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Efficacy of Oil-pulling Versus Chlorhexidine Mouthwash in Reducing Oral Streptococcus Mutans Count: A Systemic Review and Meta-analysis

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Authors' contributions

This work was carried out in collaboration among all authors. Authors ZAA, ATN, SAB and SSR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ZAA and JAQ managed the analyses of the study. Author FS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Purpose: To determine whether oil-pulling with sesame or coconut oil yields a better result in reducing Streptococcus mutans count compared to conventional chlorhexidine mouthwashes.
Methods: Multiple databases were used to search for articles up to and including August 2019. Studies which reported use of oil-pulling and chlorhexidine mouthwashes to reduce Streptococcus mutans bacterial count were analyzed procedurally. Studies that fulfilled the inclusion criteria were then undertaken for qualitative and quantitative analysis.
Results: Five studies were included in this analysis, which used oil-pulling (test group) and chlorhexidine mouthwash (control group). The follow-up period ranged from 14 to 30 days. The oil

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used in oil-pulling group were either sesame or coconut oil. Quantitative analysis showed a significant reduction in oral Streptococcus mutans count with oil-pulling as compared to chlorhexidine mouthwash at follow-up (Q value = 6.61, DF = 4, I^2 = 39.50%).
Conclusion: Use of oil-pulling showed better result in reducing cariogenic bacterial count as compared to the gold standard chlorhexidine mouthwashes. More clinical trials, evaluating additional oral hygiene parameters, would further validate the effects of oil-pulling on the oral cavity. Clinicians may advise their patients to use oil-pulling instead of chlorhexidine mouthwashes, as it is safe, cost-effective, and easily available.

Keywords: Chlorhexidine; mouthwash; oil-pulling; Streptococcus mutans

1. INTRODUCTION

Dental caries commonly termed as tooth decay, is one of the most prevalent, chronic disease present worldwide; with a number of individuals susceptible to it throughout their lifetime [1]. The human oral microbiome contains about 700 different kind of bacterial species and the most important cariogenic bacteria which plays a key role in the pathogenesis of dental caries is known as oral streptococci, especially from group *mutans* and also lactic acid bacteria (*Lactobacillus spp*). It is an accepted fact that microorganisms of the species, *Streptococcus mutans* (*S. mutans*) are the principle factor that promotes caries and significant factor of enamel decay [2].

Mouth rinses are solutions or liquids used to rinse the mouth for a number of purposes: (a) prevent the biofilm formation (b) inhibition of early microbial colonization on tooth surfaces (c) the alteration of pathogenic plaque into nonpathogenic plaque, and (d) to have a therapeutic effect by relieving periodontal infections or preventing dental caries [3]. Studies have shown that chlorhexidine (CHX) is very effective against *S. mutans* in dental plaque [4, 5]. Evidence in dental literature support and recognize, CHX, as the gold standard against which other anti-plaque and anti-gingivitis agents are measured [6]. Some in vitro studies have demonstrated that CHX when used in low potency, makes low molecular weight molecules escape from the micro-organisms, causing damage to the cell membrane. While at higher potency, CHX causes protein precipitation and coagulation of microbes. Due to this mechanism CHX can hinder with biofilm formation and prevent the growth processes [7].

The long-term efficacy and safety of CHX mouthwashes have been proven in several studies. Regardless of potent antimicrobial and anti-plaque properties of CHX, it's widespread and comprehensive uses are restricted by local side effects which mostly are dose dependent [3]. Commonly encountered side effects by the use of CHX mouthwash are oral mucosal ulceration, staining of teeth and tongue, altered taste sensation and paresthesia [8]. Platinga, et al. in 2016 reported that when 2% CHX was used as therapy, out of 295 patients 29 demonstrated oral mucosal lesions, including erosive lesions, ulcerations, white/yellow plaque formation, and bleeding mucosa [9]. However, according to recent literature, it is assumed that CHX exposure may speed up calculus formation and may serve as an ideal substrate for the attachment of micro-organisms. Also, the long-term use of CHX as an anti-septic agent can cause excess formation of supra-gingival calculus formation and allergic reactions [10]. Despite of the fact that CHX causes calculus formation [11,12], the mechanism for the uptake of calcium and phosphate is unclear [13]. In a clinical study, Gürgan *et al*. in 2006 evaluated the 0.2% CHX mouth rinse and reported that the most commonly encountered side effect was the change in color of the labial and buccal mucosa, particularly of the gingiva [14,15]. The mechanism behind the tooth discoloration especially in the interproximal areas and tongue are often caused by a precipitation reaction between chromogens from food or beverages and tooth-bound CHX [16].

