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The Effect of Tea Tree Oil as a Denture Cleanser on the Surface Roughness of an Acrylic Resin

Protez Temizleyici Olarak Çay Ağacı Yağının Akrilik Rezinin Yüzey Pürüzlülüğü Üzerindeki Etkisi

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ABSTRACT

Objective: This study aims to evaluate the effect of using tea tree oil and chemical agents in denture cleaning on the surface roughness of acrylic resin dentures.

Methods: A total number of 40 acrylic resin samples (65 mm × 10 mm × 3 mm) were prepared for the study. After the samples were enumerated, their roughness values were determined and they were randomly divided into groups (n = 10) and kept in Protefix, Corega, tea tree oil, and distilled water. The time period for the immersion in the solutions was established as 20 minutes. The roughness values were measured again after 720 immersions. The data thus obtained were evaluated using two-way analysis varinace and post hoc Tukey's test.

Results: As a result of the variance analysis, it was determined that the liquid used and the immersion time were not statistically significant ($P > .05$).

Conclusions: It is exciting that natural oils have an important place in people's lives in all aspects and that we can use them in denture cleansing. The surface roughness of base materials is important for both aesthetics and microbiology. Dentists have to consider the effects of tea tree oil on the surface roughness of base material.

Keywords: Acrylic resin, denture cleaners, surface roughness, tea tree oil

ÖZ

Amaç: Bu çalışma, protez temizliğinde çay ağacı yağı ve kimyasal ajanların kullanılmasının akrilik rezinin yüzey pürüzlülüğüne etkisini değerlendirmeyi amaçlamaktadır.

Yöntemler: Çalışma için toplam 40 adet akrilik rezin (65 mm x 10 mm x 3 mm) hazırlandı. Numuneler numaralandırıldıktan sonra pürüzlülük değerleri belirlenmiş ve rastgele gruplara (n=10) ayrılarak Protefix, Corega, çay ağacı yağı, distile suda bekletilmiştir. Çözeltilere daldırma süresi 20 dakika olarak belirlendi. 720 daldırma işleminden sonra pürüzlülük değerleri tekrar ölçülmüştür. Elde edilen veriler, iki yönlü ANOVA ve post-hoc Tukey testi kullanılarak değerlendirildi.

Bulgular: Varyans analizi sonucunda kullanılan sıvının ve daldırma süresinin istatistiksel olarak anlamlı olmadığı belirlendi ($P > ,05$).

Sonuç: Doğal yağların insanların hayatında her yönden önemli bir yere sahip olması ve bunları protez temizliğinde kullanabilmemiz heyecan verici. Temel malzemelerin yüzey pürüzlülüğü hem estetik hem de mikrobiyoloji için önemlidir. Diş hekimleri, çay ağacı yağının temel materyalin yüzey pürüzlülüğü üzerindeki etkilerini dikkate almalıdır.

Anahtar Kelimeler: Akrilik rezin, protez temizleyiciler, yüzey pürüzlülüğü, çay ağacı yağı

INTRODUCTION

In the oral environment, tartar, plaque, and stain formation are observed on dentures as well as on teeth.[1] Conditions that can vary from patient to patient such as the surface properties of dentures, duration of use, oral hygiene, dietary habits, and saliva components point out to possible variations in

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the resulting deposits on dentures.[2] Individuals that fail to maintain denture hygiene may, as a result, develop halitosis, denture stomatitis, and other mucosal infections.[3]

Denture stomatitis refers to inflammatory and erythematous formations in the oral mucosa in contact with the base. This condition, dominated by Candida Albicans fungi, was reported to feature colonizations mostly on the inner surface of the base plate.[4]

Denture cleaning can be achieved by mechanical or chemical methods employed individually or in combination.[5] Brushing, ultrasonic cleaners, and microwave ovens can be used for this purpose as mechanical methods. Chemically, denture cleaning can be performed with the use of disinfectants, enzymes, diluted acids, alkaline peroxides, and alkaline hypochlorites.[6]

