

Influence of *Cocos nucifera* Oil Extract on the Caries Activity of Removable Partial Denture Wearers: Thirty-six Months Follow-up

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ABSTRACT

Objective: This study aimed to evaluate the intraoral caries activity of removable partial denture wearing patients with the use of *Cocos nucifera* oil as an adjuvant to routine oral hygiene measures.

Materials and methods: Removable partial dentures were done for 63 patients and caries assessment was done for the remaining natural teeth which were used as the abutments for serving the purpose of retention and also for the non-abutment teeth. International Caries Detection and Assessment System (ICDAS) criteria of caries assessment was done following the regular use of *C. nucifera* oil. Standard protocols were followed, and revisits were carried out every 6 months duration for 36 months for assessment of the progression of caries activity. Qualified dental personnel examined the denture wearers for the entire study period.

Results: Clinical evaluations were done after the restoration of the partially edentulous patients for an average of 6 months with the use of *C. nucifera* oil. About 82% of the teeth made had no noticeable difference in the caries activity status and 57% of the sample were without any signs of active caries activity. Results indicate that there was no loss of both the abutment and non-abutment teeth due to caries activity during the observation period, ensuring a 91% caries protection rate.

Conclusion: *C. nucifera* oil exhibits caries protective activity and satisfactory survival rate without any loss of remaining natural teeth among removable partial denture wearing patients during the 36 months observation period.

Keywords: Caries activity, *Cocos nucifera* oil, Oil pulling, Partial dentures, Removable dentures.

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INTRODUCTION

Removable partial dentures on intraoral usage will tend toward increased plaque accumulation on the tooth surface, particularly on the abutment teeth, where extra coronal clasps are constructed for retention. Denture base areas and the connector areas in contact with the other non-abutment teeth also serve as a nidus for plaque accumulation. They can increase the incidence of caries with relatively large amounts of plaque constantly being in contact with these teeth.¹ Kennedy's classification of the partial edentulous status, the shape of the denture base, the position of the clasps around the teeth, and the occlusal rest influence the periodontal damage of the remaining natural teeth.² The greater surface area of the mucosa covered by the acrylic denture base creates favorable circumstances for the accumulation of bacteria and fungi as denture plaque. Humidity, the rise in temperature, deprived oxygen supply, and salivary self-cleaning impairment also worsen the conditions.³ Periodontal and caries activity was the most common etiological cause of tooth loss. The protection of this residual dentition from these diseases becomes imperative in removable denture wearers. Mechanical plaque removal which is supported by various antimicrobial chemical agents' forms the basis of oral hygiene.^{4,5} The side effects of these agents include bitter taste, brownish discoloration of the natural teeth, and intraoral mucosal erosion.⁶ Ancient Indian health science Ayurveda texts of Charakasamhita explained the importance of oil pulling and has claimed to cure many systemic diseases including diabetes, eczema migraine, headache, asthma, and intestinal infection. In the 1990s

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Dr. F Karach from Russia familiarized the concept and importance of oil pulling.⁷ Oil pulling was used as a folk remedy for many generations for treatments including, halitosis, cracked lips strengthening of gingival tissues, bleeding gums, prevention of dental caries, and mouth dryness. Edible oils like coconut oil, rice bran oil, palm oil, sesame oil, sunflower oil, and soya bean oil have been used for oil pulling therapy.⁸ Coconut oil (*C. nucifera* oil) was found to vary from other oils due to its predominant presence of medium-chain fatty acid than the long-chain fatty acids thus influencing the physical and chemical properties. In Indian states, coconut and its oil are commonly used for the preparation of food.⁹ *C. nucifera* oil contains a predominant 92% fatty acids which are saturated in which 50% of it constitutes lauric acid. The lauric acid present in *C. nucifera* oil had already proven to have antibacterial and also antifungal properties.⁷ The presence of monolaurin and medium-chain fatty acids in the oil can act on the bacterial cell wall by penetrating and disrupting the cell membranes. It also inhibits the enzymes which are involved in the production and nutritional transfer of cell energy, thus causing bacterial death.¹⁰ With such many beneficial effects of *C. nucifera* oil and a need in finding a suitable alternative to various chemical-therapeutic agents in reducing the caries activity among removable partial denture patients a follow-up study was required to be carried out to find its efficacy. This study was aimed at assessing the effectiveness of *C. nucifera* oil as an adjuvant to the routine intraoral measures in controlling the caries activity of the remaining natural teeth in removable partial denture wearers.

