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Tear Strength Evaluation of Maxillofacial Silicone After Disinfection with Oregano Oil Solution

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Abstract

The main objective of this study was to evaluate the tear strength property after disinfection with plant-based disinfection solution after different immersion periods. **Materials and methods:** Forty specimens of VST-30 maxillofacial silicone were prepared then divided into four main groups (n=10), a control group that was not subjected to disinfection and three experimental groups subjected to disinfection in different immersion time (1 day, 1 month, and 6 months). The experimented groups were immersed in Oregano oil solution. The tear strength test was performed by the use of Universal Testing Machine. Statistical analyzes of the data was performed via One-way ANOVA and Tukey HSD Post-hoc test to determine the significant differences between experimental and control groups at a level of significance ($p \leq 0.05$).

Results: The tear strength test showed a non-significant difference between the control group and the experimental groups. Also, there was no significant differences among the three experimental groups.

Conclusion: tear strength of VST-30 silicone elastomer was not affected after immersion in 0.4% Oregano solution.

Introduction:

Maxillofacial prosthetics has transformed the science of prosthodontics by providing remedies to facial mutilations caused by congenital deformities, acquired surgical anomalies, and trauma [(1)]. Because of silicone features such as texture, strength, and durability, it became the most preferred material used to make maxillofacial prostheses, it is also easy to use and comfortable for patients [(2)]. Previous research has found that improvements in mechanical and physical properties, particularly thin margin tear strength, flexibility, roughness, and recovery percentage, are crucial for poly dimethyl siloxane maxillofacial materials [3]. High tear strength is essential to create prostheses with thin and delicate edges that blend in with the surrounding tissues [4]. Medical adhesive is used to glue the prosthesis margins which are liable to tear particularly when removing the facial prosthesis in the evening or for cleaning [5]. Different types of bacteria may be present on the surface of maxillofacial silicone prostheses depending on the surface features, as a result, cleaning is necessary when wearing a silicone prosthesis for an extended period of time [6]. Different commercially accessible disinfection solutions, such as sodium hypochlorite, chlorhexidine, and neutral soap, are now available, also plant-derived compounds (particularly essential oils) have been shown to influence microbial biofilm development in addition to these solutions [7]. Chemical disinfection can cause changes in the characteristics of silicone used in maxillofacial prostheses [8]. After disinfection, structural changes in the distribution of molecular masses due to chain scission or additional cross-linking are the main causes of changes in physical or mechanical properties of silicone polymer [9]. Some researchers investigated the effect of different disinfection procedures on tear strength of maxillofacial silicone [4, 9, 10]. Also some other researchers studied the influence of plant-based disinfection solution on the maxillofacial silicone properties including the tear strength [11, 12]. Accordingly, the study's aim was to find how the oregano essential oil solution may affect the tear strength of VST-30 maxillofacial silicone.

Materials and Methods:

The study specimens were made using a RTV silicone elastomer: VST-30, Factor II Inc., Lakeside, USA. The material was delivered into the base (A) and the cross-linking agent catalyst (B). All specimens were fabricated and divided into four groups had ten specimens for each one: (I) a control group that did not subjected to any immersion, (II) a one-day immersion group, (III) a one-month immersion group, and (IV) a six-month immersion group.

Determination the Oregano oil concentration:

The best Oregano oil concentration was determined by testing the antibacterial activity and the effective concentration for preventing the growth of *Staphylococcus aureus* and *Staphylococcus epidermidis*. Clevenger-type apparatus (Simax, Czech Republic) was used to extract the essential oil by hydrodistillation technique [13]. The VITEK system (Biomerieux, France) was used to identify the bacteria [14], and Mueller Hinton Broth (MHB) was used for the bacterial suspension [15]. The microdilution method was used to determine the Minimum Inhibition Concentration (MICs) of the essential oil [16]. In sterile U-bottom 96-well plates, two-fold serial dilutions of the essential oil were prepared in (MHB) and the different concentrations of the oil were distributed in a row then bacterial suspension was added to each well. After incubation, the MIC of the extract was determined by the first well that appears clear as shown in fig (1). In this study, the optimal concentration to utilize was 0.4 %.

