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Natural Remedies for Oral Health: Assessing Fennel and Cardamom Seeds in Plaque Control and Salivary pH Regulation

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ABSTRACT:

Background & Objective: Evaluate an impact of chewing fennel and cardamom seeds on dental plaque and salivary pH levels.

Materials and Methods: This clinical trial included 50 consenting individuals from Teerthanker Mahaveer Dental College & Research Centre, ages 18 to 60. The subjects were randomly assigned to 2 groups, one for chewing fennel seeds and the other for cardamom seeds. Salivary and plaque pH were assessed at baseline, immediately post-chewing the seeds for 5 minutes, and 10 minutes thereafter, utilising a calibrated glass combination electrode, with findings evaluated via ANOVA.

Results: The average salivary pH scores for the fennel seed group were 7.1 at baseline, 7.3 immediately post-intervention, and 7.5 at the 10-minute mark ($p = 0.001$). For the cardamom seed group, the mean salivary pH scores were 7.4 at baseline, 7.6 immediately after, and 7.76 at 10 minutes ($p < 0.05$). The mean plaque pH scores for the fennel seed group were 7.4 at baseline, 7.55 immediately after, and 7.53 at 10 minutes ($p = 0.001$). For the cardamom seed group, the mean plaque pH scores were 7.73 at baseline, 7.71 immediately after, and 7.83 at 10 minutes, which was not statistically significant.

Conclusions: It was discovered that cardamom and fennel seeds increased the pH of plaque and saliva just as well. These seeds can be used to lubricate and moisten the mouth while providing caries protection for individuals at high risk.

INTRODUCTION:

Since ancient times, plants have acted as herbal remedies to treat different illnesses or conditions, herbs or species hold high productive value. Plants are known for their important biological activities, especially their antioxidant and antimicrobial effects.¹⁻²

Foeniculum vulgare is part of the Umbelliferae family. People commonly call it Fennel in English & Saunf in Hindi. Fennel had a lengthy background in conventional medicine. to help with different problems. Many oral & dental care products also use it because of its antiseptic qualities. It can be used alone too, like as a breath freshener or for caring for gums with fennel oil. The extract from its seeds can stop the growth of microorganisms, particularly *Streptococcus mutans*, which causes dental caries & periodontal diseases. The dry fruit of the fennel seed has been traditionally used. It has properties that can fight inflammation, relieve pain, help digestion, increase urine flow, and even deal with issues like glaucoma & hypertension. Additionally, fennel can aid in promoting menstruation, improving milk flow, treating the condition of heartburn allergies, retention of water in coronary artery disease osteoarthritis, and stress.³⁻⁵

Research by Kang et al.⁶ has shown which *S. mutans* creation of biofilm may be inhibited by fennel oils & reduce harmful factors they express. In another study by Ravi et al., a significant but short-lived decrease in salivary pH was noted after chewing fennel seeds; however, the pH of the plaque remained unchanged.⁷

Cardamom is often referred to as the “queen of spices.” Its strong aroma & flavour make it well-known worldwide. Cardamom packs a lot of nutrients,⁸ A study by Cohen et al.⁹ highlighted the cardamom-flavoured chewing gum could help reduce negative feelings during nicotine withdrawal and may assist those trying to quit smoking.

Aneja & Radhika¹⁰ investigated the antimicrobial properties of cardamom against bacteria that cause dental caries. Diet affects dental caries closely—so do salivation levels & the presence of bacteria on teeth surfaces. When plaque pH drops, it creates a situation where acid-loving microorganisms like *Streptococcus mutans* thrive. This leads to conditions that promote decay and additional pH decline which can demineralize dental enamel.^{11,12,13} Thus, plaque pH is essential for maintaining balance among the biofilm flora on tooth surfaces. Saliva’s buffering ability plays a key role in balancing demineralization & remineralization too.¹⁴

Therefore, the purpose of the research was to investigate how chewing fennel seeds & cardamom seeds affects plaque & salivary pH levels.

MATERIALS AND METHODS:

Objective of the current randomised controlled study was to investigate the impact of chewing cardamom and fennel seeds on the pH levels of saliva and dental plaque.

Research population and sample size:

50 subjects between the ages of 18 and 60 who were at the Teerthanker Mahaveer Dental College and Research Centre outpatient department were chosen. (Figure 1). To account for dropouts, an additional 10% was added, bringing the total sample size to 50. There are 25 cardamom and 25 fennel seeds.

