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EFFECT OF CHEWING FENNEL AND CARDAMOM SEEDS ON DENTAL PLAQUE AND SALIVARY pH – A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT: Objectives: To know the effects of chewing the fennel and cardamom seeds on plaque and salivary pH. **Materials and Methods:** 50 subjects (aged 18-60 years) attending V.S dental College and Hospital who gave consent to participate were recruited for this clinical study. Subjects were randomized in to two groups for chewing fennel and cardamom seeds. Salivary pH and plaque PH at baseline and immediately after chewing seeds for 5 minutes and after 10 min was measured using calibrated glass combination electrode and analysed by ANOVA. **Results:** The mean salivary PH scores at baseline, immediately and 10 minutes after chewing fennel seeds was 7.1, 7.3 and 7.5 (p value 0.001). The mean salivary PH scores at baseline, immediately and 10 minutes after chewing cardamom seeds was 7.4 , 7.6 , 7.76 (p<0.05). The mean plaque pH scores at baseline, immediately and 10 min after chewing fennel seeds was 7.4, 7.55, 7.53 (p value 0.001). The mean plaque pH scores at baseline, immediately and at 10 min after chewing cardamom seeds was 7.73, 7.71, 7.83 which was not significant. **Conclusion:** Chewing both fennel seeds and cardamom seeds are equally effective in increasing salivary and plaque pH. Both the seeds can be used to lubricate and moisten the mouth, while at the same time providing caries protection to highly susceptible individuals.

INTRODUCTION: Many traditional medicines and medicinal plants have been used as a therapeutic agent for the maintenance of the health of the people. Since from ancient times plants have been used as herbal remedies for the treatment of various diseases and disorders. In India, some species and herbs have great economic importance, being utilized as foods and in medicine. These possess notable biological activities, in particular the antioxidant and antimicrobial action.¹⁻²

Foeniculumvulgare belongs to Umbelliferae family. It is commonly known as Fennel (English) and Saunf (Hindi). Foeniculumvulgare has a long history of usage in traditional medicine against various ailments. It is also used in many oral and dental care products for its antiseptic properties and can be used on its own as a breath freshener and for gum care in the form of fennel oil ¹. The extract of seeds inhibits the growth of micro-organism, especially Streptococcus mutans that are responsible for dental caries and periodontal diseases.³⁻⁴

Fennel fruit is a dry seed, traditionally used as anti-inflammatory, analgesic, carminative, diuretic and antispasmodic agent. Other uses of fennel are it is used in treatment of glaucoma, galactoaqoque and

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hypertension. It is also used for increasing urine flow, breast enlargement, promotes menstruation, improves digestive system, improves milk flow, in treatment of anxiety, arthritis, water retention angina, asthma and heartburn.⁴⁻⁵

Kang et al has found that Fennel essential oil may inhibit *S. mutans* biofilm formation and virulence factor expressions⁶. Ravi et al found a highly significant but a very transient drop in salivary pH on chewing fennel seeds, but plaque pH did not show any significant change.⁷

Cardamom, which is also known as the “queen of spices”, is one of the most widely known spices due to its strong aroma and flavour. Cardamom is said to be loaded with a variety of health promoting nutrients such as calcium, iron, phosphorous, volatile oil (cineole), flavonoids, and ether extracts.⁸

A study by Cohen et al indicate that cardamom flavoured chewing gum are effective in reducing the negative affect associated with nicotine withdrawal and may serve as a valuable tool in helping smokers quit.⁹ Aneja and Radhika conducted a study on the antimicrobial action of cardamom on the dental caries causing microorganisms. The study concluded that the cardamom extracts showed antimicrobial activity against oral pathogens like streptococci mutans and *Candida albicans*.¹⁰ Apart from this, its slightly pungent but pleasant taste stimulates salivary flow. Thus there is a strong possibility that cardamom can be used as a caries preventive agent.

Dental caries is closely linked to diet, salivation and the presence of a bacterial biofilm on dental surfaces. The drop of plaque pH creates an environment that helps the growth of acidophilic microorganisms, such as *Streptococcus mutans* and the *Lactobacilli*, which find the ideal conditions for promoting caries and with further pH drop and creates areas of demineralization of the dental enamel. Plaque pH therefore plays a fundamental role in balancing the biofilm flora on the tooth surfaces.^{11, 12, 13}

The buffering capacity of saliva also plays a fundamental role in balancing the phenomena of

demineralization and remineralization.¹⁴

Hence the purpose of present study was to know the effects of chewing the fennel seeds and cardamom seeds on the plaque and salivary pH.