Samples' fabrication:

The Auto CAD 2015 computer program was performed to design the mold shape with perfect measurements. The plastic matrices were made with holes that approximate the specimens' dimensions using a plasma CNC machine [17]. Following the manufacturer's directions, the silicone was mixed in a 10:1 ratio for the base and catalyst, then the needed amount of the base material was loaded into the bowl and placed in the vacuum mixer (Multivac 3 Degussa, Germany) for 5 minutes in a clockwise direction with the vacuum set at (28) inches HG. The silicone mixture was poured slowly and steadily until all of the specimen holes were filled, then the cover was positioned over. After 30 minutes, the silicone was vulcanized, according to the manufacturer instructions. The specimens were carefully removed from the mold after complete vulcanization. Using sterilized scissors, flashes and excess silicone were removed. Until testing, all specimens were kept in a zip-lock plastic bag within a custom-made light-proof box [12].

Disinfection procedure:
Silicone samples were immersed in a container containing the selected concentration of the Oregano oil. As the patients supposed to clean their prostheses at least for (5) minutes/day, so the examined periods simulation was (5) min for one-day, (150) min for one-month, and (900) min for six-months [11].

Testing procedures:
A C-type angle test sample without neck was fabricated according to (ISO 34-1:2010) specifications. In each grip of the machine, the test specimen was placed symmetrically and in axial alignment with the pull direction fig (2). Specimens were tested at a strain rate of 500mm/min by a computer-controlled Universal testing machine (Laryee, China). Tear strength (*Ts*), expressed in kilo Newton per meter of thickness (kN/m) was calculated according to Eq:

$$T_S=F/D$$

Where: T_S: the tear strength, F: the maximum force in newton, and D: the sample thickness in millimeters (ISO 34-1:2010).

Statistical method:
The obtained data were subjected to SPSS program for analysis using One-way ANOVA to get the significant differences between the control and the experimental groups. A significance level of $\alpha \leq 0.05$ was selected.

Results:

Fig (3) represents the mean and the standard deviation of the tear strength values. Control group showed the highest mean value compared with the Oregano experimental groups. The highest mean value of the experimental group was for one-day immersion group, followed by the one-month immersion group, and the six-month immersion group showed the least value. One-way ANOVA showed that there was no significant difference among the tested groups as shown in table (1). Also One-way ANOVA showed non-significant difference among the experimental groups when a comparison was made according to the time of immersion, Table (2).

Discussion:

High tear resistance, high tensile strength, excellent elongation at break, and sufficient hardness are all necessary characteristics for maxillofacial silicone elastomers [10]. The tear strength results in this study showed a non-significant decrease in their values after immersion in the plant extract materials. After immersion in disinfecting solutions, the polymerization of the silicone elastomer has been accelerated. The degree of polymerization, crosslinking, or chain scission that caused degradation may explain the decrease in tear strength after disinfection, crosslinking has also been accelerated by moisture exposure [5]. Because silicone was immersed in disinfecting solutions, it polymerized quickly. From the time the silicone ingredients were mixed to the time the prostheses were used, there was growth during cross-linking and an increase in density [12]. Even though tear strength was improved by cross-linking propagation, this process decreased as cross-linking levels increased because of the obstacles' formation that prevent the sliding of the molecules past one another resulting in a material that is brittle and ruptures at lower deformation [9].

These results showed an agreement with Abdul-Ameer [12], who investigated the effect of two alcoholic extract of Salvadora persica L. concentrations (10%, 15%) and 2% chlorhexidine digluconate on (RTV) VST50F and (HTV) Cosmesil M511 silicone elastomers, and found that tear strength of (HTV) Cosmesil M511 was not significantly affected by the disinfection material. On the other hand, these results disagreed with Fouad and Moudhaffer [4], Hatamleh et al [9] who concluded there was a significant reduction in the tear strength of silicone after disinfection. This difference could be attributed to different disinfection procedure or silicone materials.

