

Efficacy of Coconut Oil and 0.12 % Chlorhexidine Mouthrinses in Reduction of Plaque and Gingivitis: A Two-Week Randomized Clinical Trial

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Abstract

The objective of this study was to compare the clinical effects of coconut-oil and 0.12 % chlorhexidine (CHX) on the reduction of plaque and gingivitis. Forty healthy undergraduate dental students were randomly allocated into two groups of 20 participants each: control group (0.12 % CHX) and experimental group (coconut oil). All participants were instructed to rinse their mouth daily strictly and consistently for two weeks. Oral examination, plaque index (PI) and gingival bleeding index (GBI) were performed at baseline and on day 14. At the end of the study, satisfaction, adverse effects and a desire to continue mouthrinse usage were recorded by questionnaires. Thirty-five participants completed the trial. The results revealed that there were significant reductions in PI and GBI between baseline and day 14 in both groups ($p=0.001$; $p<0.001$). The mean percentage reductions in PI and GBI in each group were; 0.12 % CHX (41.05 % and 33 %, respectively) and coconut oil (29.43 % and 36.35 %, respectively). There was no significant difference in the percentage reductions in PI and GBI between the two mouthrinses. Coconut oil had significantly higher overall satisfaction scores, greater satisfaction scores for taste and fewer side effects ($p=0.03$, $p<0.001$, $p=0.003$, respectively). However, the numbers of participants who desired to continue using coconut oil were significantly lower than those who desired to use CHX because the long rinsing duration for coconut oil was an obstacle. Coconut oil can be considered as an alternative mouthrinse in reducing PI and GBI in participants with gingivitis because of its fewer side effects.

Keywords: Chlorhexidine, Coconut oil, Gingivitis, MouthRinse, Oil-pulling

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Introduction

Dental plaque is the main etiologic factor in the development of gingivitis.¹ Thus, supragingival plaque control is the mainstay for prevention of gingivitis.² Chemical mouthrinses are used as an adjunctive agent for daily oral hygiene regimens, especially in patients who are unable to consistently maintain adequate levels of plaque control using mechanical methods alone.³

Chlorhexidine gluconate (CHX) has been known as an excellent chemical antimicrobial mouthrinse for preventing dental plaque and gingival inflammation.⁴ To a large degree, it can inhibit plaque formation and has a high substantivity effect.⁴ However, its pronounced adverse effects are superficial staining of the teeth, altered taste perception and a bitter, unpleasant taste.⁵ These affect patient compliance for daily rinsing and the possibility of using CHX over an extended period of time. A previous study showed that a 0.2 % CHX mouth rinse has more side effects than those of 0.12 % CHX; in contrast it does not seem to be more effective against plaque and gingivitis.⁶ Therefore, there is a continued search for a substance with antimicrobial properties which avoids the side effects of CHX.

“Oil-pulling” or “Oil-swishing” therapy is an ancient Ayurvedic medicine that has been practiced for centuries in India and other parts of southern Asia.⁷ This technique involves swirling edible oil in the mouth for 10-20 minutes and then spitting it out.⁸ Edible oils used for oil-pulling⁹ include sesame oil, olive oil, sunflower oil, and coconut oil. Coconut oil is a natural product and commercially available in the local market of Thailand. It is becoming increasingly of interest for use as an alternative mouthrinse though the price of coconut oil is approximately twice as expensive as that of CHX mouthrinse (0.5 baht/ml for coconut oil and 0.25 baht/ml for CHX mouthrinse). Scientific evidence shows that coconut oil-pulling therapy can reduce oral microorganisms.^{10,11} A recent study revealed that there were no significant differences between coconut oil and 1 % CHX gel (Hexigel)

after 10 minutes of daily gum massage for three weeks in the reduction of *S. mutans* count, Lactobacillus count, plaque scores, and gingival scores.⁹ There has not been a study that has evaluated the satisfaction of people using coconut oil or compared the reduction of dental plaque and gingival bleeding between coconut oil and CHX mouthrinses. Furthermore, the adverse reactions of coconut oil are of interest and there are limited studies on the topic.

Therefore, the objectives of this study were to clinically evaluate the antiplaque and antigingivitis effects of coconut oil and also to investigate the adverse reactions and the satisfaction of people using coconut oil compared to a 0.12 % CHX mouthrinse.