MATERIALS AND METHODS:

The present randomized controlled trial was conducted to assess the variation in plaque and salivary pH after chewing the fennel seeds and cardamom seeds.

Study population and sample size:

Fifty Subjects among age group of 18-60 years visiting outpatient department of V.S Dental College and Hospital were selected. (Fig.1). Sample size estimation was done based on previous study by Ravi et al⁷, using the mean difference of 0.21 and standard deviation 0.24, with 80% power and 95% confidence interval the total sample size in each group was 22. For this 10% was added to compensate for the dropouts so that total sample was 50. (fennel seeds- 25 and cardamom seeds =25).

Ethical clearance was obtained from Institution Review Board of V.S Dental College and Hospital. Informed consent was obtained from study subjects. Inclusion criteria was Healthy Adults volunteers with age group 18-60 year who agreed to refrain from brushing and using any oral hygiene procedures for 24 hrs and with good physical and psychological conditions at the time of examination. Exclusion criteria was Subjects undergoing topical fluoride therapy, subjects on chemotherapeutic procedures, antibiotics and drugs having effect upon salivary function/salivary pH/plaque formation or plaque pH.

The subjects were assigned to one of two groups, for chewing fennel seeds or cardamom seeds using simple random sampling with the help of lottery method. Each group consisted of 25 subjects selected on the basis of inclusion and exclusion criteria. The study was conducted for a period of 40 days in the month of May – July, with clinical examination and analysis of salivary and plaque samples. Plaque index given by Sillness P and Loe H 1964 was used to record oral health status of participants at baseline before chewing fennel and

cardamom seeds. The examiner was trained and calibrated to record indices. The intra examiner reliability of the examiner recording plaque index was 0.90 which was considered as good. The scores of index teeth were recorded and average of scores represented study subject score. The group score was average of scores of twenty five study subjects allocated to that group.

Saliva and plaque collection and analysis of pH:

Appointments were arranged and consenting subjects were requested to refrain from brushing and using any other oral hygiene procedures for 24 hours in order to allow for plaque accumulation as mentioned in previous studies as the plaque harvesting technique. The subjects were requested to consume their normal diet and to avoid major deviations in diet prior to the study. Patients were also requested to refrain from eating or drinking anything (except plain water) 2 ½ hours prior to the appointment on the test day. The resting plaque and salivary pH was measured to record the baseline data. For measurement of salivary pH 2 ml of saliva was taken.

Plaque harvesting and pH measurement:

Plaque pH was measured using the method of Fosdick et al.¹⁵ modified by Frostell¹⁶ and Rugg-Gunn et al.¹⁷ On each test day, a sample of plaque was taken from the buccal surfaces of four sites of the subject's teeth using a sterile stainless steel straight probe. Subjects were asked to swallow immediately before plaque collection to minimize salivary contamination, and during sample collection care was taken to avoid contamination with blood or saliva. This formed the baseline plaque sample. The collection time for each sample was standardised (30 seconds). The plaque sample was mixed with 20 ml of distilled water and the pH was measured with a using a previously calibrated glass combination electrode. This formed the baseline saliva and plaque pH (S1 and P1). After determination of the baseline (S1 and P1) pH, the subjects were requested to chew a known quantity (1.3 grams) of fennel (*foeniculumvulgare*) seeds or 3 cardamom seeds for about five minutes. The plaque and salivary pH were measured again (S2 and P2) using the same methodology but taking the other half of the tooth for plaque collection immediately after chewing the seeds. A third

saliva sample (S3) and plaque sample (P3) was taken 10 minutes after chewing the seeds.

Salivary and plaque pH analysis:

Analysis of plaque and salivary pH was done through calibrated glass electrode cathode. Calibration of the system was carried out using standard solutions of pH 7.0 and 4.0, and tests of standards run randomly between the plaque pH readings. In between each reading the electrode was cleaned with a stream of distilled water and placed in a standard solution of pH 7.0. This ensured stable readings and a constant check on drift.

A pilot study was conducted on 10 subjects to assess the difficulties in collecting saliva and plaque samples and also in analysing the pH of the salivary and plaque samples.

