

The Role of Coconut Oil in Treating Patients Affected by Plaque-Induced Gingivitis: A Pilot Study

Francesca Ripari¹ Federica Filippone¹ Giulia Zumbo¹ Francesco Covello¹ Francesca Zara¹
Iole Vozza¹

¹Department of Oral and Maxillo-facial Sciences, Sapienza University of Rome, Rome, Italy

Address for correspondence Francesco Covello, DDS, PhD, Department of Oral and Maxillo-facial Sciences, Sapienza University of Rome, Via Caserta 6, 00161 Rome, Italy (e-mail: francesco.covello@uniroma1.it).

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Abstract

Objectives The aim of the study was to evaluate the coconut oil pulling efficacy as adjuvant in reducing plaque formation and in treating plaque-induced gingivitis.

Materials and Methods A sample of 20 patients was divided into two groups: a study and a control group. In the study group, coconut oil, in form of mouthwash, was administered to a sample of patients affected by gingivitis, aged between 18 and 35. The protocol established a daily application of the product for 30 days, where clinical parameters for plaque formation and gingivitis—plaque index (PI), bleeding index (BI)—will be evaluated during the recalls on a specific periodontal chart. The control group did not associate a coadjuvant to the normal daily oral health procedures and the same clinical parameters were evaluated at t0 and after 30 days (t1). The data were statistically analyzed using Student's *t*-test, establishing the significance level as $p < 0.05$.

Results PI and BI decreased in both groups, with a more relevant and significant drop in the study group, from a mean value of PI of 58.0 to 19.3 and a mean value of BI of 33.5 to 5.0. In the control group, the values decreased, respectively, from 53.9 to 29.1 for PI, and from 33.5 to 16.2. Furthermore, no significant side effect was reported during coconut oil pulling therapy.

Conclusions The collected data showed significant and promising improvements in reducing plaque formation and gingivitis. However, further researches have to be performed to have more consistent and statistically significant data on larger samples and to fully understand the mechanisms of action and effectiveness.

Keywords

- ▶ gingivitis
- ▶ coconut oil
- ▶ oil pulling
- ▶ oral hygiene

Introduction

Gingivitis is a reversible inflammatory disease that affects soft support tissues and shows spontaneous and/or induced bleeding, gingival hypertrophy, edema, and absence of periodontal pockets.¹ It has multifactorial etiology characterized by bacterial plaque and the interaction of three main cofactors: host susceptibility, environmental, and behavioral factors.²⁻⁴

The classification of gingival pathologies is based on the presence of dental plaque and the factors that modify the gingival inflammatory status. Plaque-induced gingivitis is a

gum inflammation induced by the bacteria located on the gingival margin. Premature alteration of the gingival health status in plaque-induced gingivitis is not clinically evaluable; however, with the progression of the gingivitis, clinical signs and symptoms become more evident. This inflammatory process can either have an acute or chronic development. It becomes chronic when the pathogenic noxa is not removed and/or the organism defenses are not capable to quickly remove the etiological agent or the damages created.

Being plaque the first cause of periodontal disease,^{5,6} with first manifestation in form of gingivitis, an efficient

domestic and professional oral hygiene aimed at the removal of the main etiological factor, plays a key role in the maintaining of the oral health and in the prevention of periodontal diseases and caries.⁷ The professional mechanical removal is performed through manual, ultrasonic, and sonic instruments. Furthermore, a proper domestic oral hygiene is sufficient to reduce the accumulation of plaque on dental surfaces, decreasing the incidence of several gingival diseases; to accomplish this, a correct use of manual or electric toothbrushes, combined to mechanical interdental cleaning, is necessary. Moreover, a chemical plaque control can be added, through the use of toothpaste and mouthwashes. Many substances can be used as coadjuvant in reducing plaque formation, but there are still few scientific evidences validating it.^{8,9}

Recent studies regarding “oil pulling” therapy using sunflower oil, sesame oil, and coconut oil were performed to reduce plaque-induced gingivitis.¹⁰⁻¹⁴

“Oil pulling” is a term defining a traditional ayurvedic remedy consisting in rinsing the mouth with oil. This practice is mentioned in the text “Charak Samhita and Sushruta Samhita” as “Kavala Graha” or “Kavala Gandoosha.”

