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Original Article

Dentistry Section

Effect of Oil Pulling on pH, Buffering Capacity and Total Antioxidant Capacity of Saliva in Children: A Randomised Control Study

FAIZAL C PEEDIKAYIL[1], NEETHU DIWAKAR[2], T PREMKUMAR CHANDRU[3], SONI KOTTAYI[4], Y SHIBU VARDHANAN[5], DHANESH NARASIMHAN[6]

ABSTRACT

Introduction: Saliva is emerging as a diagnostic tool in the field of dentistry. The changes in salivary composition, its physical and chemical properties determine the state of both oral and general health. Chemical plaque control measures improve oral health, by effectively controlling the microbial load in the dental plaque and these agents are thought to alter the properties of saliva. Oil pulling with edible oils has proved to be an adjunct to routine oral hygiene methods to improve oral health.

Aim: To evaluate and compare the effect of oil pulling therapy with sesame oil and virgin coconut oil with Chlorhexidine (CHX) gargling and plain water gargling on pH, buffering capacity, and total antioxidant capacity of saliva.

Materials and Methods: A four armed randomised controlled study was conducted in 80 female children in the age group of 12-14 years from July 2019 to December 2019 in Department of Paediatric and Preventive Dentistry, Kannur Dental College, Anjarakandy, Kannur, Kerala, India. Children with mild to moderate gingivitis were selected and assigned into four groups to use different types of mouth rinsing (Group A: chlorhexidine, Group B: sesame oil , Group C: virgin coconut oil and Group D: plain water as control) for one month. Unstimulated whole saliva, collected from these participants were evaluated for the changes in pH, buffering capacity and total antioxidant capacity, at baseline and at 30 days. The data were tabulated and statistical analysis was done using Analysis of Variance (ANOVA) (Post-hoc), followed by Dunnet's t-test, using Statistical Package for Social Sciences (SPSS) 25.0 version. Tukey's post-hoc test was done to identify the significant pairs.

Results: The mean age of the study participants was 13.4 years. Intragroup comparisons showed there were statistically significant changes in the baseline to 30th day values of gingival index, values, antioxidant capacity and buffering capacity for all the experimental groups ($p<0.05$). Coconut oil pulling ($p=0.0345$) and sesame oil pulling ($p=0.026$) and CHX gargling ($p=0.045$) showed statistically significant changes in salivary buffering capacity when compared to the control. On intergroup comparisons of experimental groups, there was no statistical difference in antioxidant capacity, salivary buffering capacity and pH of the saliva ($p>0.05$).

Conclusion: Oil pulling with coconut oil and sesame oil had equal effectiveness as CHX on the antioxidant capacity and buffering capacity of saliva.

Keywords: Gingivitis, Oral hygiene, Plant oil, Plaque control, Potential of hydrogen

INTRODUCTION

Saliva is one of the most important components in the oral environment and an integral component of oral health [1]. It plays a critical role in oral homeostasis, by modulating the ecosystem within the oral cavity [2]. The The main functions of the saliva are lubrication, protection, buffering action and clearance, maintenance of tooth integrity, antibacterial activity, taste perception, and digestion [3].The buffer systems, bicarbonates, and phosphates present in saliva help in the maintenance of the pH of the oral cavity between six to seven by neutralising the acids produced by the plaque microorganisms [4].

Salivary antioxidants aids in protection against bacterial metabolic products and oxidative stress produced by these microorganisms [4]. Saliva is intended to be the first line of defence against free radicals associated with diseases in the oral cavity [5,6]. Therefore, the initiation and progression of such diseases can be prevented by these antioxidants thereby controlling the plaque microorganisms which are the primary aetiologic agents [7].

Oral hygiene measures are an important preventive measure to control plaque induced diseases. CHX is one of the gold standard plaque control agents but it is associated with slightly lower compliance due to its unpleasant taste and unwanted effects like staining [7]. To overcome these disadvantages, attention is being given to exploring natural alternatives for oral hygiene maintenance [8].

Oil pulling or oil gargling or oil swishing is one such practice that involves placing a tablespoon of edible oils like sesame, olive, sunflower, coconut, sipped into the mouth, and swished or pulled through the teeth and oral cavity for 1-5 minutes. This system had been practiced in India as a traditional health remedy [8]. Numerous studies have been conducted recently supporting this technique of oil pulling and is found to have a definite antibacterial and anti-plaque activity [9,10]. In addition to these beneficial effects, these oils also contain natural antioxidants like sesamol, sesamin, and sesamolin and polyphenols which can help in disease prevention [11,12].