These chemical agents should not cause any chemical, physical, or mechanical changes on the dentures.[7] Since the dentures will need to be cleaned numerous times with such agents during their period of effective use, it is important that they should offer good efficacy and not damaged dentures.[7]

Given the fact that the users of dentures are mostly of advanced age, it should be foreseen that they will not be able to achieve sufficient denture cleaning through mechanical means. In addition, the microbiological efficiency of mechanical cleaning can be ranked rather low. For these reasons, it is often recommended to hold dentures in chemical solutions, as they offer a method to facilitate denture cleaning. Effervescent tablets are the most commonly recommended chemical agents.[7] Users are urged to keep their dentures in solutions prepared with agents in tablet or powder form. This method can also be stated to complement chemical cleaning with micro-mechanical cleaning owing to the release of oxygen in the solution containing such a tablet or powder.[6]

These products, when used regularly, can remove lightly attached food residues and mucin, but their efficacy falls short in removing settled, thickened plaque.[4]

Tea tree oil was reported as an ideal disinfectant for topical applications as it can easily penetrate the skin and offer antimicrobial efficacy against a wide range of microorganisms without causing irritation.[8] This substance is found in numerous products such as toothpaste, mouthwash, soap, facial cleansers, shampoo, and moisturizer in different concentrations or without dilution.[9]

Plants belonging to the genera *Leptospermum*, *Melaleuca*, and *Kunzea* from the Myrtaceae family are known as "tea tree." These plants do not share any similarities with the true tea plant (*Camelia sinensis*) in terms of taste, smell, and composition.[10] The essential oils present in the leaves of these plants are called "tea tree oil." The plants known as "tea tree" and the essential oils obtained are denominated as follows:[11,12] *M. cajuputi* (swamp tea tree, paperbark tea tree), Cajuput oil, *Kunzea ericoides*, Kanuka oil, *Melaleuca quinquenervia* (broad-leaved tea tree, broad-leaved paperbark), Niaouli oil, *Leptospermum scoparium*, Manuka oil, *Melaleuca Alternifolia* (Australian tea tree), and Australian tea tree oil (ATTO).[11,12]

Australian tea tree oil produced from *Melaleuca alternifolia* stands out as the prominent, thoroughly researched oil of medical and economic value.[12]

Patients using toothpaste containing tea tree oil were observed to enjoy improvements in hygiene and the condition of periodontium.[13]

Good surface properties are required in the materials to be utilized in dental treatments to prevent plaque retention and stain formation, as well as to provide an aesthetic appearance. These materials should be shiny and smooth.[14] Plaque retention was reported in the presence of surface roughness greater than 0.2 μm.[14,15]

Although there are a large number of studies examining the effects of denture cleaning solutions on the mechanical and physical properties of acrylic resins, the literature does not offer any studies conducted with the aim of investigating the effects of antibacterial solutions prepared with tea tree oil on the surface roughness of acrylic resins. Our study aimed to evaluate the effect of the use of tea tree oil solutions on the surface roughness of acrylic resin dentures. The hypothesis of the study is that the use of denture cleaners prepared with tea tree oil will change the surface roughness values of acrylic resins at a lesser degree than the common denture cleaners currently available in the market.

MATERIAL AND METHODS

Ethics committee approval was received for this study from Atatürk University Faculty of Dentistry (Date: 21.04.2022, Number: 51).

About 40 acrylic resin samples were prepared in dimensions of 65 mm x 10 mm x 3 mm in accordance with ISO:1567.[14] The present study employed heat-polymerized acrylic resin (Meliodent, Heraeus Kulzer, Hanau, Germany). In order to prepare standard-sized samples, a wax model (Cavex Set Up Regular, Cavex Holland BV, Haarlem, The Netherlands) was put into a muffle with common methods and this step was followed by wax removal. Heat-polymerized acrylic resin (Meliodent, Heraeus Kulzer) was prepared in line with the manufacturer's recommendations, placed in a muffle, and polymerized. Information on the manufacturer and place of manufacture of the materials used in this procedure is given in Table 1.

