash [9].

Dental plaque

Dental plaque is a soft, sticky film that forms on the teeth surfaces and is made up of bacteria, food debris, and saliva. It is the main cause of tooth decay, gum disease, and other oral health problems. Understanding what dental plaque is and how it forms is important for maintaining good oral hygiene and preventing oral health problems. Plaque begins to form on teeth just minutes after eating and drinking. If not removed, the bacteria in plaque produce acids that can erode tooth enamel and lead to cavities. Plaque can also irritate the gums and cause inflammation, which can eventually lead to gum disease [10].

The formation of plaque can be influenced by a number of factors, including diet, oral hygiene habits, and genetics. A diet high in sugar and carbohydrates can promote plaque formation. Certain medical conditions and medications can also increase the risk of plaque buildup. Preventing plaque buildup begins with good oral hygiene habits. This includes brushing teeth at least twice a day, flossing at least once a day, and using an antiseptic mouthwash. It is also important to visit the dentist regularly for checkups and professional cleanings, as the dentist can remove plaque and tartar that cannot be removed by brushing and flossing alone [11].

In addition to maintaining good oral hygiene habits, there are other steps to prevent plaque buildup. These include avoiding sugary and starchy foods and drinks, drinking plenty of water, and chewing sugar-free gum after meals to stimulate saliva production, which can help neutralize acid in the mouth [12].

If left untreated, dental plaque can lead to serious oral health problems, including tooth decay, gum disease, and tooth loss. By understanding what dental plaque is and how it forms, and by taking steps to prevent its buildup, you can maintain good oral health and overall health [13].

Plaque control

It is the removal of microbial plaque and the prevention of its accumulation on the teeth and adjacent gingival tissues. Besides it also deals with the prevention of Calculus formation. Plaque control is the most essential Step towards maintaining a proper and a healthy Oral Environment [14].

Methods of Plaque Control:

1. Mechanical Plaque Control
2. Chemical Plaque Control

Mechanical Plaque Control:

1) **Tooth Brushes:**

- Manual Toothbrush
- Electrical Toothbrush

2) **Interdental Aids:**

- Dental Floss
- Triangular Tooth Picks
- Interdental Brushes
- Yarn
- Superfloss
- Perio-Aid

Mechanical plaque control measures include toothbrushes such as manual, electric, ionic, chewable, ecological, end-tuft brushes and beam toothbrushes. Interdental aids

such as dental floss, triangular tooth picks, interdental brushes, yarn, superfloss, and perio-aid are also used [15].

Mechanical plaque control refers to the daily removal of supragingival microbial plaque and the prevention of its accumulation on the teeth and adjacent gingival surface using a tooth brush and other mechanical hygiene aids.[24] The objective of mechanical plaque control is the removal of dental plaque with a minimum effort, time, and devices, using the simplest methods possible [16].

Manual toothbrushing is the most common mechanical method. Toothbrushes have different types of head designs, angulations, shapes, sizes, and different types of bristles, these modifications made the plaque removal by these toothbrushes easier and more efficient. There have been many modifications in the design of manual toothbrushes, such as handle of the toothbrushes, bristles of toothbrushes, and shape and size of toothbrush heads [17].

Dental floss is one of the most widely used methods of interdental cleaning. It is used as an adjunct to toothbrushing especially in the interproximal areas where toothbrushes cannot reach. Different types of dental floss are found currently, which include floss with and without handle, flavored and unflavored floss, waxed and unwaxed floss, and floss classified according to the diameter such as thin, medium, and thick. Recently, with the integration of technology, powered flossing devices have also come into use (18). Tooth brushing alone will not remove plaque from all surfaces of the tooth as 40% of the surfaces are interdental.

One technique that can be used to access these areas is dental floss. When the proper technique is used, flossing can remove plaque and food particles from between the teeth and below the gums. The American Dental Association (ADA) reports that up to 80% of plaque may be removed by this method. The ADA recommends cleaning between the teeth as part of one's daily oral hygiene regime.