Sesame oil is an edible cooking oil derived from sesame seeds whereas Virgin Coconut Oil (VCO) is obtained from fresh and mature kernel of the coconut without undergoing chemical refining, bleaching or deodorizing [8,9]. Both oils were found to reduce the plaque related gingivitis and has been comparable to CHX [10]. Therefore, these oils were used in the present study to know more about physiochemical changes in oral cavity by its use. The effectiveness of all these agents on oral health status can be assessed by evaluating the changes they bring about in the saliva. But, literature is scarce on the comparison of the action of oil pulling therapy with other chemical plaque control agents, on salivary parameters such as buffering capacity and total antioxidant capacity. Therefore, this study aims to evaluate and compare the effect of oil pulling and CHX gargling

on salivary pH, buffering capacity, and total antioxidant capacity of saliva in children.

MATERIALS AND METHODS

A four arm randomised controlled study was conducted from July 2019 to December 2019 among 80 children in the age group of 12-14 years by Department of Paediatric and Preventive Dentistry, Kannur Dental College, Anjarakandy, Kannur, Kerala, India. The saliva samples were analysed for pH, buffering capacity and total antioxidant capacity at Toxicology and Biochemistry laboratory division, Department of Zoology, Calicut University, Thenhipalam, Malappuram, Kerala state, India. The selected subjects of the study were the residents of the female residential sports school. The study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments, involving humans. Ethical clearance for the study was obtained from the Institutional Ethics Committee of Dental College (KDC/2019/221) and informed consent was taken before the study.

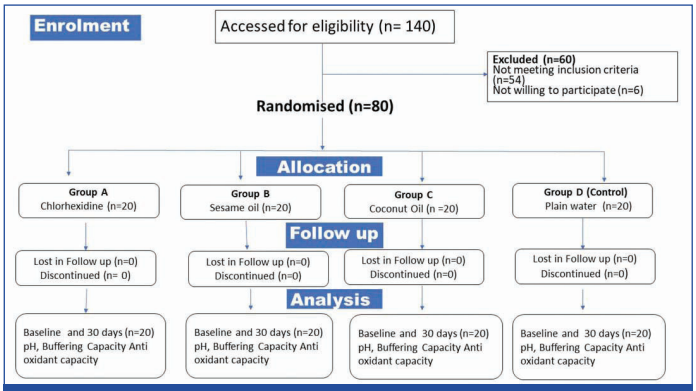
Inclusion and Exclusion criteria: The inclusion criteria of study participants were those who were caries free with mild to moderate gingivitis. Children with caries, severe gingivitis, or any systemic diseases, history of dental treatment in previous three months and participants on regular use of mouthwash before the study were excluded from the study.

Sample size calculation: The number of samples for the study was calculated using the formula:

$$n = \frac{2(Z_{a} + Z_{1-\beta})^{2}\sigma 2}{\Delta^{2}}$$

Where n=sample size per group, Z=Normal distribution to give required power of distribution according to the pilot study, α=significance level (0.05), β power determined at 90%, Δ=size of difference. The value obtained was 18 and was rounded off to 20 per group.

The screening of the population was done by a single examiner. Gingival index by Loe and Silness was used to select the participants [13]. The CONSORT 2010 guidelines were followed in this randomised control trial [Table/Fig-1]. The observer who checked the subjects and the lab analysis personal was blinded regarding the intervention. The study population was divided into four groups, i.e. three experimental groups, and one control group, with 20 children in each group. The subjects were allotted to each group by a computer generated random number table.



[Table/Fig-1]: CONSORT flowchart.

Group A: CHX mouthwash (Clohex, Dr Reddy's Laboratories Ltd. India)

Group B: Sesame oil (Pavithram , Pazhangadi Oil Industries, Kerala, India)

Group C: VCO (Nutriko , Rubco Kerala India)

Group D: Plain Water as control

Study Procedure

Baseline unstimulated salivary samples by spitting method were collected from all four groups, and pH, buffering capacity and total antioxidant capacity were checked [14]. The experimental groups were advised to do CHX gargling or oil pulling under the supervision of trained observers at the residential school. The salivary samples were collected to checked at day 30, for pH, buffering capacity and total antioxidant capacity. Gingival index was also checked at baseline and 30th day to check for changes in gingival health of each subjects.

Group A participants, were advised to dilute 5 mL of 0.2% CHX with an equal volume of water and swished in the mouth after routine tooth brushing. Group B and C were advised to sip and pull one teaspoon of sesame oil and virgin coconut oil between the teeth for five minutes, after brushing till the oil turns thin and milky white. Whereas, the control group group D participants were asked to gargle with plain water after routine tooth brushing .

Unstimulated whole saliva was collected from the participants by draining method within 15-30 minutes of oil pulling or CHX gargling. The participants were advised not to eat or drink before sample collection. The collected samples were transferred to the laboratory in cryovials, placed in a mini cooler at -20° celsius, within a hermetically sealed box. In the laboratory, the salivary samples were immediately centrifuged at 9000 rpm, at -4° celsius for 12 minutes, and samples were separated into aliquots and stored under -20° celsius, until analysis [15].