This procedure then became famous thanks to Dr. F. Karach, who affirmed that many oral pathologies could be cured thanks to this method, but his statements could not be sustained by proofs.¹⁵

Coconut oil (*Cocos nucifera*) is still a little-known product, obtained through the cold squeezing of the dried coconut copra. It has antibacterial, antiviral, antimycotic properties together with many others. It contains 92% of saturated acids, 49% of which is lauric acid, a medium chain saturated fat acid. Medium chain saturates and their derived products (e.g., monoglycerides) are effective in destroying a wide range of bacteria (lipid coated bacteria) demolishing their lipidic membrane. They can be effective, for instance, against the bacteria causing gastric ulcer, sinusitis, food poisoning, urinary tract infections, and caries.^{5,16}

There are still a few evidences in literature of studies regarding the properties of coconut oil in relation to the oral cavity. That is why the aim of this study was to evaluate the effects of the coconut oil as coadjuvant in reducing plaque formation and for the treatment of gingivitis.

Oil Pulling and Coconut Oil

For many years, coconut oil has been used by many populations all over the world. It has been for centuries the main source of food fats for the majority of west Africa, and later labeled as an oil full of unhealthy highly saturated fat acids. This negative vision caused a reduction in its use, substituting it with other vegetable oils. Nevertheless, recent studies pointed out beneficial effects of this oil, especially regarding its role in nutrition, health, and national development.

Several properties are associated with this product and have been reported in different studies: antibacterial,¹⁷ antiviral, and antimycotic¹⁸ are the main ones; an immunostimulatory effect has been reported too,¹⁹ as well as the vasorelaxant and antihypertensive one²⁰; it has also been described an antidote effect toward the overdose-related

toxicity of drugs; an effect as antioxidant has been mentioned as well; due to the high content of mineral ions, a cardioprotective effect has been demonstrated²¹; and an antiatherosclerotic effect has been reported as well.^{22,23}

Thanks to the above-mentioned medical properties, together with the nutritional ones, coconut oil has been used in several fields, from the nutritional one to the cosmetical and the medical.

In the oil pulling procedure, the oil has to be kept in the mouth for the duration of 20 minutes, preferably in the morning before breakfast. The quantity for adults is equal to a tablespoon, for children to a teaspoon. The oil, during the rinsing, has to be pulled and forced in between all the teeth and brought to contact to all the parts of the mouth. At the end of this procedure, if it has been performed properly, the aspect of the oil should be thin, viscous, and milky. Afterward, it has to be spat out and the mouth has to be rinsed with warm water.

There are numerous theories regarding the mechanism of action of coconut oil during this practice, such as the antioxidants generated damaging the cell wall of microorganisms that are then killed; but also, the oily film generated by its emulsification, covers teeth and gums, reducing plaque and bacterial cohesion. Coconut oil also contains lauric acid that together with sodium hydroxide and bicarbonates creates a substance that reduces adhesion and plaque accumulation, having a cleaning action. Despite its ambiguous mechanism of action, some studies have clearly demonstrated an anti-inflammatory effect, together with the one against adhesion/aggregation of plaque.^{24,25}

Materials and Methods

The study protocol was conformed to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the appropriate ethics committee of Sapienza University of Rome. The protocol of study used for this trial has been performed in the dental clinic of the Local Health Authority of Latina, Cisterna di Latina district, where 20 patients aged between 18 and 35 and affected by mild gingivitis have been first evaluated and then selected.

After verbal information about nature and objectives of the trial, effects of the treatment and their clinical conditions, informed consent forms have been handed out to be signed.

Inclusion Criteria of the Study:

- Age between 18 and 35;
- Presence of plaque and calculus on dental surfaces;
- Presence of clinical signs of gingivitis: edema, bleeding, swelling, and redness.

Exclusion Criteria of the Study:

- Poorly motivated and/or poorly collaborating patients;
- Patients undergoing treatment with hormones;
- Patients undergoing treatment with calcium antagonists, cyclosporine, and phenytoin;
- Patients allergic to coconut;
- Pregnant women.

Afterward, a periodontal chart (►Fig. 1A, 1B) was filled; it considered plaque index (PI), bleeding index (BI), presence of mobility, halitosis, gingival recession, and probing depth.

The PI used was the O'leary one, examining the four tooth surfaces (mesial, distal, buccal, and oral) and reporting the presence or absence of plaque.

The index was calculated summing up the number of surfaces with plaque divided by the total number of examined surfaces and then multiplied by 100.

The BI used was the Ainamo & Bay one, probing the four tooth surfaces (mesial, distal, buccal, and oral) and reporting the presence or absence of bleeding.

The index was calculated summing up the number of surfaces showing bleeding divided by the total number of examined surfaces and then multiplied by 100.