The Teerthanker Mahaveer Dental College and Research Centre’s Institution Review Board granted ethical clearance. Researchers acquired informed consent from study participants. Healthy Adult volunteers in the 18–60 age range who consented to abstain from applying any dental care products, including brushed products on a full day and who were in good physical and mental health at the time of the assessment met the inclusion criteria. Subjects receiving topical fluoride therapy, those undergoing chemotherapy, and those using antibiotics or medications that affect salivary pH, salivary function didn’t participate in the research.

Using a lottery-style approach and simple random sampling, 2 groups of participants were formed to chew cardamom or fennel seeds. Twenty-five subjects were chosen for each group based on inclusion and exclusion criteria. Over the course of 40 days in October and November, salivary and plaque samples were analysed and clinical examinations were performed. Prior to eating cardamom and fennel seeds, participants’ baseline dental health status was recorded using the plaque index, as provided by Sillness P and Loe H in 1964. To record indices, the examiner was calibrated and taught.

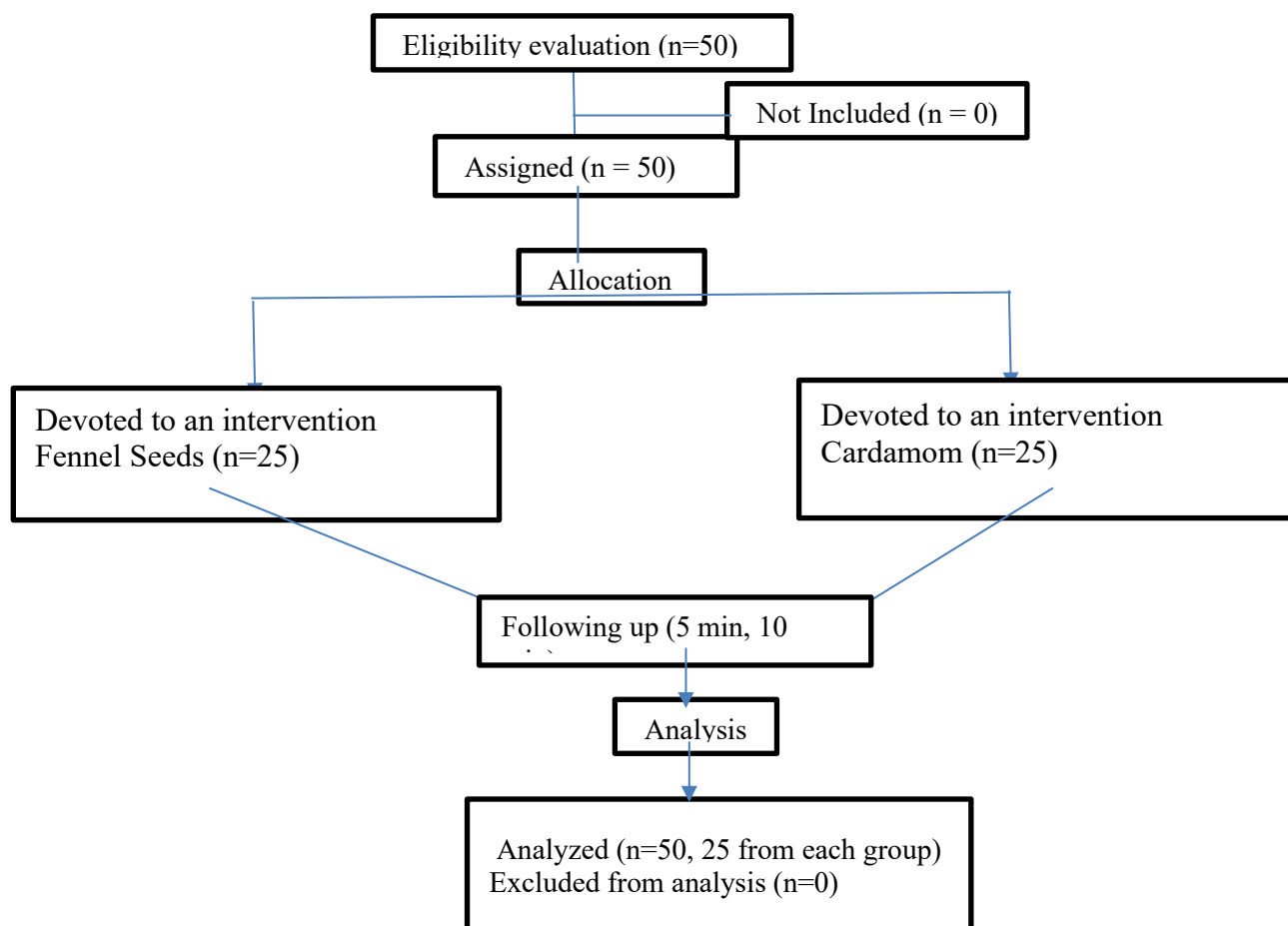


FIG 1: Displaying Study Participant Allocation by Consort 2010

Gathering saliva and plaque and measuring pH:

Consenting subjects were asked to schedule appointments and abstain from brushing and other oral hygiene practices for a whole day in order to allow plaque to accumulate, a process known as the "plaque harvesting technique" that has been described in other investigations. Prior to the trial, the subjects were asked to follow their regular diet and refrain from making significant dietary modifications. Additionally, patients were asked to fast for two and a half hours before their test-day session, just consuming plain water. The baseline data was recorded by measuring the salivary pH and resting plaque. Two millilitres of saliva were collected to measure the salivary pH.

Plaque harvesting and pH measurement:

Frostell¹⁶ and RuggGunn¹⁷ et al. modified the method of Fosdick et al. to determine the pH of plaque. On each test day, a sample of plaque was taken from the buccal surfaces of four locations on the test subjects' teeth using a sterile stainless steel straight probe. Subjects were told to swallow immediately prior to plaque collection in order to minimise salivary contamination, and care was taken to ensure that neither blood nor saliva could contaminate the samples. This was the initial sample of the plaque. The same duration of 30 seconds was used to collect each sample. Twenty millilitres of distilled water were added to the plaque sample, and a glass combination electrode that had been previously calibrated was used to measure the pH. This led to the creation of the baseline pH values for plaque and saliva (S1 and P1). Following the determination of the baseline (S1 and P1) pH, the patients were instructed to chew three cardamom seeds or a known quantity (1.3 grammes) of fennel (*foeniculum vulgare*) seeds for roughly five minutes. The same methods were used to measure the salivary pH and plaque (S2 and P2) again, but this time, the other half of the tooth was extracted for plaque collection soon after the seeds were chewed. A third saliva sample (S3) and a third plaque sample (P3) were taken ten minutes after the seeds were chewed.

Salivary and plaque pH analysis:

A calibrated glass electrode cathode was used to analyse the pH of saliva and plaque. The equipment was calibrated using standard solutions with pH values of 7.0 and 4.0, and tests of the standards were carried out at random between plaque pH readings. Between readings, the electrode was immersed in a standard pH 7.0 solution and cleaned with distilled water. Stable measurements and continuous drift monitoring were thus guaranteed.

To determine how difficult it is to collect saliva and plaque samples and to determine the pH of the samples, a pilot study involving ten patients was carried out.

Statistical analysis:

The data was analysed using the SPSS 19 software. The difference in salivary and plaque pH levels before, right after, and ten minutes after chewing cardamom and fennel seeds was assessed using an ANOVA test. Before and after the two groups chewed cardamom and fennel seeds, their plaque scores were compared using the Z test. The plaque index average score for each subject was calculated. A value of $P < 0.05$ was considered statistically significant.

RESULTS:

The purpose of this randomised controlled study was to determine how chewing cardamom and fennel seeds affected salivary pH and plaque. The average age of the cardamom seed chewing group was 31.08, whereas the average age of the fennel seed chewing group was 32.8. In the fennel and cardamom seed chewing groups, 64% and 60% of the participants were male, while 36% and 40% of the participants were female (Table 1). The cardamom and fennel seed groups had mean plaque scores of 1.17 and 1.42, respectively. With a P value of 0.31, the mean plaque scores for the two groups did not differ significantly. (Table II).

Mean plaque pH scores:

The fennel seed group's mean plaque pH was 7.4 at baseline, 7.55 immediately after chewing the seeds, and 7.53 following a 10-minute break. Salivary pH levels increased statistically significantly ($p = 0.001$) after fennel chewing. The group that chewed cardamom seeds had a mean plaque pH of 7.73 at baseline, 7.75 immediately after, and 7.83 following a 10-minute break. Salivary pH scores increased after chewing cardamom seeds, with a statistically significant p value of 0.08 (Table 3).

Mean salivary pH scores:

The mean salivary pH of the fennel seed group was 7.1 at baseline, 7.3 right after the seeds were chewed, and 7.5 after a 10-minute break. After chewing fennel, salivary pH levels rose statistically significantly (p value 0.001). The mean salivary pH of the cardamom seed group was 7.45 at baseline, 7.62 right after chewing the seeds, and 7.76 after a 10-minute break. With a p-value of 0.03 (Table 4), salivary pH levels rose statistically significantly following cardamom seed chewing.