Parameters Measured

The pH and buffering capacity were evaluated by Ericsson's method, 1.0 mL of saliva was taken in a test tube, and the initial pH was measured using the digital pH meter (Eutech pH tutor) [16]. After transferring 1.0 mL of the saliva to 3.0 mL (0.0033 mol per liter) HCl, and mixing thoroughly for 20 minutes to remove CO_2, the final pH of the saliva was measured. The buffering capacity of the salivary samples was measured by assessing the final pH value as given in [Table/Fig-2].

Final pH value	Evaluation
More than 4.75	High
4.25-4.75	Normal
3.50-4.24	Low
Less than 3.50	Very low

[Table/Fig-2]: Values of buffering capacity of salivary samples by Ericsson's method [16].

The total antioxidant capacity of saliva was measured by (1,1-Diphenyl-2-picrylhydrazyl solution (DPHH) radical scavenging assay) using a microplate reader [17]. This method is based on the reduction of DPPH alcoholic solution in the presence of hydrogen donating antioxidants. The reduction of DPPH radical leads to a colour change from deep violet to light yellow.

Around 150 µL of freshly prepared DPPH solution in methanol was added to 50 µL of centrifuged saliva in the wells of the microplate. The scavenging activity was assessed by using chemical and biometric assays (Biotek-Synergy). The samples were kept in darkness for 30 minutes at room temperature and the absorbance was then measured at 517 nm (AS) against methanol as blank. The absorbance of the methanol solution of DPPH was taken as control (Ac).

Free radical scavenging activity was calculated using the following relationship[18]:

DPPH radical scavenging activity (%)=[(Ac-AS)/Ac]×100.

Ac- absorbance of control

As- absorbance of the sample

The percentage scavenging of DPPH radical denotes the antioxidant activity of the sample.

STATISTICAL ANALYSIS

Data analysis was done using SPSS 25.0. ANOVA test was used to compare the means of difference in the dimensions between and within the groups. Leven's homogeneity of variance test was done to check that homogeneity of variance. Dunnet's t-test was applied to find the statistical significance between the groups, Tukey's post-hoc test done to identify the significant pairs. A p-value less than 0.05 was considered statistically significant at a 95% confidence interval.

RESULTS

About 80 female subjects in the age group of 12-14 years took part in the study. The mean age of the participants was 13.4 years. [Table/Fig-3] shows comparison of pre (at baseline) and post (at 30th day) gingival scores within the groups. A significant decrease in gingival scores was noted on CHX gargling, sesame oil, and virgin coconut oil pulling in groups, and the results were statistically significant (p<0.05). The control group did not show any significant changes.

Groups	Gingival score (Mean±SD)		p-value
	Pre	Post	
Group A	1.10±0.9	0.86±0.20	0.03*
Group B	1.10±0.21	0.92±0.23	0.04*
Group C	1.18±0.20	0.98±0.22	0.04*
Group D	1.04±0.23	1.04±0.23	0.34

[Table/Fig-3]: Comparison of pre and post gingival scores within the group.
*p<0.05 significant compared pre and post within the groups

The mean of values and the mean difference of salivary parameters between baseline and 30th day for the experimental groups CHX, coconut oil, and the control group are seen in [Table/Fig-4]. Leven's homogeneity of variance test showed that homogeneity of variance has not been violated and is fit for parametric test using one-way ANOVA.

Parameters	Day	Chlorhexidine		Sesame oil		Virgin coconut oil		Control	
		Mean	Mean difference	Mean	Mean difference	Mean	Mean difference	Mean	Mean difference
pH	30th day	6.81	0.05	6.89	0.17	6.8	0.25	6.65	0.07
	Baseline	6.76		6.72		6.55		6.58	
Salivary buffering capacity	30th day	5.63	-0.17	5.73	-0.19	5.64	-0.3	5.62	0.17
	Baseline	5.8		5.92		5.94		5.45	
Antioxidant capacity	30th day	55.42	36.49	48.26	33.62	56.05	41.95	16.96	0.08
	Baseline	18.93		14.64		14.1		16.88	

[Table/Fig-4]: Mean of values and the mean differences in pH, salivary buffering capacity and antioxidant capacity between baseline and 30th day.
Leven's Homogeneity of variance test

The intragroup comparison of mean pH values of different groups at baseline and at 30th day [Table/Fig-5]. The results show that values obtained were not statistically significant (p>0.05).

Time	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	Group D (Mean±SD)
Baseline	6.76±0.23	6.72±0.07	6.55±0.18	6.58±0.12
30th day	6.81±0.29	6.89±0.14	6.8±0.15	6.65±0.14
p-value	0.29	0.45	0.20	0.31

[Table/Fig-5]: Comparison of mean pH values of different groups at different time periods.
ANOVA *p<0.05=significant

The intragroup comparison of comparison of mean buffering capacity values of different groups at baseline and at 30th day is seen in [Table/Fig-6]. The results show that there was no statistical difference in p-values for CHX, sesame oil, coconut oil groups (p<0.05) whereas for control group there was no statistical difference (p>0.05).