The presence of mobility and gingival recession was evaluated with Miller index.

The above-mentioned data and indexes have been examined and collected by a single calibrated researcher.



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Dental Department of
the Local Health Authority of Latina
Cisterna di Latina District

SURNAME:	NAME:	DATE OF BIRTH:
SYSTEMIC DISEASES:	MEDICATIONS:	SMOKER:
DATE:	HALITOSIS:	PLAQUE INDEX: ____%
		BLEEDING INDEX: ____%

DBM											MBD											DBM											MBD										
18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38												
PROBING											PROBING											PROBING											PROBING										
RECESSION											RECESSION											RECESSION											RECESSION										
MOBILITY											MOBILITY											MOBILITY											MOBILITY										
B											B											L											L										
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BLEEDING INDEX											BLEEDING INDEX											BLEEDING INDEX											BLEEDING INDEX										

NOTES: _____

	T0 - FIRST VISIT	T1W - 7 DAYS	T2W - 15 DAYS	T4W - 30 DAYS
PLAQUE INDEX				
BLEEDING INDEX				
MOBILITY				
HALITOSIS				
BURNING SENSATION				
DRYNESS				
TASTE PERCEPTION				
TASTE ALTERATION				
PIGMENTATION				

Fig. 1 Periodontal chart used in the study.

After the chart was filled, the patient underwent mechanical nonsurgical causal therapy.

Subsequently domestic oral hygiene instructions and motivation were given.

The patients selected were divided into two groups of 10: a study group and a control group.

The patients of the study group underwent a domestic treatment with coconut virgin oil-based mouthwash; the therapy consisted in a daily rinse of the mouth for 5/10 minutes after brushing and interdental cleaning before going to bed, for 30 days.

These patients were given 30 pre-dosed bottles containing 10 mL of coconut oil.

The patients of the control group were instead asked not to rinse their mouth for 30 days and to maintain their domestic oral hygiene routine just with toothbrush and floss/pipe cleaners.

Checkups were performed at 7, 15, and 30 days (t1w, t2w, and t4w, respectively) since the first session (t0) and in each one of them PI, BI, mobility, and halitosis have been evaluated and, furthermore, in each session, tasting like and dislike of the mouthwash, taste alterations, burning sensation, mouth dryness, if noticed during the treatment, were recorded. The values pre- and post-treatment of both groups were compared using Student's *t*-test with $p < 0.05$.

Results

The percentages of the data collected are shown in ►Fig. 2, with the aim of showing the variation of the parameters during the therapy combining the nonsurgical periodontal treatment with domestic treatment with coconut oil mouthwash.

►Fig. 2A shows the variation over time of PI, and so of the formation of plaque in the study group during the domestic treatment with coconut oil mouthwash, following the periodontal nonsurgical therapy.

It can be remarked how the mean PI is lower at 7 and 15 days, and then slowly increases over time.

►Fig. 2B shows how BI, and therefore the grade of tissue inflammation during the treatment with coconut oil, varied over time. A substantial drop of the BI is shown over time, being clearly represented by the mean value.

During the first and the last checkup, the presence or absence of halitosis was evaluated too, through the wrist-lick test. ►Fig. 2C shows the number of patients affected by halitosis at t0, while ►Fig. 2D shows the number of patients affected by halitosis after the treatment with coconut oil, pointing out how for 50% of the patients an improvement was recorded by the end of the treatment.

During the recalls, information regarding the domestic treatment was collected: dryness of the mouth and/or