Materials and methods

This *in vivo* study was designed as a randomized, single-blind (observers) study and was approved by the Human Experimentation Committee of the Faculty of Dentistry, Chiang Mai University (Document No.26/2558). Forty participants who were 2nd to 6th year undergraduate dental students at Chiang Mai University, Thailand met the selection criteria and were assigned to the study. The procedures of the study and its potential risks and benefits were fully explained to all participants. They were instructed to report if they had adverse effects from using the mouthrinses. Participants who had allergic reactions or a burning sensation would have been referred to an oral medicine specialist. Tooth staining was subsequently resolved within 15 days by tooth cleaning. All participants voluntarily participated in the study and informed consent was obtained from them.

Selection criteria

Medical and dental histories were recorded for each participant at a pre-screening visit. Inclusion criteria were: 18–25 years of age, male or female dental students with mild to moderate gingivitis associated with dental plaque¹², clinical attachment level <3 mm,

a minimum of 20 natural teeth. Conversely, exclusion criteria were as follows: participants with systemic diseases, pregnancy or lactation, having orthodontic or prosthodontic appliances, using tobacco products, undergoing antibiotic therapy three months before and during the study, using other mouthrinses one month before and during the investigation and/or having an allergy to coconut oil, CHX or any of the ingredients to used in the study treatment.

Procedure

At the beginning of the study, all participants were interviewed about demographic characteristic, medical history, dental history and oral hygiene practice. Oral examinations, including bleeding on probing and plaque index were performed by two experienced dental examiners at baseline and on day 14. Each examination was conducted by the same examiner. Intra-examiner reliability was determined with a kappa statistic of ≥ 0.75 , which indicates satisfactory calibration.

- Bleeding on probing (BOP) was evaluated at the mesial, distal, buccal and lingual surfaces of all teeth. The gingival bleeding was recorded as “presence” or “absence” of bleeding in a period of 10 seconds after UNC-15 periodontal probe insertion in the gingival sulcus.¹³ The periodontal probe was inserted into the gingival sulcus with a force of 25 grams.¹⁴ The gingival bleeding index (GBI) was expressed as the percentage of all sites examined that bleed on probing.¹³

- Plaque index (PI) was assessed on the mesial, distal, buccal and lingual surfaces of all teeth after disclosing with an erythrosine solution.¹⁵ The amount of plaque was assessed and scored from 0 to 3. The criteria were; 0= No observable plaque; 1= A thin film of plaque is detected at the gingival margin by running an explorer across the tooth surfaces; 2= Moderate accumulation of plaque is detected along the gingival margin. Plaque is visible clinically; 3= Heavy plaque accumulation is detected at the gingival margin and in the interdental spaces. The PI was calculated by adding the tooth scores together and dividing by the total

number of teeth examined.

Forty participants were randomly allocated to one of the two groups according to mouthrinses:

1. Experimental group (n=20): Virgin coconut oil (Coco Delight®, GPO, Bangkok, Thailand) (lot: NP580021) was used. Fifteen milliliters of coconut oil was kept in the mouth and swished for 10 minutes every night after tooth brushing.

2. Control group (n=20): 0.12 % CHX mouth rinse (Manufactured by the Faculty of Dentistry, Chiang Mai University, Chiang Mai, Thailand) was used. Fifteen milliliters of CHX was rinsed for one minute twice a day after meals. If CHX rinsing occurs after toothbrushing, the volunteers should wait for at least 30 minutes.

All participants received oral hygiene instruction by a clinician. They were also instructed to brush the teeth twice a day using the modified Bass technique, to consistently use the mouthrinses every day for 14 days and to avoid drinking or eating for 30 minutes after using the oral rinses. Soft nylon toothbrushes (Colgate slim soft, Colgate-Palmolive, Bangkok, Thailand) and fluoridated toothpastes (Colgate Total Pro Gum Health, Colgate-Palmolive) were given to all participants to exclude the effects of the different toothbrushes and the compositions of different toothpastes. On day 7, the subjects were recalled to evaluate any adverse reactions experienced and their compliance by measuring the residual volume and returning their mouthrinse bottle. At two weeks of enrollment, the examinations were repeated by the same researchers who were blind to the type of mouthrinse being used.

The satisfaction questionnaires

The questionnaire, composed of two parts, was evaluated and scored on day 14. It was validated and pretested prior to data collection. The first part included demographic characteristics, such as age, sex and educational level. The second part included information about adverse reactions, overall satisfaction with the mouthrinses, taste, smell, time of rinsing, and desire to continue using the mouthrinses. The overall satisfaction

scores were based on VAS score in the form of a 10-cm horizontal line on which the participants placed a mark somewhere along the line at a point that they rated their overall satisfaction with the mouthrinse received. The level of satisfaction with taste, smell and duration of rinsing were evaluated as a simple “satisfied” or “dissatisfied”. The desire to continue using the mouth rinses was assessed by answering with “yes (desire)” or “no (reject)” and describing the reasons. The scope of the study is demonstrated in Figure 1.