[Table/Fig-7] shows the intragroup comparison of antioxidant capacity values of different groups at baseline and at 30th day. The results show that there was a statistical difference in p-values for CHX, sesame oil and coconut oil groups (p<0.05), whereas for control group there was no statistical difference.

Time	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	Group D (Mean±SD)
Baseline	5.8±0.42	5.92±0.17	5.94±0.16	5.45±0.31
30th day	5.63±0.34	5.73±0.31	5.64±0.28	5.62±0.42
p-value	0.05*	0.035*	0.021*	0.56

[Table/Fig-6]: Comparison of mean buffering capacity of different groups at different time periods.
ANOVA *p<0.05=significant

Time	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	Group D (Mean±SD)
Baseline	18.93±12.74	14.64±8.89	14.1±4.47	16.88±7.65
30th day	55.42±16.88	48.26±3.47	56.05±13.13	16.96±21.57
p-value	0.001*	0.023*	0.001*	0.33

[Table/Fig-7]: Comparison of mean free radical scavenging values of different groups at different time periods.
ANOVA *p<0.05=significant

Multiple comparisons of experimental groups with that of the control [Table/Fig-8]. The results showed that salivary buffering capacity of CHX (p=0.045), mean sesame oil (p=0.026) and VCO (p=0.034) were statistically significant when compared to the control. When the pH of the experimental groups were compared to the controls, no statistically significant results are obtained whereas when antioxidant capacity of the experimental groups were compared with the control, statistically significant results were obtained (p<0.05).

Intergroup comparisons of the experimental groups [Table/Fig-9]. A Tukey's post-hoc test revealed that the salivary buffering capacity, pH and free radical scavenging scores were not statistically significant (p>0.05) between the experimental groups.

DISCUSSION

The changes in the physicochemical properties of saliva can determine the health status of an individual. Hence, it is emerging as a diagnostic tool for many oral and systemic diseases [18]. In the present study, the saliva was taken as a tool, and the changes in its property like pH, buffering capacity, and total antioxidant capacity was evaluated to assess the effectiveness of oil pulling with two different oils and CHX gargling.

Oil pulling therapy has been used as a traditional Indian folk remedy to prevent tooth decay, halitosis, bleeding gums, dryness of throat, and cracked lips. The exact mechanism of oil pulling therapy on plaque inhibition is not clear. The viscosity of oil probably inhibits bacterial adhesion and plaque co-aggregation and the soap forming effect of oil, produces a cleansing action over the tooth surface [19]. The results of the present study showed that there was an improvement in the gingival health following oil pulling therapy with coconut oil and sesame oil. Asokan S et al., had shown sesame oil pulling is as effective as CHX in reducing plaque-induced gingivitis [20]. Studies by Sheikh FS and Iyer RR and Kohle SA et al., showed the effectiveness of sesame oil on halitosis and reducing

Variables	(I) Study group	(J) Control	Mean difference (I-J)	Std. Error	Sig.	95% Confidence interval	
						Lower bound	Upper bound
Salivary buffering capacity	Chlorh-exidine	Plain water	-0.24400	0.11501	0.045*	-0.5197	0.0317
	Sesame Oil	Plain water	-0.36400	0.11501	0.026*	-0.6397	-0.0883
	Virgin coconut oil	Plain water	14350	0.11501	0.0345*	-0.1322	0.4192
pH score	Chlorh-exidine	Plain water	-0.02150	0.05438	0.960	-0.1519	0.1089
	Sesame oil	Plain water	0.09750	0.05438	0.185	-0.0329	0.2279
	Virgin coconut oil	Plain water	0.18100	0.05438	0.064	0.0506	0.3114
Anti-oxidant capacity	Chlorh-exidine	Plain water	36.41200*	4.10156	0.001*	26.5811	46.2429
	Sesame oil	Plain water	33.53850*	4.10156	0.001*	23.7076	43.3694
	Virgin coconut oil	Plain water	41.87300*	4.10156	0.001*	32.0421	51.7039

[Table/Fig-8]: Multiple comparisons of the study groups with the control.
One way ANOVA, Dunnet's t-tests*, significant at p≤0.05 level