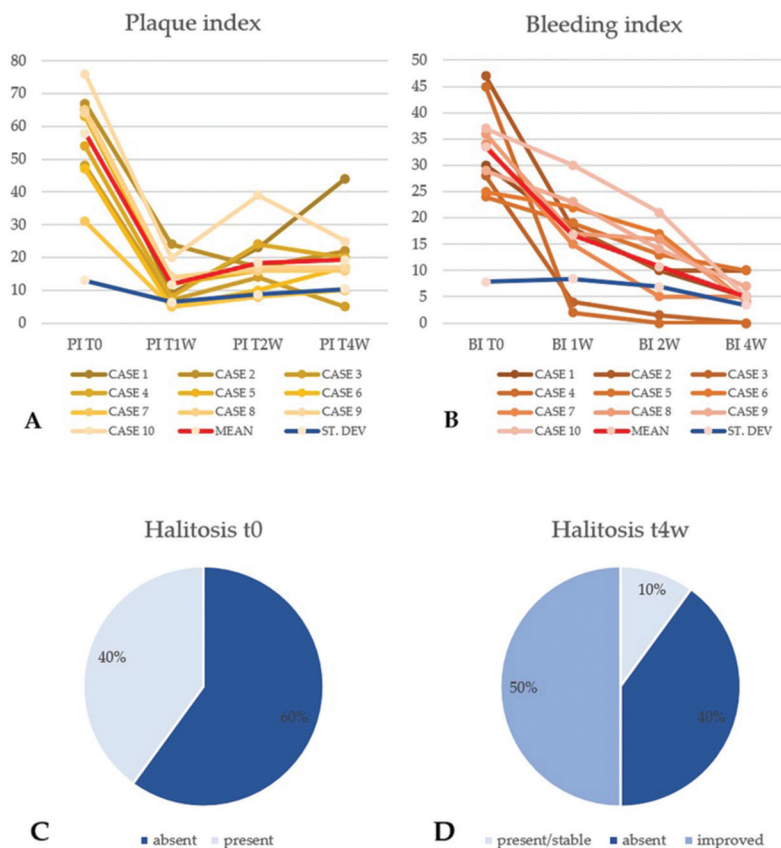


Fig. 2 (A) Variation over time of plaque index in the study group. (B) Variation over time of bleeding index in the study group. (C) Halitosis in study group at t0. (D) Halitosis in study group at t4w.

burning sensation, taste alteration, and presence of pigmentation. These were reported in ►Fig. 3, showing how burning sensation and taste alteration were totally absent, pigmentation was slightly reported, and dryness of the mouth was instead more often registered.

In the study group, during the checkups, no variation in probing depth and recession was recorded. No patient of the study group showed mobility over grade 0 of Miller index. No patient reported allergic reactions to the product.

For the control group, ►Fig. 4 shows the data collected before, during, and after the mechanical nonsurgical therapy are aimed at showing the variation in the parameters over time.

The recalls for the control group were performed with the same sessions and parameters of the study group were collected.

►Fig. 4A shows the graphic of the data related to PI of the control group before the mechanical nonsurgical therapy and at 30 days after it and how in each one of the cases it dropped.

►Fig. 4B shows the values of BI of control group decreased for each case at week four.

►Fig. 4C and 4D show the presence or absence of halitosis of the patients of the control group at t0 and t4w.

In the control group, during the checkups, no variation regarding probing depth and recession was recorded. No patient of the control group showed a mobility index over grade 0 of Miller index.

The pre and post-treatment values of both groups were compared using Student's *t*-test, establishing the significance level as $p < 0.05$ and are reported in ►Tables 1 and 2.

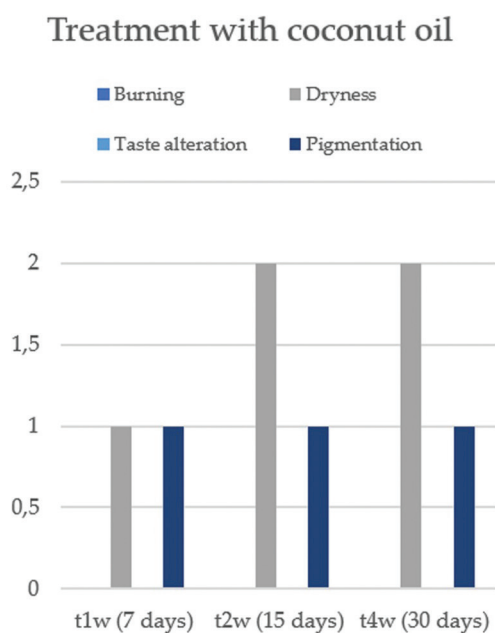


Fig. 3 Evaluation of side effects during coconut oil treatment.

In the study group, the mean PI (►Fig. 5A) before the non-surgical causal treatment was equal to 58%, decreasing to a mean value of 19.3% after 30 days.

In the control group, the mean PI (►Fig. 5A) before the nonsurgical causal treatment was equal to 53.9%, decreasing to a mean value of 29.1% after 30 days.

The study group showed a drop in the PI of 38.75, that's to say it decreased of 66.72%, while the control group equal to 24.8 and so of 46.01% (►Fig. 5D).

The mean BI (►Fig. 5B) of the study group and the control group was, both cases, 33.5%. At 30 days, the control group had a mean value of 16.2%, while the study group had a mean value of 5%.