In Complementary and Alternative Medicine (CAM) there is a renowned Ayurvedic practice known as oil pulling that includes extended rinsing of oil in the oral cavity to promote better oral hygiene. This technique has been practically implemented from ancient times due to the fact that it is natural and safe and also considered as a holistic Ayurvedic therapy [17]. In oil pulling, a teaspoonful of any kind of oil is swished around the mouth early in the morning preferably before having breakfast, for about 15-20 minutes. The oil is 'pulled' and forced around the oral cavity. If done correctly, oil will become viscous, milky white and thinner. It is then expectorated; the mouth is thoroughly washed with warm saline or

normal tap water followed by routine tooth brushing [18]. According to literature oil-pulling is known to be a well-known CAM remedy for different systemic and oral diseases [19] that includes reduced chances of tooth decay, swollen and bleeding gums, dry mouth and chapped lips [20]. It also helps to eliminate bad odor from the mouth and stimulates the taste buds. Oil pulling can be used as an alternative oral hygiene method in those patients where brushing is not easy as in oral ulcers, or in those who have a tendency to gag as in asthmatics and severe cough [21]. Coconut oil, sesame oil, palm oil and sunflower oil are the most commonly used oils for oil-pulling technique [20]. Coconut oil has an exceptional role in the diet with added health and nutritional benefits as it acts as an anti-inflammatory, immune modulator, moisturizer and healing wounds. Coconut oil is also found to be a potent anti-microbial, anti-fungal and anti-viral agent [22,23]. Lauric acid is among the highest antimicrobial medium chain fatty acids. When lauric acid is esterified to glycerol making monolaurin, its antimicrobial effect is increased [24]. Similarly, capric acid possesses bactericidal activity as well as its monoglycerol derivative monocaprin. It is also known that monocaprin is active against gram-positive bacteria and enveloped viruses [25,26]. Several studies showed that monolaurin is mainly active in vitro against many gram-positive, gram-negative pathogenic bacteria and fungi such as *Staphylococcus aureus*, *S. mutans, Escherichia vulneris*, *Enterococcus spp*, *Helicobacter pylori* and *Candida albicans* [23,27-29].

Sesame oil is additionally found to be effectual in reducing microorganism growth and adhesion [30]. Sesamin and sesamolin, the foremost lignans found in oil, are identified for their antioxidative properties. Roasted sesame oil incorporates a higher concentration of sesamol, the thermally degraded product of sesamolin, which is taken into account as a strong antioxidant compared to its parent molecule. Due to this factor, free radical scavenging and antibacterial properties were also found in the isolated lignans and sesamol [31] According to literature, *S. mutans* and *L. acidophilus* were moderately sensitive to oil, that are identified to be essential caries pathogens [32].

The objective of this systemic review and meta-analysis was to determine whether oil-pulling with sesame or coconut oil yields a better result in reducing Streptococcus mutans count compared to conventional chlorhexidine mouthwashes.

2. METHODOLOGY

2.1 Review Registration and Protocol

This review was registered at "National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews" (Registration number: CRD42019135435). Guidelines from "Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)" were taken to design this review [33]. The "PICO principle (i.e., 'Patients' – individuals with DMF of < 2; 'Interventions' – oil pulling (using sesame or coconut oil); 'Comparison' – CHX mouthwash; 'Outcomes' – oral *S. Mutans* bacterial count)" was employed for the development and addressing the research question: "Is oil pulling using either sesame or coconut oil, more effective then CHX mouthwashes in reducing oral *S. mutans* bacterial count"?

2.2 Source of Literature

Literature search was performed through several databases up till August 2019 for articles focusing on the research question. Combinations of MeSH (Medical Subject Headings) words and free text words were used: *"oil-pulling", "chlorhexidine", "mouthwash", "sesame oil", "coconut oil", "oral", "hygiene", "rinsing", "bacteria" and "S. mutans"*.

2.3 Eligibility Criteria

Studies taken for the current review were case-control, cross-sectional, and clinical trials that included at least 10 individuals per group using either CHX mouthwash (control) or oil-pulling (test). Studies compared the oral *S. mutans* bacterial count after the use of CHX mouthwash or oil-pulling in addition to regular brushing.