After polymerization, any excess around the samples was removed and the samples were polished appropriately. In order to remove residual monomer, the samples were kept in distilled water at 37°C for 48 hours. The samples were randomly divided into 4 different groups according to the solution used (n = 10).

The initial and 10-day roughness values of the samples were measured with a profilometer (Surtronic 25; Taylor Hobson, Leicester, UK). In this study, the measurement length was set at 2.5 mm and the cutoff value at 0.25 mm.[16] The surface roughness value of each sample was calculated by averaging out measurements repeated in 3 different areas on the surfaces of the sample.

The chemical denture cleaning agents used in the study were Corega (Glaxo Smith Kline, Ireland) and Protefix (Helago-Pharma

Table 1. Information on Manufacturers of Denture Cleaners and Acrylic Resins Used in the Study

Material	Manufacturer	Place of Manufacture
Meliodent	HeraeusKulzer	Germany
Protefix	Helago-Pharma GmbH An der Schleifmühle 2	Germany
Corega	Glaxo Smith Kline	Ireland
Tea tree oil	Toroslar Doğal ve Kozmetik Ürünler A.Ş.	Turkey

Table 2. Breakdown of Obtained Values (n = 10)

	Time							
	At the Start				10 Days Later			
Solution of Immersion	Minimum	Maximum	*X*	SD	Minimum	Maximum	*X*	SD
Protefix	0.300	1.19	0.852	0.261	0.500	1.61	1.05	0.348
Corega	0.490	1.56	0.802	0.320	0.320	1.42	0.849	0.303
Tea tree oil	0.430	1.13	0.770	0.242	0.380	1.12	0.701	0.198
Distilled water	0.460	1.23	0.907	0.242	0.360	1.12	0.684	0.205

Table 3. Comparison of Solutions by Surface Roughness Values

Solution		Difference Between Averages	SE	*df*	*t*	Ptukey
Protefix	Corega	0.1235	0.105	36.0	1.179	0.644
	Tea tree oil	0.2135	0.105	36.0	2.038	0.193
	Distilled water	0.1535	0.105	36.0	1.465	0.468
Corega	Tea tree oil	0.0900	0.105	36.0	0.859	0.826
	Distilled water	0.0300	0.105	36.0	0.286	0.992
Tea tree oil	Distilled water	−0.0600	0.105	36.0	−0.573	0.940

GmbH An der Schleifmühle 2, Germany), which are easily accessible in our country and belong to the alkaline peroxide group. These denture cleaning agents are available in the market in the form of effervescent tablets. While Corega and Protefix effervescent tablets were prepared with 1 tablet each placed in 200 mL lukewarm water in line with the recommendations of the manufacturer, tea tree oil was used in its pure form as obtained through herbal distillation (Taurus Natural & Cosmetics Inc., Turkey). About 15 mL of tea tree oil was added to 85 mL of water. This concentration was used in the present study due to the significant efficacy reported for a tea tree oil concentration of 15%.[17] The samples in the control group were kept in the distilled water.

In the literature, the immersion times employed in similar studies for solutions vary from 5 minutes to 8 hours.[18,19] In order to compare the results accurately, all the solutions used were kept for an equal period of time.[18,20,21] Acrylic resin samples and solutions were kept in 100 mL capped plastic containers.

As the solutions are to be renewed once every 8 hours[18] and 72 immersions of 20 minutes each will be completed in 1 day, the samples were immersed in the solutions for a period of 10 days to simulate 720 individual uses.[18] Baseline measurements and 10th-day measurements were evaluated using two-way analysis variance (ANOVA) and post hoc Tukey's test (α = ,05).