The study group BI dropped to 28.5 that is to say it decreased to 85.07%, while in the control group the drop was of 17 so it decreased to 51.64% (►Fig. 5D).

Before the treatment, halitosis was reported in 20% of the patients of the control group and in 60% of the patients of the study group. In the control group, improvements were recorded in 50% of the patients at 30 days, while in the study group, improvements were recorded in 80% of the patients (►Fig. 5C).

The comparison with the Student's *t*-test, of the PI and BI of both groups, showed that the difference of the means of the two groups before the treatment was not significant to *p*-value (significance level) < 0.05 . The BI, in fact, was equal to $p = 1.0$ and the PI equal to $p = 0.48$.

Meanwhile, the difference in the means of the two groups, both for PI and BI, was statistically significant. The BI was significant for $p < 0.01$ with a value of 0.0003, while the PI was significant for $p < 0.05$ with a value of 0.037 (►Table 1).

The comparison of the pre- and post-treatment values of the single study group and the single control group showed a statistically significant result for $p < 0.01$.

Discussion

Together with the professional scaling and removal of etiological factors, proper home hygiene instructions and procedures have to be performed to maintain a healthy oral environment that would not facilitate bacterial growth.²⁶ That is why, it is believed that not only brushing and flossing are fundamental, but also a coadjuvant is strongly recommended in treating gingivitis. In the last decades, several alternative methods have been studied, trying to demonstrate to be effective in reducing plaque formation and aggregation, among them coconut oil pulling seemed to be one of the most promising.

This study focused treatment with virgin coconut oil-based mouthwash showing a very positive indexes variation, compared with simple mechanical nonsurgical procedure.

Oil pulling therapy performed in this trial proved to be effective in treating plaque-induced gingivitis, without showing any negative effect or disadvantage, if not for the slightly longer procedure (5–10 minutes).

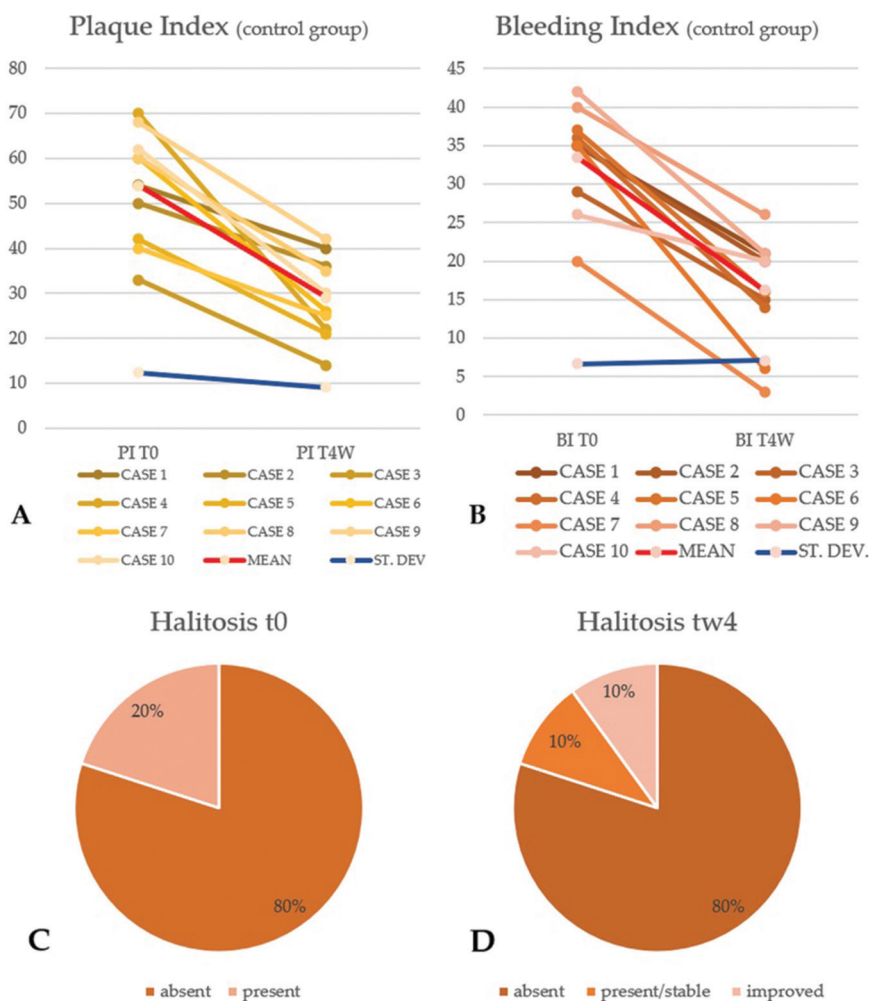


Fig. 4 (A) Variation over time of plaque index in control group. (B) Variation in control group of the bleeding index over time. (C and D) Halitosis in the control group before the nonsurgical periodontal treatment and after 30 days from it.