Types of floss include:

- Unwaxed floss: Unbound nylon filaments that spread across the tooth. Plaque and debris get trapped for easy removal.
- Waxed floss: less susceptible to tearing or shredding when used between tight contacts or areas with overhanging restorations.
- Polytetrafluoroethylene (Teflon): Slides easily through tight contacts and does not fray.

The type of floss used is a personal preference; however, without proper technique it may not be effective. The correct technique to ensure maximum plaque removal is as follows: Floss length: 15–25 cm wrapped around middle fingers.

1. For upper teeth grasp the floss with thumb and index finger, for lower teeth with both index fingers. Ensure that a length of roughly an inch is left between the fingers.

2. Ease the floss gently between the teeth using a back and forth motion.

3. Position the floss in such a way that it becomes securely wrapped around the interdental surface of the tooth in a C shape.

4. Ensure that the floss is taken below the gum margins using a back and forth up and down motion.

There are a few different options on the market that can make flossing easier if dexterity or coordination is a barrier, or as a preference over normal floss. Floss threaders are ideal for cleaning between orthodontic appliances, and flossettes are ideal for children and those with poor dexterity. Special flossettes are made for those with orthodontics [19].

Chemical plaque control:

Chemical plaque control using mouthwash is an adjunct to mechanical plaque control that inhibits the accumulation, growth, and survival of microbiota involved in plaque formation. Chemical agents such as Sanguinarine**,** Propolis, Cetylpyridinium chloride, Benzalconium chloride, Chlorhexidine, Alexidine, Octenidine, Octapinol, Delmopinol, Thymol, Hexylresorcinol, Eucalyptol, and Triclosan are used to control plaque formation by inhibiting the accumulation, growth, and survival of microbiota involved in plaque formation. Chemical agents act on the plaque structurally and prevent the formation of plaque, making them useful in prevention rather than cure. However, chemical plaque control cannot eliminate plaque when used as a monotherapy [(20)].

Mouthwash

Mouthwash, mouth rinse, oral rinse, or mouth bath is a liquid which is taken and held in the mouth passively or swished in the mouth and may be gargled and then spat out [(21)].

Chemical mouthwash

Chlorhexidine digluconate is a chemical antiseptic and is used in a 0.05–0.2% solution as a mouthwash. Chlorhexidine has good substantivity (the ability of a mouthwash to bind to hard and soft tissues in the mouth) [(22)]. It has anti-plaque action, and also some anti-fungal action. Chlorhexidine mouthwash alone is unable to prevent plaque, so it is not a substitute for regular toothbrushing and flossing. Instead, chlorhexidine mouthwash is more effective when used as an adjunctive treatment with toothbrushing and flossing [(23)]. Chlorhexidine mouthwash is an effective antiseptic agent. However, it may cause staining, alter taste perception, and increase tartar. Common side effects of chlorhexidine treatments include a dry mouth

and stained teeth. The most common side effects associated with chlorhexidine gluconate oral rinses are an increase in staining of teeth and other oral surfaces, an increase in calculus formation, and an alteration in taste perception. Oral irritation and local allergy-type symptoms have also been reported as side effect [24]

Natural mouthwash

Natural, safe alternatives to commercial mouthwash include herbal mouthwash and mouth rinses made from natural extracts. These alternatives are preservative free and contain essential oils which are not just antibacterial, but possess anti-inflammatory, antimicrobial and antifungal properties too [25]. They also have been found to have fewer negative effects, are less toxic, and do not contain alcohol [26]. mouthwashes formulated with natural herbs have shown good sensitivity to microorganisms in the oral cavity. These natural alternatives can provide a safe and effective way to maintain oral health without the use of chemical compounds found in commercial mouthwash [27]. there are several types of natural extracts that are incorporated in the mouthwash like green tea, ginger, cinnamon, Peppermint, Turmeric, mint and others.