Statistical Analysis

The data obtained in this study were evaluated with two-way ANOVA and Tukey's post hoc comparisons at a significance level of $P < .05$ Statistical Package for Social Sciences (SPSS) version 20.0 software (IBM Corp.; Armonk, NY, USA).

RESULTS

An examination of the results of the analysis of variance employed for the evaluation of collected data statistically indicated that the liquid used and immersion time were not significant ($P > .05$), while the interaction between the liquid used and immersion time was significant ($P < .05$).

The minimum, maximum, and average levels and standard deviation results of the values obtained are shown in Table 2.

The surface roughness values were observed to have increased the most after 10 days in the samples immersed in Protefix, followed by samples immersed in Corega, and to have changed on a decreasing trend in samples kept in tea tree oil.

Table 4. Comparison of Surface Roughness Values by Time

Time	Difference Between Averages	SE	*df*	*t*	Ptukey
Initial Measurement–10th-day measurement	0.0127	0.0423	36.0	0.301	0.765

An evaluation of the results of the post hoc Tukey multiple comparison test assessing the roughness values by individual solution (Table 3) and immersion time (Table 4) established that the difference between the surface roughness values was not statistically significant ($P > .05$).

DISCUSSION

A decrease was found in the surface roughness values of acrylic resins kept in tea tree solution, which can be used as a denture cleaner, but the hypothesis of the study was rejected because this decrease was not found to be statically significant.

Efforts to eliminate plaque and ensure hygiene surely play an important role in the longevity of removable dentures. Tablets used for these purposes generally do not contain abrasives and they achieve the cleaning effect with surfactant and antimicrobial activity with hydrogen peroxide, alkaline peroxide, radical oxygen, and peracetic acid.[22] It has been reported that the activity that occurs in the solution of alkaline or hydrogen peroxides in water causes dissolution in the organic matrix in the polymer structure.[23] It has also been reported that the roughness of the acrylic base increases with the use of chemical cleaning tablets.[24] In the present study, it was determined that the chemical cleaning agents are used to increase the surface roughness values of acrylic, which may be due to the dissolution they create in the acrylic structure.

In this study, a significant increase was observed in the roughness values following the exposure of heat-polymerized base to denture cleaners;[25] but in another study, it has been reported that heat-polymerized resins exposed to chemical cleaning agents have less surface roughness changes than injection-molded thermoplastic resins. [26] The fact that the change in the roughness values was not statistically significant in the present study may be attributed to the use of heat-polymerized acrylic.

Even though studies employing cleaners available in the market as effervescent tablets indicate a significant increase in the roughness values of polymethyl methacrylate resins,[27] there are also studies that conclude that surface roughness does not vary with the use of Corega tablets.[19,27] In the present study, although

surface roughness increased in the Corega group, such increase was not statistically significant.

The present study measured surface roughness with a profilometer as in numerous other evaluations of resin roughness.[28] What we express as "Ra" refers to the surface roughness parameter. The use of this device is significant in that it secures the comparability of the results with those of the other studies. In addition, its ease of measurement and calculation can be considered as an advantage.[23] However, there is a perceived disadvantage in the two-dimensional nature of the resulting measurement.

Higher surface roughness increases microorganism retention. It has been reported that the microorganism colonization on the base decreases when Ra is below 0.2 µm.[25] In the present study, it was found that tea tree oil, unlike chemical agents, reduced surface roughness. Such reduction may be attributed to oil adherence on already rough surfaces. On the other hand, the decrease in the control group suggests water absorption. Any decrease in roughness leads to a decrease in colonization.