Variables	Medium 1	Medium 2	Mean difference (Medium 1- Medium 2)	Significance	Lower bound of mean difference	Upper bound of mean difference
Salivary buffering capacity	Chlorhexidine	Sesame oil	0.12000	0.725	-0.1821	0.4221
		Virgin coconut oil	-0.38750	0.086	-0.6896	-0.0854
	Sesame oil	Chlorhexidine	-0.12000	0.725	-0.4221	0.1821
		Virgin coconut oil	-0.20750	0.110	-0.8096	-0.2054
	Virgin coconut oil	Chlorhexidine	0.38750	0.086	0.0854	0.6896
		Sesame oil	0.20750	0.110	0.2054	0.8096
pH score	Chlorhexidine	Sesame oil	-0.11900	0.136	-0.2619	0.0239
		Virgin coconut oil	-0.20250	0.073	-0.3454	-0.0596
	Sesame oil	Chlorhexidine	0.11900	0.136	-0.0239	0.2619
		Virgin coconut oil	-0.08350	0.422	-0.2264	0.0594
	Virgin coconut oil	Chlorhexidine	0.20250	0.076	0.0596	0.3454
		Sesame oil	0.08350	0.422	-0.0594	0.2264
Anti-oxidant capacity	Chlorhexidine	Sesame oil	2.87350	0.897	-7.9005	13.6475
		Virgin coconut oil	-5.46100	0.546	-16.2350	5.3130
	Sesame oil	Chlorhexidine	-2.87350	0.897	-13.6475	7.9005
		Virgin coconut oil	-8.33450	0.185	-19.1085	2.4395
	Virgin coconut oil	Chlorhexidine	5.46100	0.546	-5.3130	16.2350
		Sesame oil	8.33450	0.185	-2.4395	19.1085

[Table/Fig-9]: Intergroup comparisons of salivary buffering capacity, pH, antioxidant apacity.
One way ANOVA, Tukey's post-hoc test significance at p≤0.05 level

the microbial load respectively [21,22]. Peedikayil FC et al., in two different studies [19,23], had shown coconut oil pulling, reduced S.mutans count, and plaque-induced gingivitis as compared to CHX mouthwash.

Salivary parameters also get altered in oral diseases and also in patients with poor oral hygiene status [24]. In the present study, the salivary pH, increased from baseline, to 30th day on CHX gargling and oil pulling. Singh S et al., had shown that the increase in salivary pH might be due to improvement in oral hygiene by controlling and reducing the microbial load in the plaque [25]. Velmurugan A et al., had shown that CHX gluconate, which is charged positively, shows a high affinity for negative ions found in the cell membranes of microorganisms resulting in the disruption of the cell membrane, that resulted in a definite reduction in the microbial activity and an increase in the pH [26].

In the oral cavity, any pathology may be associated with oxidative stress. Free radicals continuously produced by the body play an important role in cellular response, like defense against an infectious agent, but in high concentrations, it damages cell structure and results in oxidative stress [27]. This oxidative imbalance leads to damage of important biomolecules and cells, and their elimination is achieved by protective mechanisms referred to as antioxidants [28]. In the present study, the change in antioxidant capacity of saliva with CHX gargling and oil pulling was evaluated by the free radical scavenging activity of the saliva. The study showed that CHX mouthwash and oil pulling had a statistically significant effect when compared to plain water gargling. The studies conducted by Battino M et al., and Yeung SY et al., [29,30]. Respectively, showed that CHX exhibited antioxidant properties. Besides this effect, CHX was found to inhibit superoxide radical production by neutrophils by scavenging effect or inhibition of NADPH oxidase, which mediates neutrophil Reactive Oxygen Species (ROS) production. Even though, the mechanism of antioxidant activity of oils on saliva is not clear , it may be inferred that it may be due to the contribution by the phenolic compound like protocatechuic, vanillic, caffeic, syringic, ferulic and p-coumaric acids in virgin coconut oil and sesamin, sesamolin, and sesamol in sesame oil and tocopherols present in both [31]. The virgin coconut oil produced through the fermentation method had also shown the strongest scavenging effect than the refined coconut oil. Phenolic antioxidants present in these oils can react directly with free radicals and convert them into stable products [32]. The antioxidant activity of the tocopherols is mainly due to their ability to donate their phenolic hydrogens to free radicals [33]. The studies by Nagarajappa AK et al., and Battino M et al., had shown that when mouth rinses supplemented with exogenous antioxidants, they have topical effects in the oral cavity [34,35]. This also could be the reason for the increase in the antioxidant activity of saliva by oil pulling.

