Original Research Paper

Volume - 15 | Issue - 07 | July - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Orthodontics

EFFICACY OF CURCUMIN AND COCONUT OIL PULLING MOUTHWASHES VERSUS FLUORIDE MOUTHWASH IN ORTHODONTIC PATIENTS

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ABSTRACT Oral hygiene holds utmost significance in the field of Orthodontics. The placement of a fixed appliance often impedes the maintenance of good oral hygiene for the orthodontic patient despite numerous advancements in orthodontics and dentistry 1. The constituents of the appliance generate fresh regions of attachment for microorganisms and obstruct appropriate entry to the dental surfaces, hindering optimal cleansing. Numerous studies have shown a consequential rise in the amount of Streptococcus mutans (S.mutans) found in the dental plaque of these subjects when compared to both pre-treatment and post-treatment time frames.2 S.mutans have a robust correlation with the initiation of dental caries. The initial clinical proof of the demineralization process affecting the outer layer of the tooth, known as white spot lesions (WSL), signifies the preliminary phase of dental caries development. The suggested optimal oral hygiene regimen for individuals undergoing orthodontic treatment with permanent braces entails regular tooth brushing in conjunction with daily rinsing using fluoride mouthwash. This has proved efficacious in inhibiting the progress of WSLs', although it has not completely halted it.3 Furthermore, after more than five decades of administering fluoride treatment, S. mutans resistant strains have developed and become ineffective. Therefore, novel antimicrobial mouthwashes that are effective against S. mutans are required. Researchers have found that curcumin extracts have potential antimicrobial effects against microorganisms.5 It has also been proved that coconut oil pulling significantly reduced plaque scores6. Curcumin and coconut oil-based pulling oil mouthwashes were taken into this study to determine their effectiveness in reducing S.mutans during Fixed Orthodontic treatment. To the best of our knowledge, no trials have been conducted to compare the effectiveness of these three oral rinses on S. mutans among orthodontic patients. Consequently, this study, which followed a randomized clinical approach, was initiated to evaluate and compare the effectiveness of curcumin and coconut oil-based pulling with that of a fluoride mouthrinse in controlling S. mutans.

KEYWORDS : Oral Hygiene, Fluoride, Curcumin, Coconut Oil Pulling, Colony Forming Units, Orthodontic Treatment

INTRODUCTION

Oral hygiene holds utmost significance in the field of Orthodontics. The placement of a fixed appliance often impedes the maintenance of good oral hygiene for the orthodontic patient despite numerous advancements in orthodontics and dentistry[1]. The constituents of the appliance generate fresh regions of attachment for microorganisms and obstruct appropriate entry to the dental surfaces, hindering optimal cleansing. Numerous studies have shown a consequential rise in the amount of Streptococcus mutans (S.mutans) found in the dental plaque of these subjects when compared to both pre-treatment and post-treatment time frames.[2] S.mutans have a robust correlation with the initiation of dental caries. The initial clinical proof of the demineralization process affecting the outer layer of the tooth, known as white spot lesions (WSL), signifies the preliminary phase of dental caries development.

The suggested optimal oral hygiene regimen for individuals undergoing orthodontic treatment with permanent braces entails regular tooth brushing in conjunction with daily rinsing using fluoride mouthwash. This has proved efficacious in inhibiting the progress of WSLs', although it has not completely halted it.[3] Furthermore, after more than five decades of administering fluoride treatment, S. mutans resistant strains have developed and become ineffective. Therefore, novel antimicrobial mouthwashes that are effective against S. mutans are required. Researchers have found that curcumin extracts have potential antimicrobial effects against microorganisms.[5] It has also been proved that coconut oil pulling significantly reduced plaque scores[6]. Curcumin and coconut oil-based pulling oil mouthwashes were taken into this study to determine their effectiveness in reducing S.mutans during Fixed Orthodontic treatment.