Table 1 Comparison of the mean values of the two groups of PI (plaque index) and BI (bleeding index) at t0 and t4w

Group	Mean	Standard deviation	p-Value ^a
PI t0			
Study group	58	13.03	0.48
Control group	53.9	12.04	
BI t0			
Study group	33.5	7.87	1.0
Control group	33.5	8.40	
PI t4W			
Study group	19.3	10.37	0.0372
Control group	29.1	9.06	
BI t4W			
Study group	5.0	3.43	0.0003
Control group	16.2	7.11	

^ap-value (level of significance) < 0.05 is considered statistically significant (Student's t-test). t0: before treatment; t4W: 30 days after treatment.

Table 2 Comparison of PI and BI pre- and post-treatment in control group and PI and BI pre- and post-treatment in study group

Group	Mean		p-Value ^a
	PI	BI	
PI/IB			0.0001
Control group t0	53.9	33.5	
Control group t4w	29.1	16.2	
PI/BI			0.0000
Study group t0	58.0	33.5	
Study group t4w	19.3	5.0	

^ap-value (level of significance) < 0.05 is considered statistically significant (Student's t-test). PI: plaque index; BI: bleeding index; t0: before treatment; t4W: 30 days after treatment.

In this trial, oil pulling treatment with coconut oil demonstrated to be an effective adjuvant to the maintaining of home oral hygiene, thanks to its capacity in reducing adhesion and the formation of bacterial plaque.

Some other studies have considered and experimented the use of coadjuvant products and procedures (such as essential

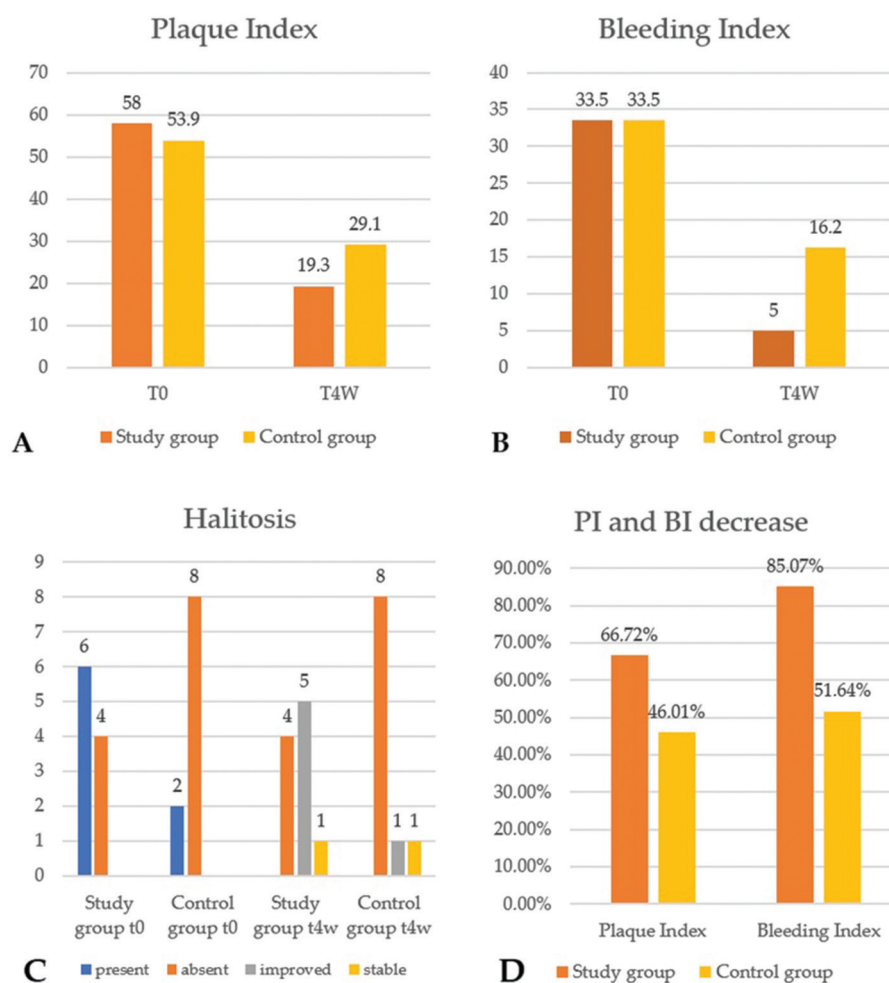


Fig. 5 (A) Mean of the plaque index (PI) over time, in study and control group. (B) Mean of the bleeding index (BI) over time, in study and control group. (C) Halitosis in study group and control group at t0 and at t4w. (D) Decreasing PI and BI (%) of the study group (orange) and control group (yellow).