S. No.	Author's name and year	Place of study	Number of subjects	Intervention done	Parameters compared	Conclusion
1.	Woolley J et al., 2020 [9]	United Kingdom	Systematic review	Oil pulling with coconut oil.		Oil pulling with coconut oil may have a beneficial effect on improving oral health and dental hygiene.
2.	Peedikayil FC et al., 2015 [19]	Kannur, India	60	Effect of coconut oil pulling on gingival health.	Plaque Index. Gingival Index.	Oil pulling using coconut oil could be an effective adjuvant procedure in decreasing plaque formation and plaque induced gingivitis
3.	Asokan S et al., 2009 [20]	Chennai, India	20	Effect of sesame oil pulling on oral health.	Plaque Index Modified gingival index Total microbial colonies count.	The oil pulling therapy showed a reduction in the plaque index, modified gingival scores, and total colony count of aerobic microorganisms in the plaque of adolescents with plaque-induced gingivitis.
4.	Peedikayil FC et al., 2016 [23]	Kannur, India	50	Antibacterial efficacy of coconut oil on oil pulling.	Dentocult SM Strip Mutans test.	Coconut oil is as effective as CHX in the reduction of S.mutans
5.	Kaushik M et al., 2016 [39]	Secunderabad, India	60	Antibacterial efficacy on oil pulling.	Bacterial count in saliva.	Reduction in S.mutans count was seen in both the oil pulling and CHX group
6.	Shetty SS et al., 2019 [41]	Malaysia	20	Effect of oil pulling on oral health.	Plaque index Microbial analysis of plaque.	The chlorhexidine mouthwash and oil pulling with coconut oil produces near similar effects in terms of plaque formation and reduction of oral bacteria
7.	Salian V and Shetty P, 2018 [42]	Mangalore, India	Review article			Coconut oil is effective in reducing oral microbial load and decreasing plaque and gingival indices
8.	Peedikayil FC et al., 2022 [43]	Kannur, India	80	Efficacy of virgin and regular coconut oil on plaque related gingivitis and the perceptions of the subjects regarding its taste and odour.	Modified gingival Index Taste perceptions.	Coconut oil pulling reduces modified gingival index scores Taste need to be improved for better compliance with the oil rinsing procedure.
9.	Sezgin Y et al., 2019 [44]	Turkey	29	To evaluate the plaque inhibiting effects of oil pulling.	Plaque index, Gingival index, Stain index, Bleeding on probing.	Oil pulling with coconut oil have similar plaque inhibition activity as CHX
10.	Present study	Kannur, India	80	Salivary changes due to oil pulling.	pH Buffering capacity Total antioxidant capacity.	Coconut oil and sesame oil were effective as CHX in relation to buffering capacity, and total antioxidant capacity of saliva .

[Table/Fig-10]: Summary of studies on oil pulling with coconut oil and sesame oil [9,19,20,23,39,41-44].

Salivary buffer capacity is important because it shows the effectiveness of saliva in neutralising acids in the oral environment [36]. The results of the study shows significant decrease in buffering action of CHX, coconut oil and sesame oil after 30 days of intervention. There was a paucity of literature regarding the alteration in salivary buffering capacity following oil pulling therapy. The reason might be due to low bicarbonate concentrations in unstimulated saliva [37]. Some literature have indicated that CHX has a neutralizing effect on saliva [7,38].

Chlorhexidine on long term use alters taste sensation and produces brown staining on the teeth which is very difficult to remove and some of its constituents can cause allergic reactions. The advantages of oil pulling over CHX are that there is no staining or lingering taste, no allergy, cost effective, readily available in households and can be used for life time [39,40]. Previous studies about oil pulling were mostly comparative studies regarding the gingival health, plaque formation and microbial growth and taste perceptions as shown in [Table/Fig-10] [9,19,20,23,39,41-44].

The present study was the first study to compare the physiochemical properties such as buffering capacity and total antioxidant capacity of oil pulling with sesame oil and coconut oil. Due to the absence of high quality evidence in the literature regarding oil pulling, the systematic reviews and meta-analysis called for more well-designed randomised controlled trials to determine the impact of oil pulling with coconut oil on oral health [9,10]. The findings of the present study will improve the quality of evidences.

Limitation(s)

Even though the study was done under supervision, there may be variations in the use of plaque control measures by the participants which may reflect in the results. Another drawback of the present study is that, it was conducted in a limited number of participants and for a short period of time. The fact that both genders are not included in selection of the subjects is a major drawback of the present study.

CONCLUSION(S)

The present study shows that coconut oil and sesame oil were effective as CHX in relation to buffering capacity, and total antioxidant capacity of saliva and could be a natural choice as an adjuvant in oral healthcare. Therefore, it can be concluded that oil pulling reduces the risk factors for oral diseases, moreover, the buffering capacity and antioxidant activity of oil pulling contributes to salivary antioxidant system which helps in improving the defensive action of saliva against the initiation and progression of diseases in the oral cavity. Further studies with a large number of subjects and randomised controlled clinical trials using various chemotherapeutic agents can improve the quality of evidence.

REFERENCES

[1] Dawes C, Wong DTW. Role of saliva and salivary diagnostics in the advancement of oral health. J Dent Res. 2019;98(2):133-41.
[2] Kaczor-Urbanowicz KE, Martin Carreras-Presas C, Aro K, Tu M, Garcia-Godoy F, Wong DT. Saliva diagnostics- Current views and directions. Exp Biol Med (Maywood). 2017;242(5):459-72.
[3] Malamud D. Saliva as a diagnostic fluid. Dent Clin North Am. 2011;55(1):159-78.
[4] Carpenter GH. The secretion, components, and properties of saliva. Annu Rev Food Sci Technol. 2013;4:267-76.
[5] Tóthová L, Kamodyová N, Ervenka T, Celec P. Salivary markers of oxidative stress in oral diseases. Front Cell Infect Microbiol. 2015;5:73. Published 2015 Oct 20.
[6] Kumar J, Teoh SL, Das S, Mahakknaukrauh P. Oxidative stress in oral diseases: Understanding its relation with other systemic diseases. Front Physiol. 2017;8:693.