To the best of our knowledge, no trials have been conducted to compare the effectiveness of these three oral rinses on S. mutans among orthodontic patients. Consequently, this study, which followed a randomized clinical approach, was initiated to evaluate and compare the effectiveness of curcumin and coconut oil-based pulling with that of a fluoride mouthrinse in controlling S. mutans

MATERIALS AND METHODS

The study was approved by the Institutional Ethical Committee of Malabar dental college and Research Centre (IEC/O5/ORTHO-B/MDC/2021) and the trial was enrolled under the Clinical Trials Registry of India CTRI Nu (CTRI/2023/09/058056) . The study was designed as a three-arm parallel-group trial with randomization at a 1:1:1 ratio, triple-blind methodology . Forty-two participants were selected from a pool of 95 patients who began fixed orthodontic treatment between the ages of 16 and 26, based on their poor oral hygiene status, at the Department of Orthodontics and Dentofacial Orthopedics, Malabar Dental College and Research Centre. The selected participants satisfied the following selection criteria (1)Patients undergoing Fixed Orthodontic treatment with metallic brackets (2) Patients with poor oral hygiene status as decided by Oral Hygiene Index simplified [score 3.1-6] (3) Permanent dentition (4) No previous history of Fixed Orthodontic treatment . Participants were not included in the study if they were (1) allergic to Curcumin, Coconut oil, & fluoride (2) Medically compromised Patients (3) Pregnant & Lactating mothers (4)Patients with mouth breathing habit (5) Composite restoration and prosthetic crown on anterior teeth (6) Tooth with developmental abnormalities and fluorosis (7) Patients with a habit of smoking (8)Patients taking topical or systemic administration of the antibiotic. All the Participants/ Guardians needed to sign a witnessed consent form and commit themselves to the study.

Intervention

Prior to initiating orthodontic treatment, Oral hygiene instructions were given, and a professional cleaning procedure was conducted to remove plaque. All possible 95 candidates for the study from May 2023 – June 2023 were strapped up with 0.022× 0.028-inch slot MBT prescription stainless steel brackets (KODEN premium plus brackets, KODEN Inc) using a non-fluoride primer and adhesive (Transbond XT, 3M Unitek). Excessive adhesive flash was cleared using a manual scaler prior to the curing process.

Forty-two patients with poor Oral hygiene status during orthodontic treatment (T1) were selected as subjects by assessing the Oral hygiene index simplified [OHIS SCORE 3.1-6] [7]. Random sampling was done on these candidates by lottery method consecutively to allocate the

subjects with poor oral hygiene into subgroups. Until sample size is achieved sampling was continued for group allocations. Each participant was randomly allocated to one of the three mouthwash groups: Group 1: curcumin group - 14 subjects, Group 2- pulling oil group- 14 subjects, Group 3- fluoride group - 14 subjects. The details and Ingredients in these mouthwashes are given in Tables 1,2, & 3 respectively.

Orthodontic elastomeric modules from the maxillary anterior region were collected using the number 23 Shepherds Hook Explorer on the day of allocation from all subjects because it is the area most conducive to plaque accumulation[8]. These samples were considered as baseline [T1]. The elastomeric modules [3M modules] were collected in order to assess plaque specimens by analyzing microbial colonies formed by S.mutans before the use of the respective mouthwashes. On the same day of baseline sample collection, (T1) each patient was provided with respective mouthwash according to the group they belong. All subjects were instructed to rinse their mouth twice a day for 1 minute with the provided mouthwash after brushing their teeth and to adhere to the guidelines provided by the manufacturer for proper usage for the following 30 days. The data from a study[9] concludes that mouthwashes can reduce total bacterial count after 2 weeks of administration and hence are to be used by the patients from day 1 after the primary plaque test and proceed until day 30. All participants were in stainless steel Archwires and were given an assessing sheet, where the participant had to put a tick check each time after the use of mouthwash both at the morning and at night . Follow-up calls were made to ensure patient compliance with the study. Plaque samples on elastomeric modules were once again collected at the end of day 30, [Post intervention visit, T2] to analyze the microbial colonies formed after the administration of their respective mouthwashes. The number of colonies formed at T1 and T2 were compared and studied. Tabulation of values was done, and statistical analysis was performed.