The majority of the patients using dentures are of advanced age. Accordingly, chemical agents are often preferred for geriatric patients with neuromuscular dysfunction and lack of manual dexterity, who cannot physically perform denture cleaning.[29] Although these chemical cleaners offer strong antimicrobial efficacy, microorganisms developing resistance has heightened the need for the use of natural plant extracts.[29,30] Vegetable oils with antimicrobial and antifungal effects are added to toothpaste and mouthwash.[29]

A study conducted to investigate the effect of a paste containing tea tree oil on oral microflora and periodontal health reported improvements in hygiene and the condition of the periodontium among patients using the paste.[13]

Positive results have been obtained in terms of antifungal activity with the addition of tea tree oil to Viscogel-GC soft lining material.[31]

In a study comparing the antimicrobial efficacy of tea tree oil with that of chlorhexidine gluconate and fluconazole on acrylic resin, it was reported that tea tree oil was equally effective on Candida with chlorhexidine and superior to fluconazole.[32] The critical value of the present study lies in its estimation that the decrease in surface roughness values and the reduction of bacterial colonization in acrylic samples exposed to tea tree oil solution. Its effect of reducing surface roughness also suggested that its antimicrobial superiority might be maintained without any loss.

In a study evaluating the effect of the incorporation of tea tree oil in soft linings on the proliferation of *Candida albicans*, 1-, 30-, and 60-day checks were carried out and it was reported that the preparation offered significant efficacy for up to 60 days.[33]

In another study, it was stated that the antifungal activity of 15% tea tree oil was significant in heat-polymerized acrylic resin.[17,33] The present study also employed the same concentration.

It is known that the surface roughness of the materials used in dentistry affects the free surface energy.[14] This implies that the formation of bacterial plaque is directly proportional to the increase in roughness.[34] Surface roughness is also important in the occurrence of stomatitis due to the dentures. In this case, it becomes easier for *C. albicans* to adhere to the rough surface.[14,35]

One relevant study reported that thyme essential oil was superior to certain chemical agents in maintaining the surface roughness values of the base material compared to denture cleaners.[30] However, although the antifungal efficacy of tea tree oil has been investigated in comparison to chemical agents before, our study will offer guidance to the preference of tea tree oil in scientific research, since no such study has been undertaken on the evaluation of resulting changes in surface roughness.

In the present study, it was observed that, among cleaning solutions, Protefix and Corega increased while tea tree oil decreased the roughness.

It is important for the patients using dentures to be guided by their physicians in denture cleaning. They should know about the materials that can increase surface roughness. While informing the patients, we should prioritize cleaning agents that change the surface properties of dentures either slightly or none at all, offer the best antifungal and antibacterial efficacy, and contain the least amount of chemicals or are entirely made up of herbal content. Within the limits of this study, it was observed that tea tree oil reduced prosthetic surface roughness, while chemical agents were found to increase surface roughness in the 10-day evaluation. The present study will be a guide for physicians to recommend tea tree oil more commonly as a substance that we found to reduce the surface roughness value when compared to chemical agents.

Ethics Committee Approval: Ethics committee approval was received for this study from Atatürk University Faculty of Dentistry (Date: 21.04.2022 Number: 51).