MATERIALS AND METHODS

The study was done on the outpatients of the Department of Prosthodontics of a Dental College and Hospital during the period involving the 1st quarter of 2019–2022 time period. Patients who had partially edentulous arches with no history of recently done extractions in 3 months duration and needed removable partial denture prosthesis were recruited to be part of the study. All the removable partial denture patients who formed the study group were informed about the study protocols to be followed for the study and informed consent was also taken. The anonymity of the study group and the confidentiality of the study were ensured to be followed throughout the entire period of the study. Ethical clearance was obtained from the affiliated university Dr. MGR Educational and Research Institute (Dr. MGR DU/TMDCH/2019-20//260719002). This study followed the ethical standard guidelines on human experiments and was following the Helsinki Declaration act of 1975, which was revised in the year 2000.¹¹ A pilot study was done involving 15 denture wearers to assess the feasibility of the study. The study helped to estimate the required sample size for the study and thus finalize the sample size of the study group. Ninety participants who were enrolled were assessed for the eligibility criteria and 27 were later excluded from the study citing various reasons during the final enrollment process.¹² All the remaining natural teeth present in the arch were caries-free and presented with no restorations. Before the prosthodontic phase of treatment was carried out, they were motivated toward the outcome of the treatment and routine oral hygiene measures and maintenance instructions were given. Periodontal therapy was also done on those patients if required. The partial denture designed for each case was based on remaining natural teeth, the location of the missing teeth, existing oral health status, and tooth mobility not greater than 1 mm. Systemic or topical use of many antibiotics in the past 3–4 months,

any presence of chronic systemic disorders and/or dental infections were excluded from the study sample. During the visits, oral hygiene status was monitored and reassured to continue the maintenance regime. All the 63 removable denture wearer patients after their denture insertion were given routine hygiene instructions to be followed at their home after which they were advised to use the *C. nucifera* oil as an adjuvant for improving their oral health status. Pure *C. nucifera* oil used in the study was obtained by extraction from the dried kernels of coconut called the copra which was extracted by crushing copra using an extruder. The *C. nucifera* oil thus extracted was unrefined, crude, and with no additives being added for smell or taste.¹³ All the 63 who formed the study group were advised to use the oil intraorally at home. 10–15 mL of *C. nucifera* oil was dispensed using a tablespoon and taken intraorally to gargle the oil through the remaining natural teeth. The subjects were advised to take the necessary quantity of the *C. nucifera* oil till the oral cavity was half-filled and then asked to suck and pull the liquid through the teeth with the chin lifted a bit. The oil was swished from right to left, front to back for 10 minutes or till they felt fullness in the mouth. They were instructed to take precautions not to swallow the oil after the completion of the procedure. They were advised not to panic even if they swallow the swished oil accidentally. They were also instructed from using any mouth wash during the entire study period.¹⁴ At the end of 60 days, all the patients were recalled and a caries activity examination was done using the ICDAS system for the remaining teeth which included both the abutment teeth and the non-abutment teeth in the rehabilitated arch for assessment of their caries status. All the evaluations of the study group before and after the start of intervention over the entire study period of 36 months were carried out by a single qualified dental personnel to avoid bias in the evaluation process. The evaluation was continued for 36 months and the results were analyzed. The ICDAS classified the intraoral caries lesions based on their clinical appearance by visual assessment¹⁵ (Table 1). The reliability of the ICDAS system is high to excellent when used by trained examiners for evaluation in primary and permanent dentitions. Survival analysis of the natural teeth was done using the Kaplan–Meier method with 95% confidence intervals.¹⁶

RESULTS

The study group description with its characteristics was tabulated in Table 2. The study group's ages ranged from 45 to 70 years with the mean age group of 53 years. About 52% of males and 48% of females were rehabilitated of their partially edentulous condition between either of the arches. The rehabilitation in the maxillary was around 43% in comparison to 57% for the mandibular arch. The distribution for the etiology of the partially edentulous status was due to the occurrence of caries 57% and periodontal reason 35% predominating by 92% followed by the trauma of about 8%. One hundred and eighty-seven abutment teeth and 484 non-abutment teeth with an overall total of 671 remaining natural teeth present in the maxillary and mandibular arches were assessed every 6 months for an overall duration of 36 months for both pit and fissure and smooth surface caries and the ICDAS scoring were recorded after use of *C. nucifera* oil (Table 3). 57% of subjects exhibited no evidence of pit and fissure or surface caries and intact tooth structure even after the observational period of 36 months. Mild caries opacity and visual change in enamel were noted in 16 and 10% of the mean of abutment and the non-abutment, respectively. After constant air drying of the teeth, opacity or with white or brown