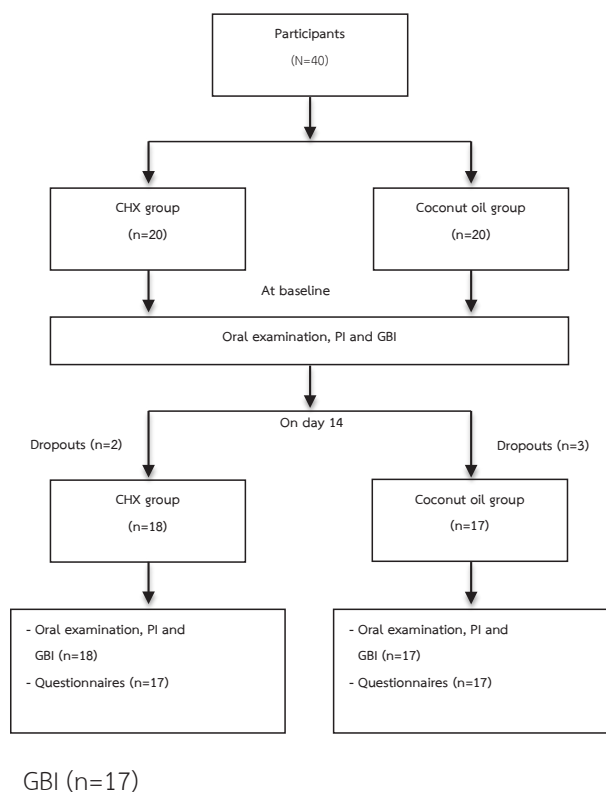


Figure 1 The scope of the study

Statistical analysis

The percentage reduction of PI and GBI in the control and experimental groups were calculated. The findings were analysed using SPSS 17 software (SPSS Inc., Chicago, Illinois, USA). The independent samples *t*-test, Mann-Whitney *U* test and Chi-square test were used to test the differences in variables between two independent groups, such as age, sex, education, the percentage reduction of PI, GBI, and overall satisfactions.

The paired *t*-test was used to test the significance of the differences between in variables at baseline and on day 14 in the same group. Fisher’s Exact test was used to compare adverse reactions, the satisfaction in taste, smell and duration of rinsing between the two mouth rinses. A significance level of $p < 0.05$ was set.

Results

Thirty-five of 40 participants completed the full two weeks of the study. Two participants in the control group left the study because of antibiotics taken during the study period. Three participants in the coconut oil group were excluded, as two participants discontinued the use of the oil and one participant took antibiotics during the study period. The demographic characteristics of subjects in the study are presented in Table 1. There were no statistically significant differences at baseline between the two groups with respect to age, sex or educational level.

There were no statistically significant differences in PI or GBI at baseline between the two groups. The results revealed a decrease in the PI and GBI from baseline to day 14 in both groups. Compared with baseline, there were statistically significant differences in PI and GBI with the two mouthrinses ($p = 0.001$; $p < 0.001$, respectively) as shown in Table 2. Table 3 presents the mean percentage reduction in PI and GBI at two weeks. CHX produced a PI reduction of 41.05 % and a GBI reduction of 33 %. Coconut oil demonstrated a PI reduction of 29.43 % and a GBI reduction of 36.35 %. There were no significant differences in percentage reduction of PI and GBI between the two groups ($p > 0.05$).

One participants in the CHX group did not answer the questionnaires. Therefore, 34 questionnaires were completed. The overall satisfaction scores of both groups are shown in Table 4. The mean overall satisfaction score in the CHX and coconut oil groups were 4.92 ± 2.14 and 6.01 ± 1.91 , respectively. The coconut oil group had a significantly higher score than the CHX group ($p = 0.03$). Satisfaction in taste, smell and duration of rinsing are

demonstrated in Table 5. The satisfaction score for taste was significantly higher in the coconut oil group ($p < 0.001$). However, there were no significant differences in the satisfaction scores for smell or duration of rinsing between the two groups.