In-vitro & animal studies, those using any other technique for maintaining oral hygiene, a combination of different therapeutic rinses, and review articles were excluded.

2.4 Screening and Selection

Independent searching and screening of the titles and their abstract was done by two reviewers. Abstracts that provided relevant information

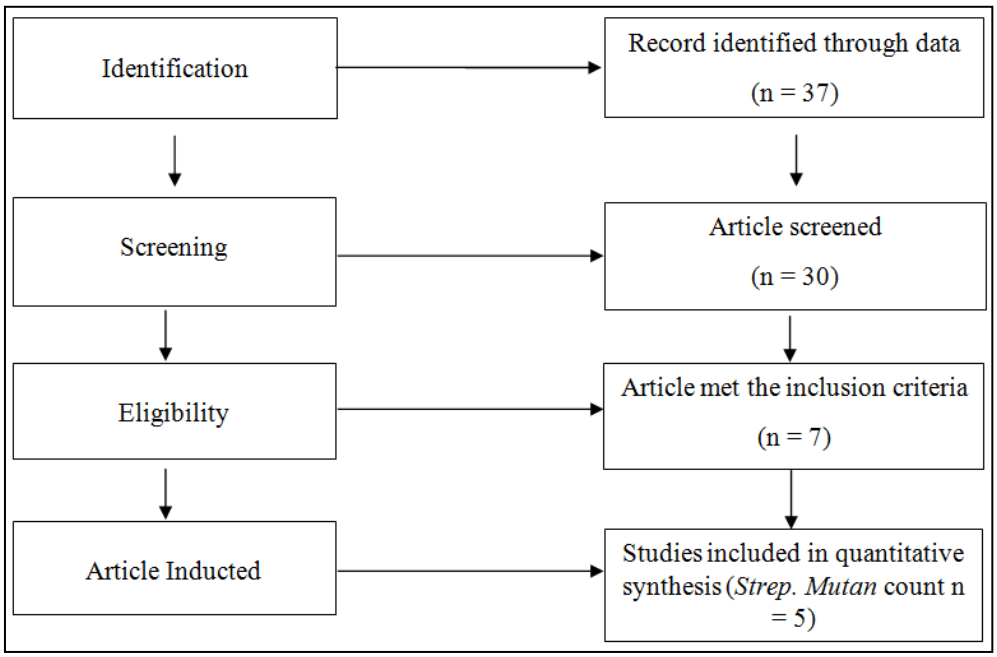

Fig. 1. Flow diagram according to PRISMA guidelines

based upon the selection criteria, then those articles were selected for a full reading of the text. Any disagreement between the reviewers were resolved through discussion with a third independent reviewer.

Studies that were in accordance with the inclusion and exclusion criteria were then processed for data extraction. (Fig. 1) describes the screening process according to PRISMA guidelines [33].

2.5 Data Extraction

Data related to the participant's age, gender, study design, sample size, follow-up period, type of oil used, concentration of CHX mouthwashes, time duration of using oral rinses, medium for bacterial count and study outcome was charted from included studies. The reviewers crosschecked all of the data obtained.

2.6 Qualitative Analysis

Meta-analysis was done for oral *S. mutans* bacterial count. To evaluate the heterogeneity among the included studies, I^2 and Q-statistics tests were used in this analysis [34]. Forest plot was used to report the weighted mean difference (WMD) of outcome and 95% confidence intervals (CI). P-value of < 0.05 was considered statistically significant for both heterogeneity and pooled effect. The I^2 statistic was applied to quantify inter-study variability having a range of 0% to 100%, 0% indicating no heterogeneity whereas the increased values indicate a higher level of heterogeneity. Statistical software (MedCalc) was used for qualitative analysis in this study.

3. RESULTS

3.1 Study Selection

A total of 37 study titles and abstracts were initially identified in multiple electronic databases such as PubMed, EMBASE, Scopus, etc. After the removal of the duplicates, 30 articles were identified. 23 studies were excluded as they were irrelevant according to our research question. Out of the total 7 papers that were selected for full-text reading, 2 research papers were further excluded. 5 studies [5,29,35-37] were finally selected and processed for data extraction. (Fig. I) shows the flow chart of study selection according to PRISMA [33].