Green tea mouthwash

There is an increasing demand for the usage of medicinal plants with antibacterial property. Green tea is a nonfermented type of tea and is considered as one of the ancient and widespread therapeutic beverages consumed worldwide [28]. Green tea extract mouthwash is a nontoxic and safe, particularly for children [29]. Catechins, the main bioactive ingredient of green tea, show an antibacterial action; thus, it has a promising effect in decreasing the count of salivary S. mutans and in the prevention of dental caries and have shown utility in the treatment of oral and topical infection [30][31]. So, using green tea mouthwash, with comparable bactericidal activity to that of chlorhexidine, is safer and more cost effective [32].

Green tea is among most popular beverages, with high daily consumption in Asia and especially in Iran. Several properties including antioxidant, anticaries, antibacter-ial, antiviral, antidiabetic, antimutagenic and antitumuralproperties are addressed for green tea. Green tea, Camellia Sinensis from the family of Thea Cease is mostlycultivated in coasts of Caspian sea in North of Iran. Its re-medial effects are associated with the polyphenol contentscomprising catechin (C), epicatechin (EC), gallocatechin(GC), epigallocatechin (EGC), epicatechin gallate (ECG),and epigallocatechin gallate (EGCG). The two latter aremainly found in green tea rather than the black tea andare among most potential contents to be reviewed forperiodontal adjunct therapies in terms of their specialanti-collagenase activity.In addition, it is suggested to inhibit the growth and cellular adherence of periodontal pathogens [33].

Ginger mouthwash

Ginger has antibacterial properties and can slow down the bacteria growth [34]. These properties are the result of the oil, resin, starch and spices found in ginger [35]. Ginger's powerful natural antibacterial properties helps to keep plaque and damaging bacterial buildup minimized. Its anti-inflammatory benefits can be ascribed to prostaglandin and leukotriene suppression as well as dual inhibition of eicosanoid biosynthesis can even make a toothache a lot more tolerable [36]. The oral health benefits of ginger are multifold. Ginger serves as a wonderful preventative method to keep your teeth and gums healthy [37].

Ginger is a rich source of antioxidants which act by scavenging superoxide anion, hydroperoxide, and hydroxyl free radicals. It also prevents lipid peroxidation (LPO) and inhibits NO synthesis. Compounds, such as 6 dehydroshogaol, 6-shogaol, and 1-dehydro-6-gingerdione, are the active ingredients implicated as potent antioxidants due to the presence of unsaturated ketone moiety in their structures. It was observed the antioxidant activity of ginger root by analyzing its components

such as vitamin C, β carotene, flavonoids, polyphenols, and tannins and concluded that maximum antioxidant activity is present in the alcoholic (methanolic) extracts. Hence, ginger can be considered as a functional food which has bioactive principles to protect against cell oxidation [38][39].

Showed its effectiveness against pathogens as antimicrobial activity routinely encountered in periodontal infections such as Prevotella intermedia, Porphyromonas gingivalis, and Porphyromonas endodontalis [40].

Materials and Methods

This study was conducted on forty female students in University of Babylon College of dentistry 5th stage, they all were 22 years old and without any systemic disease. Sample was carried out from November 2023 to March 2024. Three types of mouthwashes were used, natural (green tea and ginger) and chemical (CHX 0.12%). The students were randomly divided into 4 groups, 10 students in each group and each one were given a specific mouthwash, as follows:

- Group A: - 10 students (the control negative group).
- Group B: - 10 students (green tea mouthwash group).
- Group C: - 10 students (ginger mouthwash group).
- Group D: - 10 students (chlorhexidine 0.12% mouthwash control positive group).

Aims

The study was done to see the effects of natural mouthwashes compared with chemical mouthwashes on the supragingival plaque control in the interproximal area and maintaining good oral hygiene with minimal side effects.