The coconut oil group demonstrated significantly fewer side effects than the 0.12 % CHX group ($p = 0.003$), as shown in Table 6. Ten of the 18 participants (52.82 %) in the 0.12 % CHX group reported adverse reactions. Furthermore, only one (5.9 %) of the 17 participants in the coconut oil group had an adverse reaction (numbness

of tongue).

The number of participants who desired to continue using 0.12 % CHX was significantly greater than that for coconut oil ($p = 0.039$). Eleven of the 18 (64.71 %) participants desired to continue using 0.12 % CHX. Whereas, only five of the 17 (29.41 %) participants had any desire to continue using coconut oil. Moreover, 12 of the 17 (76.5 %) participants in the coconut oil group preferred not to continue using the mouthrinse. The main reason was long rinsing duration of coconut oil, as shown in Table 7.

Table 1 Demographic characteristics of subjects in the study.

Variables	Groups		p-value
	0.12 % CHX	Coconut oil	
N	18	17	
Mean age \pm SD (years)	22.3 \pm 1.9	22.1 \pm 1.8	0.627 ^a
Sex	Male (%)	6 (35.3 %)	0.862 ^b
	Female (%)	11 (64.7 %)	
Educational level	Pre-clinic (%)	8 (44.4 %)	0.740 ^b
	Clinic (%)	10 (55.6 %)	

a=independent samples t-test; b=Chi-square test

Table 2 Mean (\pm SD) of plaque index (PI) and gingival bleeding index (GBI) at baseline and two weeks with the two mouthrinses

Groups	N	PI			GBI		
		Baseline	2 weeks	p-value	Baseline	2 weeks	p-value
0.12 % CHX	18	1.05 \pm 0.36	0.64 \pm 0.34	0.001 ^{b*}	33.29 \pm 9.41	23.01 \pm 10.64	<0.001 ^{b*}
Coconut oil	17	1.29 \pm 0.48	0.90 \pm 0.41	0.001 ^{b*}	38.19 \pm 6.84	24.44 \pm 8.98	<0.001 ^{b*}
p-value		0.113a			0.262a		

a=independent samples t-test; b= paired t-test; *p-value \leq .05

Table 3 Mean (\pm SD) of the percentage reduction in plaque index (PI), and gingival bleeding index (GBI) with the two mouthrinses at two weeks

Groups	N	The percentage reduction (%)	
		PI	GBI
0.12 % CHX	18	41.05 \pm 26.37	33.00 \pm 24.13
Coconut oil	17	29.43 \pm 23.25	36.35 \pm 18.76
p-value		0.177 ^a	0.599 ^a

a=independent samples t-test

Table 4 Mean (\pm SD) of the overall satisfaction scores of both groups

Groups	N	The overall satisfaction scores	p-value
0.12% CHX	17	4.87 \pm 2.04	0.03a*
Coconut oil	17	6.51 \pm 1.99	

a=Mann-Whitney U test; *p-value \leq .05

Table 5 Satisfaction in taste, smell and duration of rinsing

Topics	Groups	N	Level of satisfaction		p-value
			Satisfied n (%)	Dissatisfied n (%)	
Taste	0.12 % CHX	17	3 (17.6 %)	14 (82.4 %)	<0.001 ^{a*}
	Coconut oil	17	15 (88.2 %)	2 (11.8 %)	
Smell	0.12 % CHX	17	16 (91.1 %)	1 (5.9 %)	0.758 ^a
	Coconut oil	17	16 (91.1 %)	1 (5.9 %)	
Duration of rinsing	0.12 % CHX	17	14 (82.4 %)	3 (17.6 %)	0.132 ^a
	Coconut oil	17	10 (58.8 %)	7 (41.2 %)	

a= Fisher's Exact Test; *p-value \leq .05

Table 6 Perception of the adverse reactions in both groups

Adverse reactions	0.12 % CHX (n=18)	Coconut oil (n=17)	p-value
No; n (%)	8 (44.44 %)	16 (94.7 %)	0.003 ^{a*}
Yes; n (%)	10 (58.82 %)	1 (5.9 %)	
Altered taste perception	4 (22.2 %)	0	
Numbness of tongue	4 (22.2 %)	1 (5.9 %)	
Mouth irritation	2 (11.1 %)	0	