3.2 Characteristics of Included Studies

Five studies were included in this review [5,29, 35-37]. All of them were carried out in India. Four out of five studies had participants ranging from 16-22 years [5,29,35,37], whereas one study had participants ranging from 8-12 years [36]. All the five studies included subjects with DMFT score of less than 2 [5,29,35-37]. All studies used oil

pulling technique either using sesame or coconut oil in test group and chlorhexidine mouthwash in the control group [5,29,35-37]. Three studies had a follow-up period of 30 days [35-37], whereas the other two studies had a follow-up period of 14 days [5,29].

3.3 Quality of Clinical Studies

All the five studies included in this analysis were of moderate quality. The risk of bias was estimated for each selected RCT based on the "Cochrane Handbook for Systematic Reviews of Interventions [38]: 1) low risk of bias (when all criteria were met); 2) high risk of bias (when ≥1 criterion was not met); and 3) unclear (when ≥1 criterion was partially met)" (Table 3).

3.4 Synthesized Findings

The overall findings of this analysis were found to be in favor of the experimental group, in which the oral *S. mutans* count reduced more as compared to the control group. The pool effects in term of standardized mean difference as obtained in a fixed effect models showed an impact of 0.48 in favor of oil-pulling therapy, that according to the Cohen rule of thumb depicts a

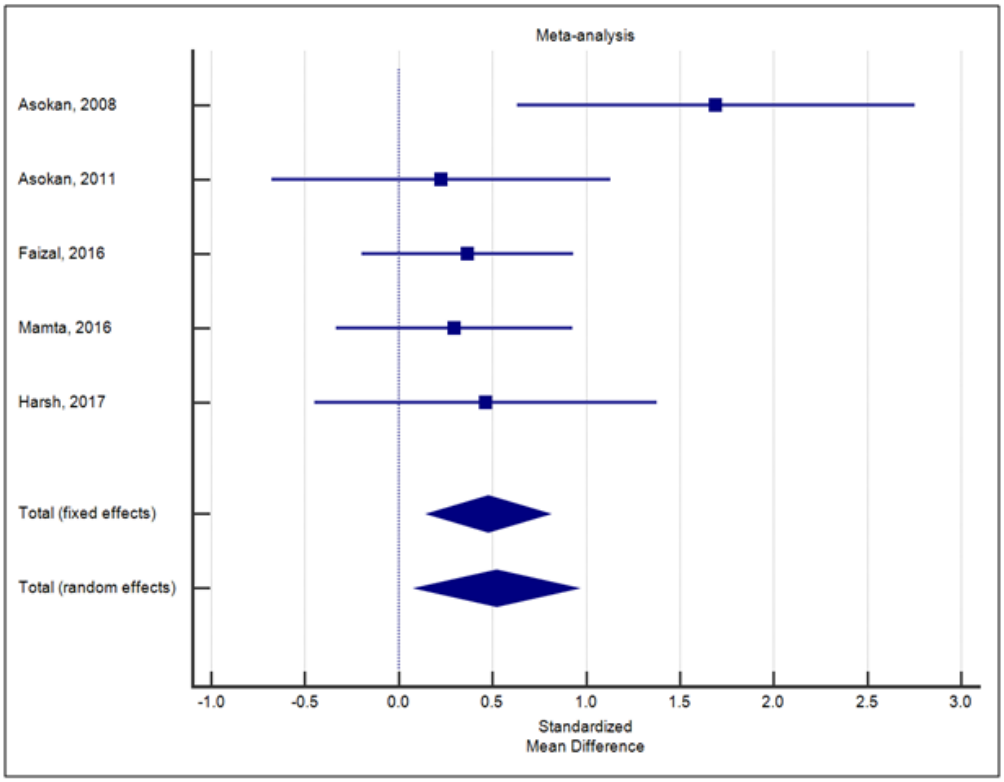

Fig. 2. Forrest plot of the studies included in the meta-analysis

Table 1. Pooled effects of oil pulling on bacterial count in terms of SMD

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Asokan, 2008	10	10	20	1.690	0.505	0.630 to 2.751			10.43	13.59
Asokan, 2011	10	10	20	0.225	0.430	-0.677 to 1.128			14.40	17.04
Faizal, 2016	25	25	50	0.368	0.281	-0.197 to 0.933			33.72	27.63
Mamta, 2016	20	20	40	0.295	0.312	-0.336 to 0.926			27.37	24.95
Harsh, 2017	10	10	20	0.465	0.435	-0.448 to 1.378			14.08	16.79
Total (fixed effects)	75	75	150	0.479	0.163	0.157 to 0.801	2.938	0.004	100.00	100.00
Total (random effects)	75	75	150	0.521	0.217	0.0929 to 0.950	2.404	0.017	100.00	100.00