[7] Jafer M, Patil S, Hosmani J, Bhandi SH, Chalisserry EP, Anil S. Chemical plaque control strategies in the prevention of biofilm-associated oral diseases. J Contemp Dent Pract. 2016;17(4):337-43.
[8] Peedikayil FC, Sreenivasan P, Narayanan A. Oil pulling therapy and the role of coconut oil. EJOD. 2014;4:700-02.
[9] Woolley J, Gibbons T, Patel K, Sacco R. The effect of oil pulling with coconut oil to improve dental hygiene and oral health: A systematic review. Heliyon. 2020;6(8):e04789.
[10] Gbinigie O, Onakpoya I, Spencer E, McCall MacBain M, Heneghan C. Effect of oil pulling in promoting oro dental hygiene: A systematic review of randomized clinical trials. Complement Ther Med. 2016;26:47-54.
[11] Wan Y, Li H, Fu G, Chen X, Chen F, Xie M. The relationship of antioxidant components and antioxidant activity of sesame seed oil: Antioxidant components and activity of sesame seed oil. J Sci Food Agric. 2015;95(13):2571-78.
[12] Hayatullina Z, Muhammad N, Mohamed N, Soelaiman IN. Virgin coconut oil supplementation prevents bone loss in osteoporosis rat model. Evid Based Complement Alternat Med. 2012;2012:237236.
[13] Löe H. The gingival index, the plaque index and the retention index systems. J Periodontol. 1967;38(6):Suppl:610-16.
[14] Gomar-Vercher S, Simón-Soro A, Montiel-Company JM, Almerich-Silla JM, Mira A. Stimulated and unstimulated saliva samples have significantly different bacterial profiles. PLoS One. 2018;13(6):e0198021.
[15] https://www.cdc.gov/biomonitoring/pdf/Human_Sample_Collection-508.pdf. Accesed on 10 Feb 2021.
[16] Amerongen AVN, Bolscher JGM, Veerman ECI. Salivary proteins: Protective and diagnostic value in cariology. Caries Res. 2004;38(3):247-25.
[17] Chrzczanowicz J, Gawron A, Zwolinska A, de Graft-Johnson J, Krajewski W, Krol M, et al. Simple method for determining human serum 2,2-diphenyl-1-picryl-hydrazyl (DPPH) radical scavenging activity- possible application in clinical studies on dietary antioxidants. Clin Chem Lab Med. 2008;46(3):342-49.
[18] Kubala E, Strzelecka P, Grzegocka M, Lietz-Kijak D, Gronwald H, Skomro P, et al. A review of selected studies that determine the physical and chemical properties of saliva in the field of dental treatment. Biomed Res Int. 2018;2018:6572381. Doi: 10.1155/2018/6572381.
[19] Peedikayil FC, Sreenivasan P, Narayanan A. Effect of coconut oil in plaque related gingivitis- A preliminary report. Niger Med J. 2015;56(2):143-47.
[20] Asokan S, Emmadi P, Chamundeswari R. Effect of oil pulling on plaque induced gingivitis: A randomized, controlled, triple-blind study. Indian J Dent Res. 2009;20(1):47-51.
[21] Sheikh FS, Iyer RR. The effect of oil pulling with rice bran oil, sesame oil, and chlorhexidine mouth rinsing on halitosis among pregnant women: A comparative interventional study. Indian J Dent Res. 2016;27(5):508-12.
[22] Kolhe SA, Patani S, Gulve N, Pawar R, Dhope SV, Gajeshwar H. Oil pulling as an adjunct to improve oral health in orthodontic patients: A clinicomicrobial study. Int J Orthod Rehabil 2019;10:152.
[23] Peedikayil FC, Remy V, John S, Chandru TP, Sreenivasan P, Bijapur GA, et al. Comparison of antibacterial efficacy of coconut oil and chlorhexidine on Streptococcus mutans: An in vivo study. J Int Soc Prev Community Dent. 2016;6:447-52.
[24] Baliga S, Muglikar S, Kale R. Salivary pH: A diagnostic biomarker. J Indian Soc Periodontol. 2013;17(4):461-65.
[25] Singh S, Anuradha P, Sahana S, Narayan M, Agarwal S. Comparative evaluation of mouth rinsing with plain water and an antibacterial mouth rinse on salivary pH: A randomized clinical trial. Journal of Indian Association of Public Health Dentistry. 2017;15(4):302.
[26] Velmurugan A, Madhubala MM, Bhavani S, Satheesh Kumar KS, Sathyanarayana SS, Gurucharan N. An in-vivo comparative evaluation of two herbal extracts Emblica officinalis and Terminalia Chebula with chlorhexidine as an anticaries agent: A preliminary study. J Conserv Dent. 2013;16:546-49.
[27] Poli G, Leonarduzzi G, Biasi F, Chiarpotto E. Oxidative stress and cell signalling. Curr Med Chem. 2004;11(9):1163-182.
[28] Duracková Z. Some current insights into oxidative stress. Physiol Res. 2010;59(4):459-69.