Microbiologic Analysis

Samples were transferred to Eppendorf tubes consisting of distilled water as a medium and coded accordingly. Plaque samples were collected on the same day and stored at 0 ° C and transported within 48 hours to the laboratory. Bacterial culture was done on the Mitis Salavarius Agar base. The samples were progressively diluted through the creation of a sequence of no fewer than 6 test tubes per sample, each filled with 9 ml of sterile distilled water. With the help of a sterile pipette, 1 ml of the sample was introduced into the first tube of the series. Labeled it as sample A-1. Mixed the contents thoroughly through a swirling motion, inverting the tube several times. From the first tube, 1 ml of the sample was collected and transferred to the second tube. Label it as Sample A-2. The process was carried out again for the rest of the tubes, systematically labeling each one until reaching sample A -6 and then spreading 0.1ml of diluted sample on the culture media with a sterile swab. The inoculums were distributed across the medium by moving the glass spreader (L-rod) in a back-and-forth motion while simultaneously rotating the plate. (fig 1). Left to dry before Incubating the plates at the required temperature. The number of colony-forming units(CFU) formed by S.mutans was counted using the naked eye method and then the number of colonies was multiplied by the dilution factor.(fig 2)

Blinding

Mouthwash products that were provided were distributed in indistinguishable opaque containers and labeled as A, B & C . Both the clinician and the subjects were unaware of the identities of the mouthwashes. The investigator did not partake in any randomization processes or distribution of the products. As a result, both the participant and the clinician remained unaware throughout the research. The allocation of a distinct identification to each participant guaranteed that the laboratory researchers were also kept unaware of the product assignments.

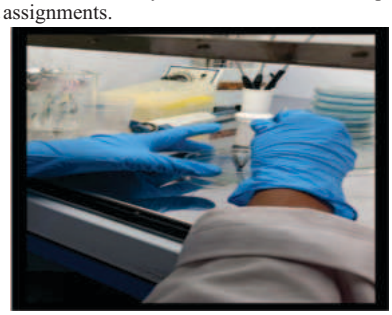

Figure 1: Spreading the Plate

Sample Size Calculation

The determination of the sample size was conducted by referencing a prior study[9] with a total sample size of 42,(n = 14) in each arm with a power of 0.90, at the 0.05 significance level, and effect size of 0.68.

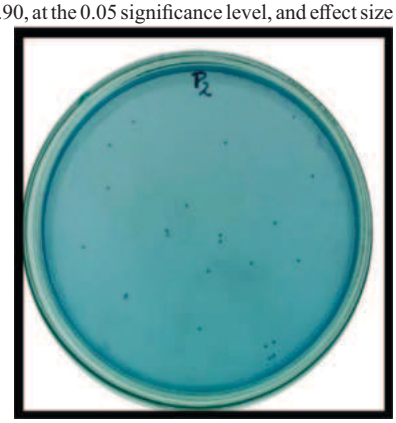

Figure 2: Colony Forming Units From the Sample

Table 1 : Curcumin Mouthwash (Cur Q Fresh, Bsa Pharmaceuticals)

INGREDIENTS
Haldi
Tulsi
Eucalyptus
Clove
Thymol
Tea Tree
Mint
Honey

Table 2: Coconut Oil Pulling Mouthwash (Coco Crush, Coconut Processing Plant, Farmers Co- Op Bank, Kerala)

INGREDIENTS
Virgin Cold pressed Coconut oil
Peppermint oil
Clove oil

Table 3: Fluoride Mouthwash (Amflor Oral Rinise, Group Pharmaceuticals)

INGREDIENTS
Purified water
Sorbitol
Propylene glycol
Amine fluoride
Poloxamer
Polyoxl 40 hydrogenated castor oil
Sodium benzoate
Soidum saccharin
Flavors

Statistical Analysis

Data was analyzed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL) and the level of significance was set at $P<0.05$. Descriptive statistics were utilized to evaluate the mean and standard deviation of the respective mouthwash groups. Shapiro Wilkinson test was done to assess the normality of the data. Inferential statistics to find out the difference within and between the groups was done using ONE WAY ANOVA TEST followed by BONFERRONI POSTHOC TEST. Paired T-test was used for between-group comparison.