oils and oil pulling) in oral hygiene routines in patients affected by plaque-induced gingivitis, to demonstrate their effect in reducing adhesion, aggregation, and plaque accumulation.

In 2015, Peedikayil et al performed a study²⁷ with 60 adolescents aged between 16 and 18 affected by plaque-induced gingivitis. They observed a statistically significant decrease in plaque and gingivitis indexes after coconut oil pulling therapy. The subjects performed the mouth rinses in the early morning before eating, together with their daily oral hygiene routine (toothbrush and floss). They have been evaluated after 4 hours and PI and modified gingival index have been measured on day 1, 7, 15, and 30. From day 7 and on a continuous decrease in the indexes was reported and they were significantly reduced after 30 days of treatment. Their study observed a 50% drop in the indexes after 4 weeks compared with the ones obtained with chlorhexidine, concluding that coconut oil pulling is effective in reducing formation of plaque and gingivitis.

In another study, Asokan et al²⁸ studied the effects of oil pulling with sesame oil on 20 adolescents affected by plaque-induced gingivitis. They concluded reporting a reduced PI and a modified gingival index.

Peedikayil et al, in 2016, studied instead the efficacy of coconut oil and chlorhexidine against *Streptococcus mutans* in an *in vitro* study,²⁹ demonstrating a statistically significant decrease in *S. mutans* both for coconut oil and chlorhexidine.

In all the studies mentioned, as well as in this current one, natural coadjuvants with specific properties, especially coconut oil used with oil pulling procedure, proved to be efficient in reducing the accumulation and aggregation of plaque and therefore PI and the further risk of plaque-induced gingivitis. Moreover, just little pigmentation was shown in few cases and no burning sensation or taste alteration was reported, suggesting how this procedure with coconut oil could be a valid and more acceptable alternative to conventional coadjuvants, especially in patients who are more susceptible and sensitive to this kind of side effects.

Of course, being this trial just one few currently present in literature, and being the sample constituted by 20 patients, more research has to be performed, deepening and investigating the properties, dynamics, mechanisms, and effectiveness of oil pulling therapy with coconut oil.

Conclusion

This study which was performed has to be considered just a starting point for future researches, due to the limited literature background and the small sample taken into consideration. The results obtained were promising and relevant, but to be more statistically significant it would be worthwhile realizing additional studies to fully understand coconut oil pulling mechanism of action and discover additional substitutes and/or adjuvants.

Despite having shown significant improvements in this study and others, the exact mechanism of this treatment is still unclear. It is then necessary, to open new gateways in oral health research, to carry out further studies with larger samples and new comparisons with other products, to verify and demonstrate the antibacterial effect of the components of this natural product and procedure, so that the quality of evidence can be implemented.

Conflict of Interest

None declared.