[29] Battino M, Ferreiro MS, Fattorini D, Bullon P. In vitro antioxidant activities of mouthrinses and their components. J Clin Periodontol. 2002;29(5):462-67.
[30] Yeung SY, Huang CS, Chan CP, Lin CP, Lin HN, Lee PH, et al. Antioxidant and pro-oxidant properties of chlorhexidine and its interaction with calcium hydroxide solutions. Int Endod J. 2007;40:837-44.
[31] MahendraKumar C, Singh SA. Bioactive lignans from sesame (Sesamum indicum L.): Evaluation of their antioxidant and antibacterial effects for food applications. J Food Sci Technol. 2015;52(5):2934-41.
[32] Marina AM, Man YB, Nazimah SA, Amin I. Antioxidant capacity and phenolic acids of virgin coconut oil. Int J Food Sci Nutr. 2009;60(Suppl 2):114-23.
[33] Yoshida Y, Saito Y, Jones LS, Shigeri Y. Chemical reactivities and physical effects in comparison between tocopherols and tocotrienols: Physiological significance and prospects as antioxidants. J Biosci Bioeng. 2007;104(6):439-45.
[34] Nagarajappa AK, Pandya D, Ravi KS. Role of free radicals and common antioxidants in oral health, an update. Journal of Advances in Medicine and Medical Research. 2015;18:01-02.
[35] Battino M, Greabu M, Calenic B. Oxidative stress in oral cavity: Interplay between reactive oxygen species and antioxidants in health, inflammation, and cancer. In: Armstrong D, Stratton RD, editors. Textbook of oxidative stress and antioxidant protection: The science of free radical biology and disease. London: Wiley Blackwell; 2016. pp. 155-66.
[36] Lynge Pedersen AM, Belstrøm D. The role of natural salivary defences in maintaining a healthy oral microbiota. Journal of Dentistry. 2019;80:S3-12.
[37] Sivapathasundharam B, Raghu AR. Dental caries. In: Rajendran R, Sivapathasundharam B, editors. Shafer's textbook of oral pathology. 7th ed. Noida: Elsevier Inc; 2012. pp. 434-35.
[38] Abouassi T, Hannig C, Mahncke K, Karygianni L, Wolkewitz M, Hellwig E, et al. Does human saliva decrease the antimicrobial activity of chlorhexidine against oral bacteria? BMC Res Notes. 2014;7:711. https://doi.org/10.1186/1756-0500-7-711.
[39] Kaushik M, Reddy P, Sharma R, Udameshi P, Mehra N, Marwaha A. The effect of coconut oil pulling on Streptococcus mutans count in saliva in comparison with chlorhexidine mouthwash. J Contemp Dent Pract. 2016;17(1):38-41.
[40] Naseem M, Khiyani MF, Nauman H, Zafar MS, Shah AH, Khalil HS. Oil pulling and importance of traditional medicine in oral health maintenance. Int J Health Sci (Qassim). 2017;11(4):65-70.
[41] Shetty SS, Quays DR, John J, Yee NS, Appu DAP, Tze LM, et al. Effect of oil pulling on oral health-a microbiological study. Rese Jour of Pharm and Technol. 2019;12(1):1.
[42] Salian V, Shetty P. Coconut oil and virgin coconut oil: An insight into its oral and overall health benefits. J Clin Diagn Res. 2018;12(1):ZE01-03.
[43] Peedikayil FC, Diwaker N, Premkumar CT, Kottayi S. Perceptions and efficacy of oral rinsing with two types of coconut oil: A comparative study. CORD. 2022;37:45-51.
[44] Sezgin Y, Memis Ozgul B, Alptekin NO. Efficacy of oil pulling therapy with coconut oil on four-day supragingival plaque growth: A randomized crossover clinical trial. Complement Ther Med. 2019;47:102193.

PARTICULARS OF CONTRIBUTORS:
1. Professor, Department of Paediatric and Preventive Dentistry, Kannur Dental College, Kannur, Kerala, India.
2. PG Scholar, Department of Paediatric and Preventive Dentistry, Kannur Dental College, Kannur, Kerala, India.
3. Professor, Department of Paediatric and Preventive Dentistry, Kannur Dental College, Kannur, Kerala, India.
4. Professor, Department of Paediatric and Preventive Dentistry, Kannur Dental College, Kannur, Kerala, India.
5. Associate Professor, Department of Zoology, Calicut University, Kozhikode, Kerala, India.
6. Reader, Department of Paediatric and Preventive Dentistry, Kannur Dental College, Kannur, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Faizal C Peedikayil,
Professor, Department of Paediatric Dentistry, Kannur Dental College,
Kannur-670612, Kerala, India.
E-mail: drfaizalcp@gmail.com

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