Regarding the immersion periods, there was also a non-significant difference between the experimental groups for both plant disinfectant solution. These results agreed with Tetteh et al [11] who found that no-significant differences in tear strength values after immersion silicone samples in plant extract solution for simulating time period (1 day, 28 days, 3 months, 6 months, 9 months and 12 months). Conversely, these results were in disagreement with Radey et al [10], who concluded that tear strength values of MED-4210 maxillofacial silicone elastomer was significantly increased after (30) hours of immersion in antimicrobial silicone-cleaning solution.

Conclusion:

Within the limitation of this study, it can be concluded that the tear strength of VST-30 maxillofacial silicone was not significantly affected after immersion in the Oregano oil solution regardless the immersion periods.

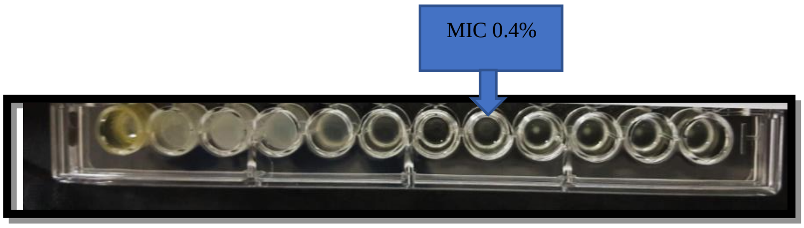

Fig. 1: MIC of Oregano oil.

Fig. 2: Tear specimen mounted in the Universal testing machine.

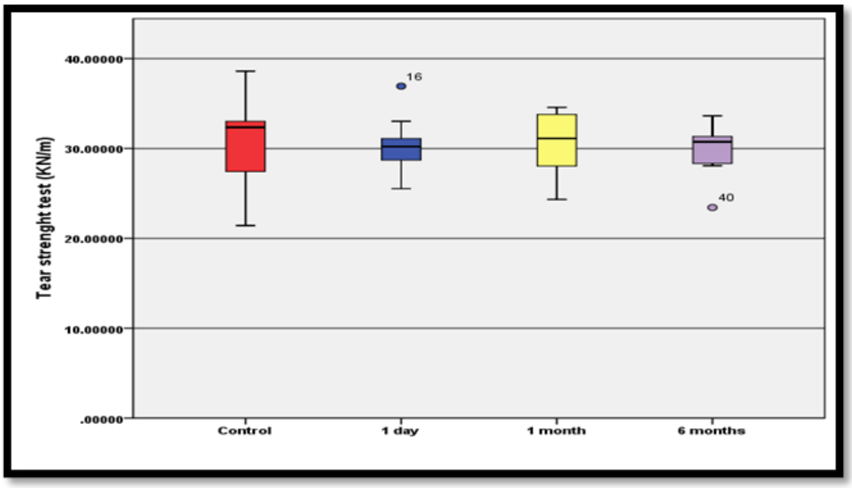

Fig. 3: Box plot of Tear Strength represents the mean values for control and experimental groups.

Table 1: One-way ANOVA to compare the Tear Strength between control and oregano groups

	Sum of Squares	df	Mean Square	F-test	Sig.(P-value)
Between Groups	4.719	3	1.573	0.114	**0.952***
Within Groups	498.149	36	13.837		
Total	502.868	39			

* Non-significantly different (*P*>0.05).