Statistical analysis: The data was analysed with SPSS 19 software package. The difference in salivary and plaque pH values before, immediately and 10 min later after chewing fennel seeds and cardamom seeds was tested by using ANOVA. The difference in plaque scores between the two groups before and after chewing fennel and cardamom seeds was tested using Z test. For plaque index the mean score per subject were calculated. The value of $P < 0.05$ was accepted as statistically significant.

RESULTS AND DISCUSSION: The present randomized controlled trial assessed the variation in plaque and salivary pH after chewing the fennel and cardamom seeds. The mean age of study participants in fennel seeds chewing group was 32.8 and in cardamom seeds chewing group was 31.08. In fennel and cardamom seeds chewing group majority were males with 64% and 60% and females were 36% and 40% respectively in both groups (**Table 1**). Mean plaque score for fennel seeds group was 1.42 and for cardamom group was 1.17. There was no significant difference between two groups in mean plaque scores with P value 0.31. (**Table 2**).

Mean plaque pH scores:

For the fennel seed group at baseline the mean plaque pH was 7.4, immediately after chewing fennel seeds was 7.55 and after 10 min interval

7.53. The increase in salivary pH scores after chewing fennel was statistically significant with p value 0.001. For cardamom seeds chewing group at baseline the mean plaque pH was 7.73, immediately after chewing cardamom seeds was 7.75 and after 10 min interval 7.83. The increase in salivary pH scores after chewing cardamom seeds was statistically significant with p value 0.08. (Table 3) (Graph1).

Mean salivary pH scores:

For fennel seeds group at baseline the mean salivary pH was 7.1, immediately after chewing fennel seeds was 7.3 and after 10 min interval 7.5. The increase in salivary pH scores after chewing fennel was statistically significant with p value 0.001. For cardamom seeds group at baseline the mean salivary pH was 7.45, immediately after chewing cardamom seeds was 7.62 and after 10 min interval 7.76. The increase in salivary pH scores after chewing cardamom seeds was statistically significant with p value 0.03 (Table 4) (Graph 2)

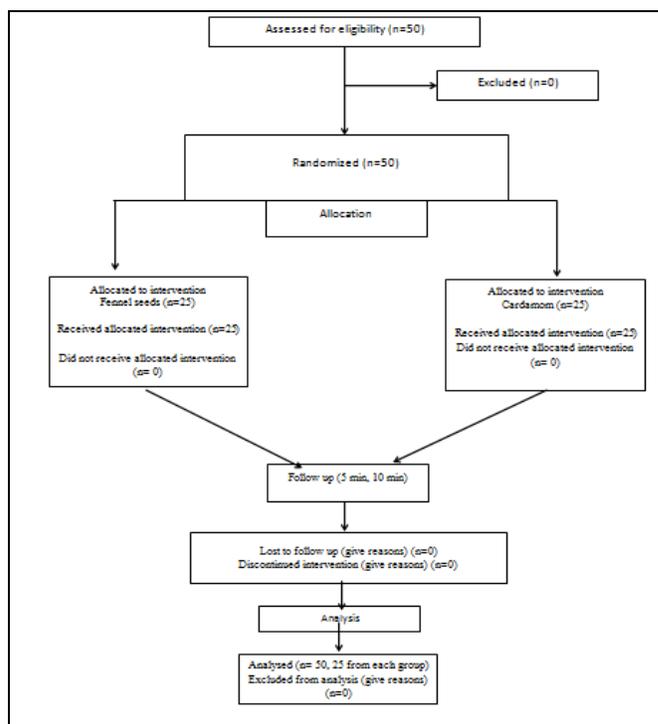


FIG. 1: SHOWING ALLOCATION OF STUDY PARTICIPANTS ACCORDING TO CONSORT 2010

TABLE 1: DISTRIBUTION OF STUDY SUBJECTS BASEDON GENDER AND AGE

Seeds chewed	Male N(%)	Female N(%)	Mean age
Fennel seeds	16 (64)	9 (36)	32.80±5.74
Cardamom seeds	15 (60)	10 (40)	31.08±5.44

TABLE 2: DISTRIBUTION OF STUDY SUBJECTS BASED ON PLAQUE INDEX SCORES (SILLNESS AND LOE) AT BASELINE

Groups	Plaque index(Sillness and Loe)			
	N	Mean (S.D)	Z value	p-value
Fennel seeds	25	1.42 (0.51)	1.02	0.31
Cardamom seeds	25	1.17 (0.62)		

*ANOVA (p≤0.05)