DISCUSSION:

Following the chewing of cardamom and fennel seeds by participants ranging in age from 18 to 60, the current randomised controlled trial assessed the variations in salivary pH and plaque. Historically, fennel seeds have been used as anti-inflammatory, diuretic, carminative, analgesic, and antispasmodic medications. Recently, there has been a lot of interest in the antibacterial and antioxidant qualities of fennel seed extracts and essential oil.^{2–3} Cardamom is one of the most popular spices because of its potent flavour and scent. It is also very helpful due to its therapeutic properties. Cardamom is said to be rich in a variety of nutrients that are beneficial to your health, such as volatile oil (cineole), calcium, iron, phosphorus, and ether extracts.⁸

Aneja and Radhika¹⁰ investigated the antibacterial qualities of cardamom against tooth cavity-causing microorganisms and found that cardamom extracts showed antibacterial action against oral infections like streptococci mutans and *Candida albicans*. A decrease in pH indicates a selection stimulation in favour of acidophilic bacteria, which, if fed enough, can sustain permanent acidity in the biofilm's environment. Plaque pH is important for maintaining the balance of the biofilm flora on tooth surfaces. The buffering ability of saliva is also inversely proportional to the incidence of caries.^{11–13}

Both fennel and cardamom seeds raised plaque pH scores before and after intake, with the fennel seeds group exhibiting a statistically significant increase in plaque pH scores 10 minutes later. The main reason for the initial rise in plaque pH values after consuming fennel and cardamom seeds seems to be the reduction in the necessary chewing time for these seeds; plaque pH increased significantly compared to baseline, which could be due to buffering the pH of the plaque, calcium and phosphorus diffusing into the plaque from the seeds, or saliva, which was induced by chewing cardamom and fennel seeds (a strong sialagogue). The current study's findings concur with those of a study conducted by Ravishankar et al.¹³, which found

that consuming dairy products, such as yoghurt and cheese, increased the pH of plaque. After consuming the different dairy products, the mean plaque pH in this study changed significantly; after 30 minutes, the cheese group's plaque pH was higher than the milk and yoghurt groups'.¹³

Salivary pH increased statistically significantly ($p < 0.001$) before and after consuming fennel and cardamom seeds, according to the results of the current study. When compared to baseline, salivary pH rose both right away and ten minutes after fennel and cardamom seed consumption. There is no literature on the effects of herbal products on pH. This makes sense because chewing herbal seeds increases salivary flow, which in turn raises saliva's pH and bicarbonate concentration. The results align with a study by Gayathri et al.¹⁸ that found that chewing herbal plants like curry and Tulasi leaves caused notable changes in salivary pH both immediately and 30 minutes later.

The results of the current study contradicted those of a study by Ravi et al.⁷ that looked at how chewing fennel seeds affected salivary pH and plaque. That study found that after consuming seeds, the pH of the saliva (including both saliva and plaque) decreased. The lack of statistical significance in the decrease in plaque pH indicates that eating these seeds does not seem to have an impact on plaque pH below the "critical pH." However, between-group comparisons for changes in salivary and plaque pH between the fennel seeds and cardamom seeds group did not reveal any statistically significant findings. Chewing fennel and cardamom seeds was found to be equally effective in raising salivary and plaque pH.

Because only one institution was used for the study, the data's generalisability was constrained. The effects of chewing fennel and cardamom seeds were evaluated both right away and ten minutes later. Therefore, additional studies should be conducted in various randomly selected contexts using a representative sample of equal numbers of men and women. Assessing changes in salivary and plaque pH can be facilitated by chewing cardamom and fennel seeds more frequently. More prospective research in the areas listed below may shed more light on the effects of fennel seeds on the oral cavity, including their "antibacterial efficacy" against oral bacteria, their ability to mechanically remove plaque, and their effects on salivary parameters like flow rate, buffering capacity, and viscosity.

CONCLUSION:

The effects of fennel seeds on the oral cavity, including their "antibacterial efficacy" against oral bacteria, their ability to mechanically remove plaque, and their effects on salivary parameters like flow rate, buffering capacity, and viscosity, may become clearer with further prospective studies conducted in the directions mentioned below. The results of this study show that chewing cardamom and fennel seeds both immediately and after a 10-minute period raises the pH of saliva and plaque, while chewing the seeds of cardamom and fennel lowers the pH of saliva and plaque just as well.