Table 2: One-way ANOVA to compare the tear strength according to the time of immersion in Oregano solution

	Sum of Squares	df	Mean Square	F-test	Sig.(P-value)
Between Groups	0.929	2	0.464	0.044	**0.957***
Within Groups	287.911	27	10.663		
Total	288.840	29			

* Non-significantly different (*P*>0.05)

References

1. Babu AS, Manju V, Gopal VK. Effect of chemical disinfectants and accelerated aging on maxillofacial silicone elastomers: An In vitro Study. Indian J Dent Res. 2018;29(1):67.
2. Goiato MC, Haddad MF, Santos DMd, Pesqueira AA, Moreno A. Hardness evaluation of prosthetic silicones containing opacifiers following chemical disinfection and accelerated aging. Brazilian oral research journal. 2010;24(3):303-8.
3. El Afandy HM, Fawzy AM. Evaluation of mechanical properties of maxillofacial silicone after long term exposure to different conditions. Egypt Dent J. 2019;65(3-July (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):2681-9.
4. Fouad M, Moudhaffer M. Effect of disinfection on some properties of heat-vulcanized maxillofacial silicone elastomer reinforced by nano silicone dioxide. Journal of Baghdad College of Dentistry. 2016;28(4):16-21.
5. Hatamleh MM, Watts DC. Mechanical properties and bonding of maxillofacial silicone elastomers. Dent Mater J. 2010;26(2):185-91.
6. Cevik P, Yildirim-Bicer AZ. Effect of different types of disinfection solution and aging on the hardness and colour stability of maxillofacial

silicone elastomers. The International journal of artificial organs 2018;41(2):108-14.
7. Al-Jumaili QB, Salim SA. Effect of Different Disinfecting Solutions on some Properties of Maxillofacial Elastomers Over Time. Sulaimani Dent Journal
8. Jaffer NT. EFFECT OF SIWAK EXTRACTSON THE HARDNESS PROPERTY OF VINYL ADDITION CURED SILICONE MAXILLOFACIAL PROSTHETIC MATERIAL. Journal of Duhok University. 2019:42-8.
9. Hatamleh MM, Polyzois GL, Silikas N, Watts DC. Effect of extraoral aging conditions on mechanical properties of maxillofacial silicone elastomer. Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry. 2011;20(6):439-46.
10. Radey NS, Al Shimy AM, Ahmed DM. EFFECT OF EXTRAORAL AGING CONDITIONS ON MECHANICAL PROPERTIES OF FACIAL SILICONE ELASTOMER REINFORCED WITH TITANIUM-OXIDE NANOPARTICLES (IN VITRO STUDY). Alex Dent J. 2020;45(3):29-36.
11. Tetteh S, Bibb RJ, Martin SJ. Mechanical and morphological effect of plant based antimicrobial solutions on maxillofacial silicone elastomer. Materials journal 2018;11(6):925.
12. Abdul-Ameer FMH. Effect of plant-extract disinfectant solutions on the specific properties of reinforced maxillofacial silicone elastomers with nanofiller and intrinsic pigment. European Journal of General Dentistry. 2020;9(2):55-61.
13. Yagi S, Babiker R, Tzanova T, Schohn H. Chemical composition, antiproliferative, antioxidant and antibacterial activities of essential oils from aromatic plants growing in Sudan. Asian Pacific journal of tropical medicine. 2016;9(8):763-70.
14. Sulaiman IM, Banerjee P, Hsieh Y-H, Miranda N, Simpson S, Kerdahi K. Rapid detection of Staphylococcus aureus and related species isolated from food, environment, cosmetics, a medical device, and clinical samples using the VITEK MS microbial identification system. J AOAC Int. 2018;101(4):1135-43.
15. Sutton S. Measurement of microbial cells by optical density. Journal of Validation technology. 2011;17(1):46-9.
16. Jeršek B, Ulrih NP, Skrt M, Gavarić N, Božin B, Možina SS. Effects of selected essential oils on the growth and production of ochratoxin A by Penicillium verrucosum. Archives of Industrial Hygiene and Toxicology journal. 2014;65(2):199-208.
17. Chi Y, Hsin-. Effect of Silica Filler on the Mechanical Properties of Silicone Maxillofacial Prothesis 2014.