Test for heterogeneity: Q value = 6.61, DF = 4, I^2 = 39.50 %, 95% CI

Table 2. Parameters of the included studies

Author, year	Study design	Gender, age	Sample size	Intervention	Duration	Medium	Method of rinsing
Asokan, et al. [5]	Randomized, controlled, triple-blind study	Males, aged 16-18 years	20	Sesame oil, CHX mouthwash	14 days	Plaque	N/A
Asokan, et al. [35]	Randomized Controlled Trial	Males, aged 16-18 years	20	Sesame oil, 0.2 % CHX mouthwash	30 days	Plaque	10 mins (oil) & 1 min (CHX), every morning
Peedikayil, et al. [36]	Comparative interventional study	Female children, aged 8–12 years	50	Coconut oil, 0.2 % CHX mouthwash	30 days	Plaque	2-3 mins every day in the morning after brushing
Kaushik, et al. [29]	Randomized Controlled Trial	Both gender of 18-22 years	40	Coconut oil, CHX mouthwash	14 days	Saliva	10 mins (oil) & 1 min (CHX), every morning
Priyank, et al. [37]	Randomized, Controlled, Triple-Blind study	Both gender of 19-21 years	20	Sesame oil, 0.12 % CHX mouthwash	30 days	Saliva	1 min every morning before brushing

Table 3. Evaluation of bias risk in the included studies

Studies	Random sequence generation	Allocation concealment	Blinding of participants & personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Asokan, et al. [5]	1	2	1	1	1	1
Asokan, et al. [35]	1	1	1	1	1	1
Peedikayil, et al. [36]	1	2	1	1	1	1
Kaushik, et al. [29]	1	2	2	1	1	1
Priyank, et al. [37]	1	2	1	1	1	1

near to moderate effects of oil-pulling on the oral *S. mutans* count as shown in (Fig. 2). I^2 value was 39.50% which shows moderate level of heterogeneity among the studies (Table 1).

4. DISCUSSION

In the current era of dentistry, there is more focus towards the preventive measures to counter factors causing oral diseases. Control of cariogenic bacteria is, therefore, vital to prevent dental caries which may have dire consequences if not treated. Hence, oil-pulling would complement and aid mechanical plaque removal (brushing). All the studies [5,29,35-37] in this review showed that the group undergoing oil-pulling showed reduced *S. mutans* oral bacterial count, as compared to CHX mouthwashes. The studies included in this review had several discrepancies such as different mediums for bacterial count, time duration of oil-pulling and CHX mouthwash use and disparity in the follow-up time (Table 2). Three studies [5,35,36] took plaque for bacterial count and rest of the two studies [29,37] took saliva samples for the analysis. Thirty-days of follow-up duration was followed by three studies [35-37] whereas two studies [5,29] had a follow-up of fourteen days. A briefer follow-up time of fourteen-days would suggest that there will be less improvement in oral bacterial count, as compared to those levels analyzed after thirty days of follow-up. There was inconsistency in regards to the time taken for oil-pulling and CHX mouthwash rinses; two studies [29,35] asked their patients to rinse for 10 minutes, other two studies [36,37] had participants who rinsed for 1-3 minutes, where as one study [5] did not reported the time suggested for each rinse either with oil or CHX mouthwash. Though, there was difference in the duration but there wasn't any significant effect seen on the *S. mutans* count. Similarly a difference between the concentration of CHX mouthwash was observed in the studies, two studies [35,36] reported using CHX mouthwash of 0.2%, one study [37] used 0.12% concentration of CHX mouthwash, whereas rest of the two studies [5,29] did not report the concentration of mouthwash used (Table 2).

The main limitations of this review were that only five studies were included and only *S. mutans* count was taken into account to evaluate the effects of oil-pulling and mouthwash. In regards to the duration of time required for oil-pulling as previously suggested was 15-20 minutes, but the studies taken in this meta-analysis suggests a shorter time period of 2-5 minutes which would have patient's compliance as well. More studies are required to validate the time taken to achieve optimum anti-bacterial effect of oil-pulling.

5. CONCLUSION

It is still questionable that whether oil-pulling therapy is more beneficial to the patient as compared to CHX mouthwashes commonly being used, since there is insufficient literature evidence. To better understand the comparison between the two rinses and obtain a conclusive result, further assessment of clinical parameters and investigations are required through the help of clinical trials with multiple follow-up periods.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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