TABLE 3: DIFFERENCE IN PLAQUE pH SCORES BEFORE AND AFTER CHEWING FENNEL AND CARDAMOM SEEDS

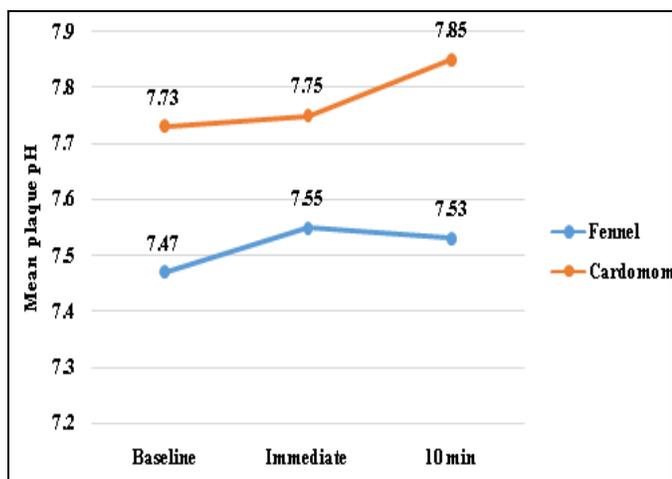
Group	Baseline plaque pH Mean (S.D)	Immediate plaque pH Mean (S.D)	10min plaque pH Mean (S.D)	F-value	p-value
Fennel seeds	7.4 (0.56)	7.5 (0.56)	7.51 (0.55)	0.126	0.001*
Cardamom seeds	7.7 (0.47)	7.7 (0.48)	7.8 (0.65)	0.238	0.08

*ANOVA (p ≤ 0.05)

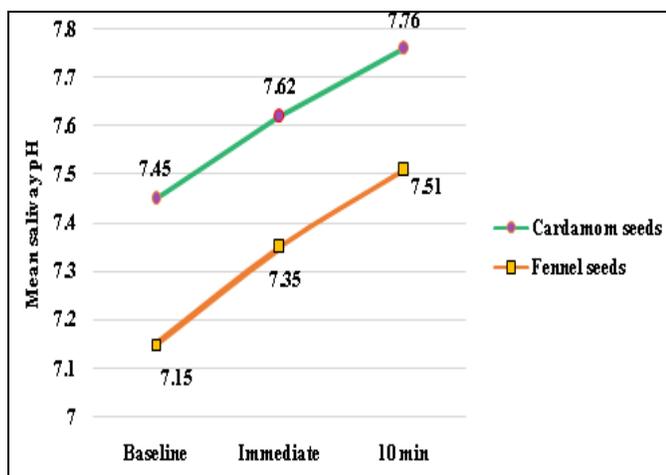
TABLE 4: DIFFERENCE IN SALIVARY pH SCORES BEFORE AND AFTER CHEWING FENNEL AND CARDAMOM SEEDS

Group	Baseline salivary pH Mean (S.D)	Immediate salivary pH Mean (S.D)	10min salivary pH Mean (S.D)	F-value	p-value
Fennel seeds	7.15 (0.61)	7.35 (0.56)	7.51(0.61)	2.385	0.001*
Cardamom seeds	7.4 (0.50)	7.62(0.53)	7.76 (0.55)	2.512	0.03*

ANOVA (p<0.05)



GRAPH 1: DISTRIBUTION OF STUDY PARTICIPANTS BASED ON MEAN PLAQUE pH SCORES AT BASELINE, IMMEDIATELY, 10 MIN AFTER CHEWING FENNEL AND CARDAMOM SEEDS



GRAPH 2: DISTRIBUTION OF STUDY PARTICIPANTS BASED ON MEAN SALIVARY pH SCORES AT BASELINE, IMMEDIATELY, 10 MIN AFTER CHEWING FENNEL AND CARDAMOM SEEDS.