Table 1: ICDAS classification

Code	Pit and fissure type	Smooth surface type
Code 0 Sound/intact	No evidence of any caries. Developmental defects and stains will be recorded as sound.	No evidence of any caries. Developmental defects and stains will be recorded as sound.
Code 1 First change is seen visually involving the enamel	Caries opacity, white discoloration, or brownish lesion visible in enamel only after prolonged air drying.	Caries opacity, white discoloration, or brownish lesion visible in enamel only after prolonged air drying seen from buccal or the lingual surface.
Code 2 Distinct change is seen visually involving enamel	Caries opacity, white discoloration, or brownish lesion visible when seen directly not indicating sound quality enamel.	Caries opacity, white discoloration, or brownish lesion visible when seen directly not indicating sound quality enamel surface.
Code 3 Localized breakdown of only enamel and no involvement of dentin	Evidence of tooth loss at the entrance or within, the pit or fissure or the fossa and wider than natural fissure or fossa not involving dentin.	Evidence of tooth loss with surface disintegration but involving the dentin in the buccal or the lingual direction.
Code 4 Dark shadow is seen in underlying dentin	Discoloration involving the dentin which may or may not show any sign of its breakdown.	Discoloration involving the dentin which may or may not show any sign of its breakdown with intact marginal ridge, facial or lingual walls.
Code 5 Cavity's involvement with visibility of dentin	Cavity involvement with enamel discoloration and exposure of the dentin extending less than half of the tooth surface.	Cavity involvement with enamel discoloration and exposure of the dentin extending less than half of the tooth's smooth surface.
Code 6 Extensive cavity with visibility of dentin	Cavity involvement with enamel discoloration and exposure of the dentin extending at least or more than half of the tooth surface.	Cavity involvement with enamel discoloration and exposure of the dentin extending at least or more than half of the tooth's smooth surface.

Table 2: General description of the study group

Variables	N = 63 (%)
Gender type	
Male	33 (52.5)
Female	30 (47.5)
Education	
Higher	25 (39.6)
Primary	23 (36.5)
Secondary	12 (19.1)
Uneducated	3 (4.8)
Status of the opposing arch	
Natural teeth	45 (71.42)
Fixed denture prosthesis	18 (28.57)
Type of the RPD according to Kennedy's classification	
CLASS 1	14 (22.2)
CLASS 1 MOD 2	10 (15.9)
CLASS 2	11 (17.46)
CLASS 2 MOD 1	7 (11.11)
CLASS 3	15 (23.80)
CLASS 4	6 (9.52)

surface discoloration was noticeable, in 17.2% of abutment teeth which showed better by a margin of 2% when compared to the non-abutment group average of 15%. Localized enamel breakdown with the cavity confined to enamel was observed in the mean of 6.5% of the teeth observed. The lesion appears as a shadow of discolored dentin was noticeable in 5.5 and 3% of the abutment and non-abutment teeth, respectively. Distinct cavitated lesions with dentin exposure involving either less or at least half of the tooth were noticed in only 3.7 and 3%, respectively during the entire study period.