Procedure

First, we picked a total of 40 students randomly from the dentistry college 5th stage they all were females, 22 years old and free of any systemic diseases. Second, the 40 students were randomly divided into 4 groups (10 each). Third, the plaque index was recorded for all the students in each group and the mean value for each patient

was recorded using disposable dental floss for the measurements. Then a specific mouthwash was given for each group, except for the control group (group A), and used by the students with dental floss for interproximal plaque control for a total of 30 days with mean plaque index measurements at day 15 and 30. The students were instructed to use the mouthwash along with the dental floss twice a day and a demonstration was done on how to use both the mouthwash and the dental floss in the interproximal area properly. After 15 days interproximal plaque index measurements were taken for all the patients in each group using disposable dental floss, and the procedure done again at the day 30 for another plaque index measurements. Finally, the final results for all the groups compared with each other to see the effectiveness of the natural mouthwash (green tea and ginger) compared to the chemical mouthwash (CHX 0.12%) on the supragingival plaque in the interproximal area.

Techniques and personalized instructions for toothbrushing and flossing were individually provided by Dental floss and chlorhexidine with another two natural mouth washes. For this study, only the anterior teeth were selected for evaluation, totalling twelve interproximal spaces on the upper arch and twelve on the lower arch. The choice to use only anterior teeth only was a tentative to facilitate flossing by the volunteers and also to make the dental biofilm visualization easier for the examiner.

The systematic use of the dental floss was established according to the American Dental Association (ADA) recommendations. The volunteers were instructed to introduce the dental floss in each interproximal space and perform three buccal–lingual movements against the mesial surfaces and three more against the distal surfaces. With the exception of the initial visit, daily oral hygiene procedures were not supervised. The researcher motivated the volunteers to perform this procedure twice a day in 12-h intervals. Subjects used only one piece of dental floss on the lower arch and another on the upper arch. On the posterior teeth, regardless of group distribution, the use of any of dental floss was allowed. At baseline appointment, the

volunteers received a printed frame that had 30 cells, each cell represented a period of the day, being two cells for each day. They were asked to mark one cell immediately after flossing. These printed frames were received in the last appointment day (15) and day (30) and assessed how often the floss was used. To achieve standard conditions, each volunteer received a kit that contained a new toothbrush with soft bristles. Fifteen and thirty days after the baseline appointment, the presence of the dental biofilm was evaluated only on four surfaces, resulting in four scores for each tooth (mesiobuccal, distobuccal, mesiolingual and distolingual). This amount of time was chosen for this study because 15 days after the biofilm control, carried out by a dental professional, the biofilm accumulation assessment may appear significantly. The four surfaces were assessed according to the Quigley–Hein Index, modified by Turesky et al.

An index that evaluates the plaque revealed on the buccal and lingual non-restored surfaces of the teeth on a scale of 0 to 5, defined by G. A. Quigley and J. W. Hein in 1962 and modified by S. Turesky, N. D. Gilmore, and I. Glickman in 1970. All teeth except the third molars are assessed. An index for the entire mouth is determined by dividing the total score by the number of surfaces examined [41][42][43].

Quigley–Hain plaque index

0 No plaque

1 Isolated flecks of plaque at the gingival margin

2 A continuous band of plaque up to 1mm at the gingival margin

3 Plaque greater than 1mm in width and covering one third of the tooth surface

4 Plaque covering from one third to two thirds of the tooth surface

5 Plaque covering more than two thirds of the tooth surface

Figure 1-chlohexidine mouthwash (Italy)

Figure 2- dental floss (Italy)

Figure 3-green tea mouthwash (Italy)