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REFERENCES

1. Pasricha N, Sidana V. Evaluation of awareness and knowledge about denture cleansers among dental professionals. *J Indian Prosthodont Soc*. 2014;14(4):400-407. [CrossRef]
2. Chandu GS, Asnani P, Gupta S, Faisal Khan M. Comparative evaluation of effect of water absorption on the surface properties of heat cure acrylic: an in vitro study. *J Int Oral Health*. 2015;7(4):63-68.
3. Cakan U, Kara O, Kara HB. Effects of various denture cleansers on surface roughness of hard permanent reline resins. *Dent Mater J*. 2015;34(2):246-251. [CrossRef]
4. Zarb GA, Hobkirk J, Eckert S, Jacob R. *Prosthodontic Treatment for Edentulous Patients-E-book: Complete Dentures and Implant-Supported Prostheses*. Amsterdam: Elsevier Health Sciences; 2013.
5. Shay K. Denture hygiene: a review and update. *J Contemp Dent Pract*. 2000;1(2):28-41. [CrossRef]
6. Oussama M, Ahmad H. Materials and methods for cleaning dentures- A review. *Int J Dent Clin*. 2014;6(2):19-22
7. Andrade IM, Andrade KM, Pisani MX, Silva-Lovato CH, de Souza RF, Paranhos HdeF. Trial of an experimental castor oil solution for cleaning dentures. *Braz Dent J*. 2014;25(1):43-47
8. May J, Chan CH, King A, Williams L, French GL. Time-kill studies of tea tree oils on clinical isolates. *J Antimicrob Chemother*. 2000;45(5):639-643. [CrossRef]
9. Murray MT. *The Healing Power of Herbs*. 2nd ed. Prima Publishing; 1995.
10. Southwell I, Lowe R. *Tea Tree: the Genus Melaleuca*. 1st ed. Boca Raton: CRC Press; 1999.
11. Lis-Balchin M, Hart SL, Deans SG. Pharmacological and antimicrobial studies on different tea- tree oils (Melaleuca alternifolia, Leptospermum scoparium or Manuka and Kunzea ericoides or Kanuka), originating in Australia and New Zealand. *Phytother Res*. 2000;14(8): 623-629. [CrossRef]
12. Carson CF, Riley TV. Safety, efficacy and provenance of tea tree (Melaleuca alternifolia) oil. *Contact Dermatitis*. 2001;45(2):65-67. [CrossRef]
13. Wiatrak K, Morawiec T, Rój R, et al. Oral health of patients treated with acrylic partial dentures using a toothpaste containing bee product. *Evid Based Complement Alternat Med*. 2017:12p, 4034179. [CrossRef]
14. Karcı M, Demir N, Yazman Ş. Evaluation of mechanical and physical properties of micro-waved acrylic resin reinforced with different nanoparticles [Farklı Nanopartiküllerle Güçlendirilen Mikrodalga Enerjisi Ile polimerize Olan akrilik rezinin mekanik ve fiziksel Özelliklerinin Değerlendirilmesi]. *J Dent Fac Atatürk Uni*. 2020;30(1):101-106. [CrossRef]
15. Joniot S, Salomon JP, Dejou J, Grégoire G. Use of two surface analyzers to evaluate the surface roughness of four esthetic restorative materials after polishing. *Oper Dent*. 2006;31(1):39-46. [CrossRef]
16. Rahal JS, Mesquita MF, Henriques GE, Nóbilo MA. Surface roughness of acrylic resins submitted to mechanical and chemical polishing. *J Oral Rehabil*. 2004;31(11):1075-1079. [CrossRef]
17. Al–Mashhadane FA. Tea tree oil: anew antifungal agents against Candida albicans Cells on heat–cured acrylic resin denture base material. An in vitro study. *RDENTJ*. 2007;7(3):54-57. [CrossRef]
18. Öztürk Ö, Gültekin M. Effect of denture cleansing solutions on microhardness of A heat-cure acrylic resin [Protez Temizleyici Solüsyonlarin Isi ile Polimerize Olan Akrilik Rezinin Mikrosertliğine Etkisi]. *J Dent Fac Atatürk Uni*. 2017;27(1):7-11. [CrossRef]
19. Paranhos F, Peracini A, Pisani MX, Oliveira C, de Souza RF, Silva-Lovato CH. Color stability, surface roughness and flexural strength of an acrylic resin submitted to simulated overnight immersion in denture cleansers. *Braz Dent J*. 2013;24(2):152-156. [CrossRef]