RESULTS

All of the Forty-two participants successfully completed the trial by following the Consolidated Standards of Reporting Trials (CONSORT) guidelines. The descriptive statistics regarding age, 1st plaque scores (T1), and 2nd plaque scores(T2) among the three groups exhibited normal distribution(Table 4). All 42 participants cooperated and completed their study till the end of the 60th day. All subjects exhibited similar initial plaque scores across the different groups (T1 – day of allocation into groups). Curcumin(T1) - 7.84±0.35, pulling oil(T1) - 8.19±0.30, fluoride(T1) -8.38±0.43 (CFU/ml). Following intervention with allotted mouthwashes the second plaque scores (T2- after 60 days of mouthwash usage) also showed similar values across groups. Curcumin -6.88±0.97, pulling oil - 7.22±1.02, fluoride - 7.15±1.29. The mean difference values before and after intervention

(between T1 and T2) were 1.04±0.76 for the Curcumin group, 1.03±0.78 for the coconut oil pulling group, and 1.23±0.87 for the Fluoride group. Regarding the comparison of CFU/ml- Within group assessment and to detect which mouthwash had the most antiplaque effect analysis by paired T-Test reported statistically significant difference for all the 3 study groups (P<0.05), with fluoride with a higher mean difference.(Table 5)

Table 4 : Descriptive Data Showing Baseline Characteristics

VARIABLE	CURCUMIN MOUTH-WASH (n=14)	COCONUT OIL PULLING MOUTH-WASH (n=14)	FLUORIDE MOUTH-WASH (n=14)
Age (mean)	16.5	15.3	16.8
Sex, (n)			
Female	8	7	9
Male	6	7	5
Initial plaque scores (mean, T1)	7.8696 ± 0.36	8.1986 ± 0.30	8.3860 ± 0.45
Final plaque scores (mean, T2)	6.9369 ± 0.98	7.2206 ± 1.04	7.0896 ± 1.31

DISCUSSION

Despite advancements in orthodontic materials and techniques, enamel demineralization resulting in white spot lesions (WSLs) remains an important issue in orthodontic practice. The plaque can co-exist alongside the patient in the oral environment in a state of equilibrium. Yet, this balance may be disrupted gradually over time or due to changes in the external environment, especially when altered with Fixed Orthodontic treatment. Several studies have shown a notable rise in the levels of S.mutans and lactobacilli in the dental plaque of patients using these Orthodontic appliances as opposed to before and after treatment periods[2]. Many interventions have been proposed to prevent or treat enamel WSLs, including probiotics, fissure sealants, resin infiltration, micro-abrasion, external bleaching and laser therapy ultrasonic toothbrushes, mouth rinses, varnish treatments, incorporation of antimicrobial substances, etc. Currently, the most recommended strategy for individuals receiving orthodontic treatment involving fixed appliances is the daily practice of rinsing with fluoride or chlorhexidine-containing mouthwash along with the use of toothpaste[10]. The extended utilization of antimicrobial therapeutic agents such as fluoride or chlorhexidine in orthodontic treatments may lead to various adverse effects, such as tooth discoloration and the development of drug resistance[11,12]. Furthermore, prolonged exposure to fluoride treatment for over five decades has resulted in the emergence of S. mutans strains that are resistant to fluoride[13]. Therefore, there is a necessity for novel antimicrobial mouthwashes that are effective in combating S. mutans. Therefore, naturally derived mouthwashes such as curcumin-based or coconut oil-based pulling oil mouthwashes, which could have a restrictive effect on S. mutans might be a safer option.