a= Fisher's Exact Test; *p-value \leq .05

Table 7 Reasons to continue or reject using the two mouthrinses

Groups	N	Reasons		p-value
		Desire to continue (n; %)	Reject (n; %)	
0.12% CHX	17	11 Subjects (64.71 %) 1. Feeling cleansed (9/11; 81.8 %) 2. Reducing oral malodor (3/11; 20 %) 3. Easy application (1/11; 9.1 %)	6 Subjects (35.9 %) 1. Bitter taste (6/6; 100 %) 2. Adverse reactions (4/6; 66.7 %) 3. Unpleasant smell (2/6; 33.3 %)	0.039 ^{a*}
Coconut oil	17	5 Subjects (29.41 %) 1. Feeling cleansed (4/5; 80 %) 2. Pleasant scent (3/5; 60 %) 3. Reducing oral malodor (3/5; 60 %)	12 Subjects (70.59 %) 1. Long rinsing duration (9/12; 76.5 %) 2. Oily taste (2/12; 16.7 %) 3. Adverse reaction (1/12; 11.8 %)	

a= Chi-Square Test; *p-value \leq .05

Discussion

Gingival bleeding is the easiest clinical sign of gingival inflammation to measure, and precedes gingival redness and swelling.¹⁶ Moreover, gingival bleeding is related to histological inflammatory evaluations of the gingival tissues.¹⁷ CHX mouth rinse as an adjunct to daily tooth brushing can successfully control gingivitis.¹⁸ Previous studies have reported no remarked differences between 0.2 % and 0.12 % CHX mouthrinses in antiplaque and antigingivitis effectiveness.^{6,19} Therefore, our study chose 0.12 % CHX mouthrinse as a control group and limited the study period to 14 days to prevent tooth staining associated with prolonged usage of CHX mouthrinse.

This study was conducted with dental students who were not submitted to professional mechanical tooth cleaning or dental prophylaxis at the beginning of the experiment. Therefore, all participants had gingivitis at the baseline. This population was chosen because they have low levels of gingival inflammation and their compliance can be easily controlled.

The results confirmed that regular and consistent daily use of coconut oil for 14 days had a beneficial effect in reducing existing plaque and gingivitis. No significant difference in the mean percentage reduction of PI and GBI was found between the 0.12 % CHX and coconut oil groups. These findings are consistent with those of two previous studies. Singla *et al.*⁹ showed that there was no significant difference in the percentage reduction of plaque scores or gingival scores between coconut oil and 1 % CHX gel (Hexigel) after 10 minutes of daily gingival massage for three weeks. The median percentage reduction in plaque and gingival index scores with coconut oil were 55.4 % and 55.3 %, respectively. These values are greater than the findings of our study. This may result from their study having been conducted with participants of low socioeconomic status with poor oral hygiene and because gingival massage has a beneficial role in mechanical disruption of the biofilm on the teeth. Peedikayil *et al.*²⁰ evaluated plaque and gingival indices

on days 1, 7, 15 and 30 after coconut oil-pulling in 60 participants aged 16-18 years. A statistically significant decrease in the plaque and gingival indices was noticed from day 7 and the scores continued to decrease during the period of study. However, CHX mouthrinse was not compared as a control group.

The exact antimicrobial mechanism of the action of coconut oil is still unclear. The major composition of coconut oil is a medium chain fatty acid (MCFAs). Some MCFAs, such as lauric acid, capric acid, caprylic acid and caproic acid in coconut oil exhibit bacterial inhibition.²¹ The body converts lauric acid to monolaurin, which is a monoglyceride. Monolaurin has the ability to destroy various gram-positive and gram-negative bacteria.²²⁻²⁴ It has been postulated that monolaurin and other medium chain monoglycerides have the capacity to alter bacterial walls, penetrate and disrupt cell membranes, inhibit enzymes involved in energy production and nutrient transfer, causing bacterial death.²⁴ It has been proposed as a possible mechanism of action of oil-pulling therapy that the viscosity of the oil can inhibit bacterial adhesion and plaque coaggregation.²⁵ Another possible mechanism might be the saponification or the soap-making process that arises as a result of alkaline hydrolysis of the oil by bicarbonates in saliva. Soaps are good cleansing agents because they are potent emulsifiers. Emulsification greatly enhances the surface area of the oil, in consequence increasing its cleansing action.²⁶

The mean overall satisfaction was significantly higher in the coconut oil group ($p=0.03$). This was to be expected because the advantages of coconut oil are better taste and fewer side effects. The results showed 88.2 % of the participants in the coconut oil group were satisfied with the taste and only 5.9 % of the participants in coconut oil group had an adverse reaction. Furthermore, there were significant differences in satisfaction with taste and in adverse reactions between the two mouth rinses ($p=0.03$; $p=0.003$). Even though, there was no

significant difference in satisfaction with the duration of rinsing between two groups, the results showed that 41.2 % of the participants in the coconut oil group were dissatisfied with the duration of rinsing. Moreover, two participants in the coconut oil group discontinued the use of the oil because they could not constantly use the oil for 10 minutes every day. This could indicate that ten minutes of coconut oil-pulling was a major obstacle.