References

- Kumar S. Evidence-based update on diagnosis and management of gingivitis and periodontitis. *Dent Clin North Am* 2019;63(1):69–81
- Germano F, Bramanti E, Arcuri C, Cecchetti F, Cicciù M. Atomic force microscopy of bacteria from periodontal subgingival biofilm: preliminary study results. *Eur J Dent* 2013;7(2):152–158
- Fiorillo L, Cervino G, Herford AS, et al. Interferon crevicular fluid profile and correlation with periodontal disease and wound healing: a systemic review of recent data. *Int J Mol Sci* 2018;19(7):190810.3390/ijms19071908
- Bayani M, Pourali M, Keivan M. Possible interaction between visfatin, periodontal infection, and other systemic diseases: a brief review of literature. *Eur J Dent* 2017;11(3):407–410
- Ripari F, Cera A, Freda M, Zumbo G, Zara F, Voza I. Tea tree oil versus chlorhexidine mouthwash in treatment of gingivitis: a pilot randomized, double blinded clinical trial. *Eur J Dent* 2020;14(1):55–62
- Robinson PG, Deacon SA, Deery C, et al. Manual versus powered toothbrushing for oral health. *Cochrane Database Syst Rev* 2005;18(2):CD002281
- Deacon SA, Glenny AM, Deery C, et al. Different powered toothbrushes for plaque control and gingival health. *Cochrane Database Syst Rev* 2010;(12):CD004971
- Meto A, Colombari B, Castagnoli A, Sarti M, Denti L, Blasi E. Efficacy of a copper-calcium-hydroxide solution in reducing microbial plaque on orthodontic clear aligners: a case report. *Eur J Dent* 2019;13(3):478–484
- Chatterjee D, Kapoor A, Vijay S, Sobti G, Kara D, Thanvi J. Efficacy of locally administered 1.2% rosuvastatin gel in patients with periodontitis: a randomized placebo controlled clinical trial. *Eur J Dent* 2019;13(1):29–35
- Amith HV, Ankola AV, Nagesh L. Effect of oil pulling on plaque and gingivitis. *J Oral Health Comm Dent* 2007;1:12–18
- Asokan S, Rathan J, Muthu MS, Rathna PV, Emmadi P, Raghuraman. Chamundeswari. Effect of oil pulling on Streptococcus mutans count in plaque and saliva using Dentocult SM Strip mutans test: a randomized, controlled, triple-blind study. *J Indian Soc Pedod Prev Dent* 2008;26(1):12–17
- 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
- Vadhana VC, Sharath A, Geethapriya PR, Vijayasankari V. Effect of sesame oil, ozonated sesame oil, and chlorhexidine mouthwash on oral health status of adolescents: a randomized controlled pilot trial. *J Indian Soc Pedod Prev Dent* 2019;37(4):365–371
- 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
- Shanbhag VK. Oil pulling for maintaining oral hygiene - a review. *J Tradit Complement Med* 2016;7(1):106–109
- DebMandal M, Mandal S. Coconut (*Cocos nucifera* L.: *Arecaceae*): in health promotion and disease prevention. *Asian Pac J Trop Med* 2011;4(3):241–247
- Effiong GS, Ebong PE, Eyong EU, Uwah AJ, Ekong UE. Amelioration of chloramphenicol induced toxicity in rats by coconut water. *J Appl Sci Res* 2010;6(4):331–335
- Rihakova Z, Filip V, Plockova M, Smidrkal J, Cervenkova R. Inhibition of *Aspergillus niger* DMF 0801 by monoacylglycerols prepared from coconut oil. *Czech J Food Sci* 2002;20:48–52
- Vigila AG, Baskaran X. Immunomodulatory effect of coconut protein on cyclophosphamide induced immune suppressed Swiss Albino mice. *Ethnobot Leaflets* 2008;12:1206–1212
- Loki AL, Rajamohan T. Hepatoprotective and antioxidant effect of tender coconut water on CCl4 induced liver injury in rats. *Indian J Biochem Biophys* 2003;40:354–357
- Nevin KG, Rajamohan T. Beneficial effects of virgin coconut oil on lipid parameters and in vitro LDL oxidation. *Clin Biochem* 2004;37(9):830–835
- DebMandal M, Mandal S. Coconut (*Cocos nucifera* L.: *Arecaceae*): in health promotion and disease prevention. *Asian Pac J Trop Med* 2011;4(3):241–247
- Dayrit FM. The properties of lauric acid and their significance in coconut oil. *J Am Oil Chem Soc* 2015;92:1–15
- Shanbhag VK. Oil pulling for maintaining oral hygiene - a review. *J Tradit Complement Med* 2016;7(1):106–109
- Singh A, Purohit B. Tooth brushing, oil pulling and tissue regeneration: a review of holistic approaches to oral health. *J Ayurveda Integr Med* 2011;2(2):64–68
- Ahmad FA, Alotaibi MK, Baseer MA, Shafshak SM. The effect of oral health knowledge, attitude, and practice on periodontal status among dental students. *Eur J Dent* 2019;13(3):437–443
- Peedikayil FC, Sreenivasan P, Narayanan A. Effect of coconut oil in plaque related gingivitis - a preliminary report. *Niger Med J* 2015;56(2):143–147
- 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
- Peedikayil FC, Remy V, John S, Chandru TP, Sreenivasan P, Bijapur GA. Comparison of antibacterial efficacy of coconut oil and chlorhexidine on *Streptococcus mutans*: an in vivo study. *J Int Soc Prev Community Dent* 2016;6(5):447–452