Curcumin compounds derived from natural sources are utilized across diverse medical frameworks to address a range of human health conditions, including the management of viral, fungal, and bacterial infections. Because of its unique medicinal qualities and wide range of impacts on the body's systems, turmeric is regarded as a safe, non-toxic, and efficient substitute for many conventional medications[5]. Oil pulling is an ancient Indian practice for maintaining dental health. The majority of the fatty acids in coconut oil are medium-chain, which sets it apart from most other dietary oils that are primarily constituted of long-chain fatty acids. Known for its antibacterial and anti-inflammatory properties, lauric acid makes up about 50% of these medium-chain fatty acids.[14]. In our study, bacterial sampling was done at two different intervals T1(day 1 of group allocation and start of mouthwash usage), and T2 (60 days after advising respective mouthwash) of the elastomeric modules for the three groups of antimicrobial agents (Group 1- Curcumin mouthwash, Group 2- Coconut oil pulling, Group 3-Fluoride mouthwash) and the samples were cultured and evaluated for the colonization of the S. mutans. The initial colony-forming units at T1 were 7.86 ± 0.35 for the curcumin group, 8.19 ± 0.30 for the coconut oil pulling group, and 8.38 ± 0.43 for the fluoride group. Normality test did not report any statistical significance, hence it was concluded that in all three groups S. mutans colonies were formed after fixed orthodontic therapy, and were normally distributed among different groups without any statistical significance. The aforementioned data is consistent with a study by Rosembloom and Tianoff that found patients receiving orthodontic treatment had persistently rising levels of S. mutans at various significance levels[15]. The final colony–forming units at T2 were 6.88 ± 0.97 for the curcumin group, 7.22 ± 1.02 for the coconut oil group, and 7.15 ± 1.28 for the fluoride group. Upon examining the three groups before [T1] and after using mouthwash [T2], a comparison was conducted. For all three groups, we found that there was a notable decrease in bacterial proliferation.This indicates that all three antimicrobial agents used were effective in controlling the formation of S. mutans.

Within-group assessment of CFU analysis by paired T-Test reported significant differences in all three study groups from T1 to T2 period. The within-group comparison of all three mouthwashes revealed their potential against S. mutans. Studies reported by Xialoin et al , Pandey et al and Gbinigie et al is also in accordance with our study which reported a significant reduction in the bacterial count and overall increase in oral hygiene of those patients who were using Fluoride, Curcumin and Pulling coconut oil mouthwashes respectively [16][17][15].

Table 5 : Comparison of CFU/ml – Between Group Analysis

	INITIAL	FINAL	MEAN DIFFERENCE	T VALUE	P VALUE
CURCUMIN	7.84± 0.35	6.88± 0.97	1.04±0.76	3.29	0.001*
COCONUT OIL	8.19± 0.30	7.22± 1.02	1.03±0.78	3.41	0.002*
FLUORIDE	8.38± 0.43	7.15± 1.29	1.23±0.87	3.38	0.002*

Several authors have discussed the impact and effectiveness of the antimicrobial agents currently in use and their effects in the context of orthodontic treatment. To the best of our knowledge, no studies have conducted a comparative analysis of the efficacy of Fluoride, Curcumin, and pulling oil during orthodontic treatment. The mean difference seen in the results was 1.23 for Fluoride , 1.04 for Curcumin, and 1.03 for Coconut oil pulling mouthwashes. The results followed the order COCONUT OIL PULLING < CURCUMIN < FLUORIDE.

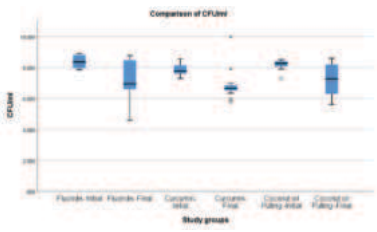

Fig 3 : box And Whisker Plot Showing S.mutans Count During Initial- Final Time Period With Mouthwashes

All three mouthwashes had a significant antibacterial effect .However, based on mean difference Fluoride was more effective (1.23).Hence it can be concluded that Fluoride is the most effective. Since Orthodontic treatment may last two- four years and fluoride may have long term side effects such as 1] staining 2] Bacterial resistance. Considering the long term side effects of fluoride it may be advisable for Orthodontic patients to use more natural antibiotic mouthwashes. This study concludes Curcumin , Coconut oil pulling mouthwashes are equally effective as Fluoride and can be considered as potential Organic alternatives.

The trial exhibited some limitations, such as its brief duration and the recruitment of patients from a single centre. Nevertheless, as a result of the limited or insufficient certainty of evidence in the majority of comparisons, definitive conclusions cannot be made. Long term studies with increased participant size are required to evaluate the effect of these mouthwashes for prolonged use.

CONCLUSIONS

A. All the three antimicrobial agents tested were all successful in combating Streptococcus mutans and thus helping in plaque reduction.
B. Among the three agents, Fluoride mouthwashes demonstrated the highest level of effectiveness followed by Curcumin and oil pulling mouthwashes
C. Considering the duration of Orthodontic treatment and potential long-term effects of Fluoride, both Curcumin and Oil pulling mouthwashes can be considered as effective organic alternatives.

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