The adverse effects of coconut oil have not previously been reported. However, this study showed that one participant in the coconut oil group perceived numbness of the tongue. According to a study by Singla *et al.*⁹, none of the participants (n=10) using coconut oil reported any kind of discomfort, burning sensation, taste alteration, or any other adverse effects after performing oil gum massage therapy for two weeks, and most of them wished to continue using it. Moreover, Peedikayil *et al.*¹¹ revealed that a few participants using 0.2 % CHX mouthrinse exhibited mild staining of teeth, whereas no staining was observed in the participants performing 30 days of coconut oil-pulling. The occurrence of tooth staining in our study was recorded during the dental examination. The data showed that the examiner's perception of tooth staining was not pronounced on day 14 in either coconut oil or 0.12 % CHX group. Furthermore, none of the participants in either group was aware of this staining. The fact that the participants using 0.12 % CHX in our study did not exhibit tooth staining may result from the use of a low concentration of CHX mouthrinse and short treatment duration. The results also showed that no one in the coconut oil group and four participants (22.2 %) in the CHX group had altered taste perception. One participant (5.9 %) in the coconut oil group and four participants (22.2 %) in the CHX group had numbness of tongue. All the participants with altered taste perception or numbness of the tongue reported that the symptoms were temporary and the participants recovered within 15-30 minutes without any treatments. The literature reveals that a zinc/parotid protein/salivary glycoprotein complex is important to maintain normal

taste activity.²⁷ CHX interaction with these components may have caused the transient altered taste perception.²⁸ Mouth irritation was also reported in the CHX group. Two participants (11.1 %) had a mild burning sensation when rinsing with CHX. The oral examination did not show desquamation, erythema, edema or any lesions. The participants were willing to continue using 0.12 % CHX until the end of the study.

Oil-pulling therapy has been reported to induce lipid pneumonia.^{29,30} Two case reports have demonstrated the aspiration of microbe-rich oil during oil pulling therapy (especially sesame oil-pulling) and resulted in lipid pneumonia.^{29,30} The common symptoms of exogenous lipid pneumonia include fever, weight loss, cough, dyspnea, chest pain and hemoptysis. Approximately 40% of the patients had no or only mild symptoms.^{31,32} The radiographic findings of lipid pneumonia resemble those of many other lung diseases. Because of the nonspecific clinical presentation and radiographic features, the diagnosis is often missed or delayed.³¹ In mild cases, spontaneous remission often occurs after discontinuation of the causative stimuli and symptomatic treatment.³³ In severe cases, high-concentration oxygen therapy or mechanical ventilation is required. Therefore, the oil-pulling therapy should be avoided for children and the elderly who could have problems with controlling a swallowing reflex because of the risk of lipid pneumonia.

An interesting finding of our study was that the number of participants who wished to continue using 0.12 % CHX was significantly greater than that for coconut oil. This result was in contrast to the overall satisfaction scores; higher satisfaction scores were found in the coconut oil group. A factor that should be considered is the possibility of the participants being psychologically biased in favor of the treatment. The participants were dental students who could recognize the bitter taste of CHX. They had knowledge of, and strongly believed in, the clinical efficacy and antimicrobial effect of a CHX mouthrinse. Therefore, generalizing the results of this topic is difficult.

Although the clinical efficacies of coconut oil are comparable to CHX mouthrinse, coconut oil has some advantages over CHX because it is a natural product that has a pleasant taste and fewer side effects, such as altered taste perception and tooth staining. Therefore, coconut oil could be considered as an alternative mouth rinse in preventive therapy to maintain oral hygiene, especially in patients who have a history of allergy to CHX or need to avoid the side effects of a CHX mouthrinse.

Conclusions

Under the conditions of this in vivo study, coconut oil was as effective as 0.12 % CHX mouthrinse in reducing PI and GBI in participants with gingivitis. Therefore, coconut oil can be considered as an alternative mouthrinse to 0.12 % CHX because there are fewer side effects, higher satisfaction and better taste. However, the long rinsing time needed for coconut oil-pulling was an obstacle and should be improved.

Conflict of interest

The authors declare that there is no conflict of interest.

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