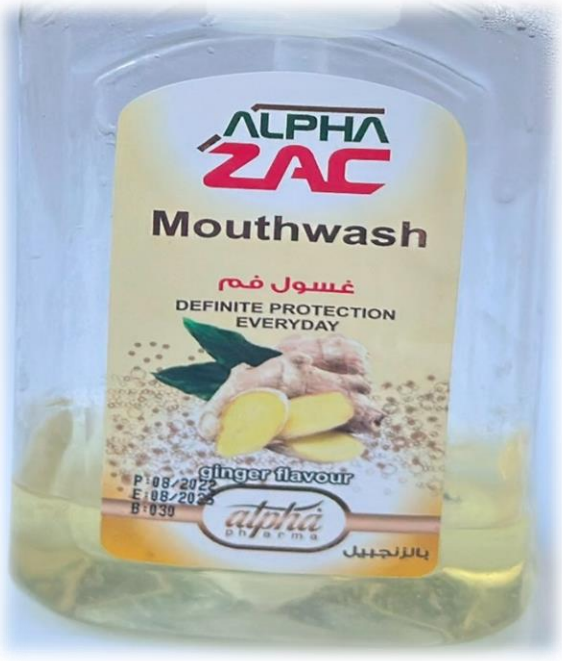

Figure 4-ginger mouthwash (Italy)

Figure 5-green tea mouthwash (Italy)

Figure 6-interproximal flossing

Figure 7-plaque measurements

Figure 8-plaque measurements

Results

Mean values, standard deviation, standard errors as a descriptive statistic for all groups with minimum and maximum values in Table (3.1) were explained.

Table: (3.1): Mean values, standard deviation, standard errors for all groups with minimum and maximum values.

Groups	No.	Mean	Std	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	10	2.9533	.26350	.08333	2.7648	3.1418	2.33	3.27
Ginger	10	1.8467	.21210	.06707	1.6949	1.9984	1.47	2.13
Green tea	10	2.3400	.22922	.07249	2.1760	2.5040	1.80	2.63
chx	10	2.2767	.28374	.08973	2.0737	2.4796	1.57	2.57
Total	40	2.3542	.46561	.07362	2.2053	2.5031	1.47	3.27

Anova in one way for comparison in general between groups using P value was shown in table (3.2). It was found highly significant differences between groups (P value< 0.001).

Table (3.2): Anova in one way for comparison in general between groups.

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.228	3	2.076	33.554	.000
Within Groups	2.227	36	.062		
Total	8.455	39			

Multiple comparison using Post Hoc Tests, comparison between two groups was shown in Table (3.3). It was found highly significant differences between groups (P value<0.001), except between CHX and green tea no significant differences (P value>0.5).

Table (3.3): Multiple comparison using Post Hoc Tests, comparison between two groups

		Mean Difference	Std. Error	Significance	95% Confidence Interval	
	Groups				Lower Bound	Upper Bound
Control	Ginger	1.10667*	.11124	.000	.8811	1.3323
	Green tea	.61333*	.11124	.000	.3877	.8389
	chx	.67667*	.11124	.000	.4511	.9023
Ginger	Control	-1.10667-*	.11124	.000	-1.3323-	-.8811-
	Green tea	-.49333-*	.11124	.000	-.7189-	-.2677-
	chx	-.43000-*	.11124	.000	-.6556-	-.2044-
Green tea	Control	-.61333-*	.11124	.000	-.8389-	-.3877-
	Ginger	.49333*	.11124	.000	.2677	.7189
	chx	.06333	.11124	.573	-.1623-	.2889
chx	Control	-.67667-*	.11124	.000	-.9023-	-.4511-
	Ginger	.43000*	.11124	.000	.2044	.6556
	Green tea	-.06333-	.11124	.573	-.2889-	.1623

Mean of plaque index of groups was shown in figure (3.1), it was shown plaque index was higher in control group then in green tea group and then in CHX group and it the lowest in ginger group.