TABLE 1: Study Subject Distribution by Age and Gender

Seed chewing	Men N (%)	Women N (%)	Average age
fennel seeds	16 (64)	9 (36)	32.80±5.74
cardamom seeds	15 (60)	10 (40)	31.08±5.44

TABLE 2: Study Subject Distribution Based on Plaque Index Scores (Loe and Sillness) At Baseline

Plaque index (Sillness and Loe)				
Group	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 ($p \leq 0.05$)

Table 3: VARIATION IN PLAQUE PH SCORES PRIOR TO AND FOLLOWING FIBRE AND CARDAMOM SEED CHEWING

Group	Baseline plaque pH Mean (S.D)	Instant 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 ($p \leq 0.05$)

TABLE 4: Variation In Specific Ph Values Prior To And Following The Chewing Of Fennel And Cardamom Seeds

Group	Baseline salivary pH Mean (S.D)	Instant 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 ($p < 0.05$)

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REFERENCES:

- [1] Rasool Hassan. Medicinal Plants: Importance and uses. Pharmaceut Anal Acta 2012, 3:10
- [2] Anita Dua, Gaurav Garg and Ritu Mahajan. Polyphenols, flavonoids and antimicrobial properties of methanolic extract of fennel (*Foeniculum vulgare* Miller). Euro. J. Exp. Bio. 2013; 3(4): pg-203-208
- [3] Neetu S Jamwal, Sunil Kumar. Phytochemical and pharmacological review on *Foeniculum vulgare*. International journal of pharmaceutical sciences. 2013; 4(3); pg-327-330.
- [4] Weiping H, Baokang Huang. A review of chemistry and bioactivities of a medicinal spice: *Foeniculum vulgare*. Journal of Medicinal Plants Research. August, 2011 Vol. 5(16), pp. 3595-3600,
- [5] Mahady GB. In vitro susceptibility of *Helicobacter pylori* to botanicals used traditionally for the treatment of gastrointestinal disorders. Phytomedicine 2010; 7(Suppl II): 95
- [6] Kang S, B. Park. Fennel essential oil inhibits virulence of *Streptococcus Mutans*. International Association of Dental Research. 2012; 9: pg-32-33.
- [7] Ravi V Shirahatti, Anil V Ankola, L Nagesh. Effect of Fennel Seeds on Dental Plaque and Salivary pH-A Clinical Study. J Oral Health Comm Dent 2010; 4 (2): pg-38-41.
- [8] Health benefits of cardamom. Available from: [http://www. Steadyhealth.com/health_benefits_of_cardamom.html](http://www.Steadyhealth.com/health_benefits_of_cardamom.html).
- [9] Cohen LM, Collins FL, Vanderveen JW, Weaver CC. The effect of chewing gum flavour on the negative affect associated with tobacco abstinence among dependent cigarette smokers. Addict Behav 2010; 35: pg-955-60.
- [10] Aneja KR and Radhika Joshi. Antimicrobial Activity of *Amomum subulatum* and *Elettaria cardamomum* against Dental Caries Causing Microorganisms. Ethnobotanical Leaflets. 2009; 13: pg-840-49.
- [11] Lingstrom P, Van Ruyven F, Van Houte J, Kent R. The pH of dental plaque in its relation to early enamel caries and dental plaque flora in humans. J Dent Res 2011; 79; pg770-7.
- [12] Isha Goel, S. Navit, Sandeep Singh Mayall. Effects of Carbonated Drink & Fruit Juice on Salivary pH: An in Vivo Study. International Journal of Scientific Study October-December 2013: Volume 01, Issue 3 pg 63-6
- [13] Ravishankar Lingesha Telgi, Vipul Yadav, Chaitra, Naveen Boppana. In vivo dental plaque pH after consumption of dairy products. Journal of General Dentistry May/June 2013 pg 56-59

- [14] Gian Marco Abate, Giada Colangelo Luca Levrini. Salivary pH after a glucose rinse: Effects of a new sodium Bicarbonate Mucoadhesive spray. A preliminary study. *Journal of Dental Hygiene*. 2013; 9(1); pg-56-59
- [15] Fosdick L S, Campaigne E, Fancher O. Rate of acid formation in various areas: the aetiology of dental caries. *Illinois Dent* 2011; 10: 86-95.
- [16] Frostell G. A method of evaluation of acid potentialities of foods. *Acta Odontol Scand* 2010; 28: 599-608.
- [17] Rugg-Gunn A J, Edgar W M, Geddes, Jenkins G N. The effect of different meal patterns upon plaque pH in hum DA an subjects. *Br Dent J* 2011; vol2: pg 351-356.
- [18] Ramesh Nagarajappa A, Madhusudan S: Estimation of salivary and tongue coating pH on chewing household herbal leaves: A randomized controlled trial. *Anc Sci Life*. 2012; 32(2): pg-69–75.