DISCUSSION

Tanaka and Tanaka found out the increase in the number of missing teeth in removable partial denture (RPD) wearers had an association with an increased count of lactobacilli in saliva in contrast to the patients with single crowns and fixed partial denture restorations, the missing teeth were not significantly affected by lactobacilli and *Streptococcus mutans* counts.¹⁷ Augustin et al. calculated the values of decayed, missing due to caries, and filled teeth (DMFT) were in the range of 0.2 for both the denture wearing and nondenture wearing groups at the start of the study and after 5 years of follow-up, it elevated to 7.1 among the denture wearing and 2.6 for the nondenture wearing group. The plaque index for the denture wearing group and the non-denture wearing group was 1 and 0.5, respectively establishing a strong relationship between dental diseases and denture wearers.¹⁸ *C. nucifera* oil has a pronounced antimicrobial tendency against *Staphylococcus aureus*, *E. vulneris*, *H. pylori*, and various *Candida* species including *albicans*, *glabrata*, *tropicalis*, *parapsilosis*, *stellatoidea*, and *krusei*. *C. nucifera* was also proved to be effective against *Streptococcus mutans* in *in-vitro* studies.¹⁹ Coconut oil usage by oil pulling was found to have a beneficial effect on the improvement of oral and dental status related to their hygiene.²⁰ The study data on the *C. nucifera* oil effect on the management of mucosal changes following postdenture usage denoted that 97.5% of the denture usage population used home remedies for their denture-induced ulcers and out of which 95.5% of them preferred the use of *C. nucifera* oil and around 93.5% have experienced improvement and relief after the usage of *C. nucifera* oil.²¹ Intraoral conditions about both the arches remained the same and hence the variations in the percentage of arches and their relevancy to the caries activity of the remaining natural teeth becomes negligible in the study. All the subjects involved in the study were initially selected to be caries-free involving all of their remaining teeth hence the need to compare with their baseline data was not put forth in the study. No evidence of caries activity was observed in the abutment group and the non-abutment teeth

Table 3: ICDAS scoring at end of 36 months with the use of *Cocos nucifera* oil

Codes	0	1	2	3	4	5	6	Total score
Abutment teeth (AT)	97 (51.87)	32 (17.27)	19 (10.16)	13 (6.95)	10 (5.34)	9 (4.81)	7 (3.74)	187 (100)
Non-abutment teeth (NAT)	304 (62.81)	75 (15.49)	40 (8.26)	29 (5.99)	14 (2.89)	12 (2.47)	10 (2.06)	484 (100)
Total (AT+NAT)	200.5 (57.24)	53.5 (16.13)	29.5 (9.51)	21 (6.47)	12 (4.11)	10.5 (3.64)	8.5 (2.9)	671 (100)

group of denture users over the entire observation of 36 months was evident in more than 55% of the study population. These results from the 36 months observation period indicated significant protection being offered by the *C. nucifera* oil for removable denture wearers in decreasing the incidence of caries activity. This is in contrast to the increased caries activity been reported in studies conducted by Paul et al. with the use of removable partial dentures. Wright et al.²² examined the correlation between the design of removable partial dentures and the incidence of root caries and found out 57% who wore the dentures had more prevalence rate of exposed root surfaces and also root caries, especially on abutment teeth. The root caries on those abutment teeth surfaces was observed to be larger and more active than on the surfaces of non-abutment teeth.²³ Marginal increase in the caries activity found in the abutment teeth in contact with the retainers would be attributed to the reduced maintenance regimen and more biofilm and plaque accumulation in contrast to the non-abutment teeth in contact with the other components of the denture. Mean carious activity restricting to just involvement of the visual changes in enamel surface was reported in less than 25% of the study group. The level of carious activity not reaching the dentin was at less than 6% involving both the abutment group and the non-abutment group. The dentinal changes with lesion appearing from just the discolored dentin appearing as a shadow beneath the enamel to the level of distinct cavity and exposure of the visible dentin constituted about overall around 7% for the abutment teeth and 9% for non-abutment teeth indicating the protecting action of use of the *C. nucifera* oil among the study group at the dentin level. None of the abutment or the non-abutment teeth were lost due to caries progression during the 36 months of the study duration. Around 9% were rated to have cavity involving visible dentin, thus indicating that the *C. nucifera* usage had 91% caries protection over the 36 months observation period of the study. Limitations of the study include sample size distribution, case selection to further include caries prone people and medically compromised subjects, the further prognosis of the caries activity needs to be assessed by increasing the study duration, influence on the presence of the various strains of *C. nucifera* oil available throughout the world and its impact on the caries activity, variations in the method of preparations and procurement of the oil, temperature impact and shelf life on the efficacy of the oil.

CONCLUSION

No evidence of caries activity was observed in the abutment group and the non-abutment group of denture users involving more than 55% of the study population. Thus the *C. nucifera* oil offers caries protective benefits for patients wearing removable dentures and reduces the incidence of caries activity during the observation of the study period of 36 months.

ETHICAL APPROVAL

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Dr. MGR Educational and

Research Institute, Chennai (Department of Prosthodontics) (protocol code Dr M.G.R DU/TMDCH/2019-20//260719002).

INFORMED CONSENT

Informed consent was obtained from all subjects involved in the study.

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