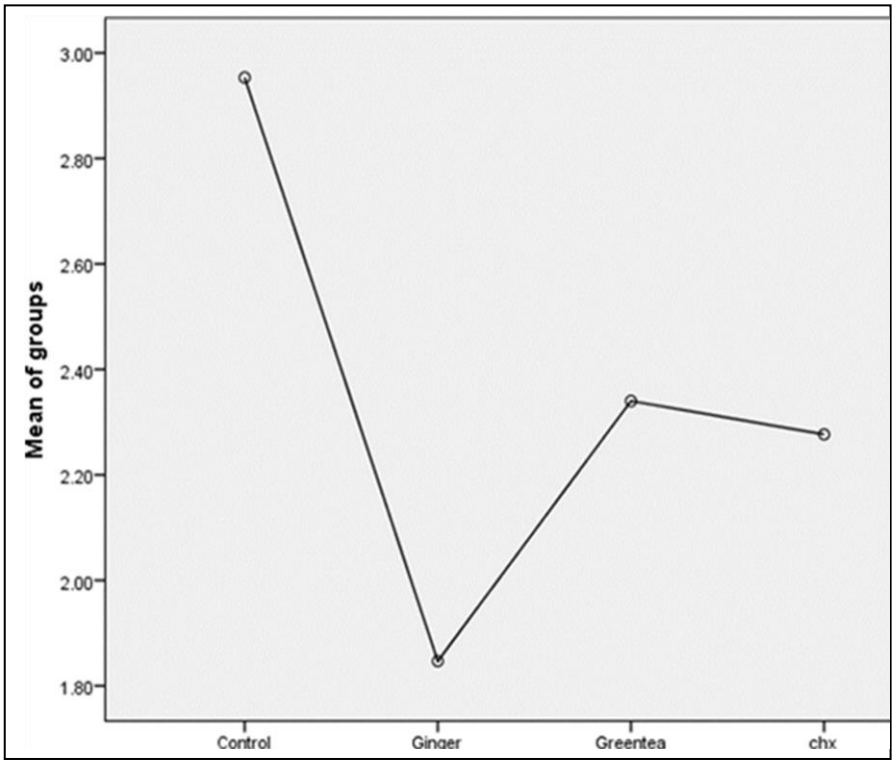

Figure (3.1): Mean of plaque index of groups.

Discussion

Mouth-rinse is most commonly used as an adjunct to the mechanical plaque control and is proven to be effective in providing complete plaque removal. chlorohexidine mouthwash, with its substantivity and anti-bacterial property, has been considered as a 'gold standard since long [(44)].

However, it is associated with certain adverse effects such as tooth-staining, burning of oral mucosa, and alteration in taste sensation [(45)].

Hence, there is a need for new herbal mouth-rinse with minimal side effects and improved patient compliance. Among various herbal agents used routinely, green tea and ginger are most commonly consumed worldwide. These plant extracts have antibacterial, anti-inflammatory, and anti-oxidant properties [(46)].

In this study, it was found no significant differences between green tea and chlorhexidine in its effects about reduction of supragingival plaque in combination with flossing. This attributed to that green tea, obtained from plant *C. sinesis*, is the most consumed beverage all over the globe and has been known for its medicinal benefits. Various *in vitro* as well as *in-vivo* studies have reported anti-inflammatory, anti-oxidant, and anti-microbial properties of green tea [(47)].

This property of green tea is associated with the presence of various catechins and polyphenolic compounds present in green tea. It also inhibits enzyme collagenase and metalloproteinase-9, thereby limits the destruction of the tissue and alveolar bone by periodontal pathogens [(48)(49)].

In this study, it was found reduction in supragingival plaque after using ginger mouth wash in comparison to chlorhexidine in combination with flossing with statistically highly significant differences ($P<0.001$). Ginger is known for its beneficial properties since centuries and is widely used as herbal medicine, owing

to anti-inflammatory, anti-oxidant property, and anti-microbial property. It has an ability to inhibit the synthesis of inflammatory mediators such as prostaglandins and leukotrienes by acting on enzymes cyclo-oxygenase and 5-lipoxygenase, respectively [50]. Furthermore, it is effective against pathogens such as *Prevotella intermedia, Porphyromonas gingivalis, and Porphyromonas endodontalis* responsible for gingivitis and periodontitis [51][52].

Conclusion

The results of the present study indicate that there was highly significant reduction in plaque score after using mouthwash containing ginger, followed by mouthwash containing chlorohexidine then mouth wash containing green tea (with no significant differences between green tea and chlorhexidine). Thus, it can be concluded that herbal mouthwash can be used effectively as an alternative to chlorohexidine and as an adjunct to mechanical plaque control represented by flossing.

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