20. Paranhos Hde F, Davi LR, Peracini A, Soares RB, Lovato CH, Souza RF. Comparison of physical and mechanical properties of microwave-polymerized acrylic resin after disinfection in sodium hypochlorite solutions. *Braz Dent J*. 2009;20(4): 331-335. [CrossRef]
21. Arruda CN, Sorgini DB, Oliveira C, Macedo AP, Lovato CH, Paranhos F. Effects of denture cleansers on heat-polymerized acrylic resin: a five-YearSimulated period of use. *Braz Dent J*. 2015;26(4):404-408. [CrossRef]
22. Axe AS, Varghese R, Bosma M, Kitson N, Bradshaw DJ. Dental health professional recommendation and consumer habits in denture cleansing. *J Prosthet Dent*. 2016;115(2):183-188. [CrossRef]
23. Mahross HZ, Mohamed MD, Hassan AM, Baroudi K. Effect of cigarette smoke on surface roughness of different denture base materials. *J Clin Diagn Res*. 2015;9(9):ZC39-ZC42. [CrossRef]
24. Sharma P, Garg S, Kalra NM. Effect of denture cleansers on surface roughness and flexural strength of heat cure denture base resin-an in vitro study. *J Clin Diagn Res*. 2017;11(8):ZC94-ZC97. [CrossRef]
25. Bollen CM, Papaioanno W, Van Eldere J, Schepers E, Quirynen M, van Steenberghe D. The influence of abutment surface roughness on plaque accumulation and periimplant mucositis. *Clin Oral Implants Res*. 1996;7(3):201-211. [CrossRef]
26. Tripathi P, Phukela SS, Yadav B, Malhotra P. An in vitro study to evaluate and compare the surface roughness in heat-cured denture-based resin and injection-molded resin system as affected by two commercially available denture cleansers. *J Indian Prosthodont Soc*. 2018;18(4):291-298. [CrossRef]
27. Peracini A, Davi LR, de Queiroz Ribeiro N, de Souza RF, Lovato da Silva CH, de Freitas Oliveira Paranhos H. Effect of denture cleansers on physical properties of heat-polymerized acrylic resin. *J Prosthodont Res*. 2010;54(2):78-83. [CrossRef]
28. Alandia-Roman CC, Cruvinel DR, Sousa AB, Pires-de-Souza FC, Panzeri H. Effect of cigarette smoke on color stability and surface roughness of dental composites. *J Dent*. 2013;41(3 suppl 3):e73-e79. [CrossRef]
29. Felton D, Cooper L, Duqum I, et al. Evidence-based guidelines for the care and maintenance of complete dentures: a publication of the American College of Prosthodontists. *J Prosthodont*. 2011;20(s1 suppl 1):S1-S12. [CrossRef]
30. Namala BB, Hegde V. Comparative evaluation of the effect of plant extract, Thymus vulgaris and commercially available denture cleanser on the flexural strength and surface roughness of denture base resin. *J Indian Prosthodont Soc*. 2019;19(3):261-265. [CrossRef]
31. Vankadara SK, Hallikerimath RB, Patil V, Bhat K, Doddamani MH. Effect of Melaleuca alternifolia mixed with tissue conditioners in varying doses on colonization and inhibition of Candida albicans: an in vitro study. *Contemp Clin Dent*. 2017;8(3):446-450. [CrossRef]
32. Dalwai S, Rodrigues SJ, Baliga S, et al. Comparative evaluation of antifungal action of tea tree oil, chlorhexidine gluconate and fluconazole on heat polymerized acrylic denture base resin - an in vitro study. *Gerodontology*. 2016;33(3):402-409. [CrossRef]
33. Pachava KR, Nadendla LK, Alluri LSC, Tahseen H, Sajja NP. Invitro antifungal evaluation of denture soft liner incorporated with tea tree oil: a new therapeutic approach towards denture stomatitis. *J Clin Diagn Res*. 2015;9(6):ZC62-ZC64. [CrossRef]
34. Hoeksema AR, Vissink A, Peters LL, Meijer HJ, Raghoebar GM, Visser A. Peri-implant health in people aged 75 and over with an implant-retained overdenture in the mandibula. *Ned Tijdschr Tandheelkd*. 2015;122(7-8):383-390. [CrossRef]
35. Zissis AJ, Polyzois GL, Yannikakis SA, Harrison A. Roughness of denture materials: a comparative study. *Int J Prosthodont*. 2000;13(2):136-140.