DISCUSSION: The present randomized controlled trial assessed the variation in plaque and salivary pH after chewing the fennel seeds and cardamom seeds among 18-60 year old subjects. Traditionally, fennel seeds are used as anti-inflammatory, analgesic, carminative, diuretic and antispasmodic agents. Recently there has been considerable interest in the antioxidant potential and antimicrobial activities of fennel seed extracts and essential oil²⁻³. Cardamom, is one of the most widely known spices due to its strong aroma and flavor. It is also invaluable for its medicinal properties. Cardamom is said to be loaded with a variety of health promoting nutrients such as calcium, iron, phosphorous, volatile oil (cineole), flavonoids, and ether extracts⁸. Aneja and Radhika¹⁰ conducted a study on the antimicrobial

action of cardamom on the dental caries causing microorganisms. The study concluded that the cardamom extracts showed antimicrobial activity against oral pathogens like streptococci mutans and *Candida albicans*.¹⁰

Plaque pH plays a fundamental role in balancing the biofilm flora on the tooth surfaces and a drop of pH represents a selective stimulus in favor of acidophilic bacteria which, if adequately nourished, can maintain persistent acidity in the environment of the biofilm itself. The buffering capacity of saliva plays a fundamental role in balancing the phenomena of demineralization and remineralization.

The buffering capacity of saliva also demonstrates an inversely proportional correlation with caries prevalence.¹¹⁻¹³

The results in the present study indicate an increase in plaque pH scores before and after in plaque pH immediately and 10 minutes later after consumption of fennel and cardamom seeds, which was statistically significant for fennel seeds group. The main factors for the initial rise in plaque pH values after fennel and cardamom seeds consumption seems to be the reduction of critical chewing fennel and cardamom seeds. When compared to baseline, there was a significant increase plaque pH. This reduction may be due to diffusion of calcium and phosphorus into the plaque from the seeds, the buffering of the plaque pH by saliva, which was stimulated by chewing fennel and cardamom seeds (a strong sialagogue). The results of the present study are in accordance with the study done by Ravishankar et al,¹³ who found an increased plaque pH scores after consumption of dairy products like cheese and yoghurt. In this study there was a in significant change in mean plaque pH after consuming the different dairy products, as the plaque pH after 30 minutes was higher in the cheese group than that of the milk and yogurt groups¹³.

The results in the present study indicate an increase in the salivary pH before and after consumption of fennel and cardamom seeds which was statistically significant ($p < 0.001$). When compared to baseline, there was an increase in salivary pH

immediately and 10 minutes later after consumption of fennel and cardamom seeds. There is no information in literature about the influence of herbal products on pH. This can be explained by the fact that chewing herbal seeds stimulates salivation which increases the saliva's bicarbonate concentration and thus increases salivary pH. The results are in accordance with study by Gayathri et al.¹⁸ where notable changes in salivary pH were observed immediately and 30 min after chewing the herbal leaves, like tulasi and curry leaves.

The results of the present study were contradictory to the study done by Ravi et al.⁷ to assess the effect of chewing fennel seeds on plaque and salivary pH, who found that there was a drop in salivary pH (both plaque and saliva) on consumption of the seeds. The drop in plaque pH was not statistically significant, indicating that chewing of these seeds don't seem to induce any change in plaque pH below "critical pH". Between groups comparisons for change in salivary and plaque pH between fennel seeds and cardamom seeds group did not reveal any statistically significant finding indicating that chewing of both fennel seeds and cardamom seeds were equally effective in increasing salivary and plaque pH. Since extensive search of literature did not reveal information on effect of fennel seeds and cardamom seeds on pH changes in oral cavity it is not possible to compare the present data to other studies. The results of present study indicate that chewing of fennel seeds are cardamom seeds increased salivary and plaque pH.

The study was done at only one institution limiting the generalizability of results and the effect of chewing fennel seeds and cardamom seeds were evaluated at only two intervals immediately and 10 min. So further studies should be conducted in other randomly selected settings with equal male and female representative sample. Changes in salivary and plaque pH should be evaluated by chewing fennel seeds and cardamom seeds at longer intervals. Further prospective studies in the following direction may throw light upon the effect of fennel seeds on oral cavity like its "antibacterial efficacy" against – oral bacteria, its ability of mechanical plaque removal, effects on salivary

parameters like flow rate, buffering capacity and viscosity.

CONCLUSION: It can be concluded from the present study that there is an increase in salivary and plaque pH after chewing fennel seeds and cardamom seeds immediately and at 10 min interval. Chewing both fennel seeds and cardamom seeds are equally effective in reducing salivary and plaque pH. Further studies should be conducted in other randomly selected settings evaluating the changes in salivary and plaque pH at longer intervals. Further prospective studies in the following direction may throw light upon the effect of fennel seeds on oral cavity like its "antibacterial efficacy" against – oral bacteria, its ability of mechanical plaque removal, effects on salivary parameters like flow rate, buffering capacity and viscosity.

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