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Assessment of the wettability of addition silicone Impression material following short term immersion in tea tree oil solution

[1] Samir Samier hammed , [2]Aseel Mohammed Al-Khafaji
[1,2] Department of prosthodontics, College of Dentistry, University of Baghdad, Baghdad, Iraq
[1]Samer.Samir2301m@codental.uobaghdad.edu.iq
[2]aseel.khafaji@codental.uobaghdad.edu.iq
ORCID: [1] https://orcid.org/0009-0003-3056-7112

Abstract:

Background: Dental impressions are often contaminated with the patient's saliva, blood, and plaque, represents a risk of cross-infection between dental practitioners. In order to prevent the spread of microorganisms, disinfection of all dental impressions is mandatory. Chemicals are usually used to disinfect impressions by immersion. Nonetheless, these chemicals may alter the physical and mechanical properties of impression material. The study purpose was to evaluate the tea tree oil effect as an impression disinfectant on wettability property of addition silicone impressions material.

This study employed a total of 60 heavy- and light-body addition silicon impression material specimens. The specimens were randomly sorted and immersed into three primary groups. These test groups where 1% TTO and the other two groups are distilled water (negative control) and 2% glutaraldehyde (positive control).all was immersed for 10 minutes .each of the three main groupings has 20 specimens.

There were no statistically significant differences in wettability of addition silicone impressions among all test groups.

The addition silicone impression material may be safely submerged in TTO for 10 minutes to disinfect it without impairing the wettability of the impression.

Keywords: Addition silicone, Tea tree oil (TTO), wettability, Glutaraldehyde, Distilled water

Introduction:

Overview: In dental practice, impressions are undoubtedly infected with possibly dangerous germs when touching patients' blood, plaques, and saliva (Chidambaranathan,A.S.& Balasubramanium, M.,2019). Which may be a source of diseases transmission and cross-infection risk for the dental professionals, dental assistant personals, and dental lab technicians (Hardan et al.,2022).Thus, it is critical to effectively sanitize dental impressions prior to its transferal to the dental lab (Al Mortadi et al.,2019).As a result, an effective method for preventing cross-contamination while preserving the physical and mechanical qualities of the impression is necessary. Dental impressions infected with potentially harmful germs come into touch with the patient's blood and saliva (Hussian,A. M., & Jassim, R. K., 2015).This might lead to cross-infections among dentists, dental assistants, and laboratory technicians 9Al-Azawi et al.,2016).Studies have focused on the removal of microorganisms using various disinfectants in terms of their endurance without causing any physical and mechanical property changes in the impression material (Muzaffar et al.,2015).A change in the characteristics can significantly affect the success of the final prosthesis inserted in the oral cavity. This has been the most crucial cause for dental personnel's negligence in disinfecting impressions to avoid losing information.

Background: The immersion and spraying approach with various disinfection solutions was tried and confirmed to be efficient for impression disinfection before being sent to dental lab (Samra, R. K., & Bhide, S. V. 2018).However, the most reliable method is immersion as the immersion approach ensures that the disinfecting solution reaches the whole surface of the impression material and tray (Chidambaranathan,A.S.M.,2017).Sodium hypochlorites,alcohols,chlorhexidine,hydrogen peroxide, and glutaraldehyde are some of the common chemical disinfectants utilized (Stoeva et al,.2019).

Problem statement: because no single disinfectant could be recognized to be a universal disinfectant for all impression materials, it is critical to select an ideal disinfectant agent with superior antimicrobial activity that does not disturb the Features captured by the impression, like the wettability (Rweyendela et al,. 2009).

Chemical cleaning involves immersing in solutions with antibacterial, antifungal, and solvent characteristics. These solutions can be used alone or in conjunction with mechanic or ultrasonic cleaners (Noori et al., 2013.)A proper disinfectant should fulfil two purposes: first, it must be effective antibacterial agent and second should have no negative impact on dimensional correctness of the impression and the resulting gypsum cast. The latter is important in the effort to offer a functioning and a well fitting completed product. Disagreement exists in literature regarding whether disinfecting technique causes deterioration or distortion of perceptions (Hardan et al., 2022).

An important consideration in disinfecting impression material is the effects of disinfectant on the properties of impression material, particularly impression-like addition silicone, where the exact fit of the dental prosthesis significantly influences the outcome of prosthodontics work, which is dependent on the accurate recording of fine intraoral details. As a result, the major requirement for many dental and maxillofacial rehabilitation treatments is to have an accurate negative copy of the appropriate site that is not damaged by disinfection (Hussian, A. M. & Jassim, and R. K. 2015).

Among the various methods of sterilization and disinfection, chemical disinfection is the ideal choice for disinfecting dental impressions, because impressions can’t be disinfected by using heat (Jasim et al., 2022)

Immersion in 2% glutaraldehyde for 10 minutes may be useful for disinfecting elastomeric dental impressions, as suggested by the (ADA) American Dental Association (American Dental Association.1996,AlZain,S,.2019).Glutaraldehyde (GA) is an odorless liquid with an overpowering odor. It has some drawbacks in clinical practice that are harmful to dental practitioners such as it causes the lipid surfactant layer to disintegrate and can cause substantial damage to the airway epithelium, capillaries in the pulmonary system, and alveolar septum. Other drawbacks of GA are Atelectasis, interstitial inflammation, and the emergence of the hyaline membrane are other pathogenic indicators (Saboo et al., 2023).

Natural or herbal derivatives have long been used in dentistry and medicine, and because of their antibacterial activity, biocompatibility, lack of germ resistance, anti-oxidant, anti-inflammatory, easy availability, and affordable qualities, they are becoming even more well liked (Al-Badr et al., 2017) Tea tree oil (TTO) is generated from Melaleuca alternifolia, a native Australian plant (Figure-1), whose leaves could be steam-distilled to yield TTO.TTO composed of a mixture of compounds, primarily alcohols of monoterpene and sesquiterpene hydrocarbons. Originally used as a disinfectant and herbal medicine by Australian aboriginals, the medicinal properties of this oil were documented in the 1920s. Since then, several studies have documented its broad-spectrum antimicrobial activity and it is now utilized as an effective ingredient in a variety of oral hygiene and dermatological products (Brun et al., 2019).

Extracts possess advantages over produced products because of their non-toxic nature and antimicrobial tolerance (Yahya Khalid et al., 2024).

Tea tree oil possesses antiseptic, antibacterial, anti-inflammatory, and antifungal qualities, especially those that were anti-Candida it has also been proposed as an anti-tumor agent, it also may inhibit in vitro human melanoma cell growth by inducing programmed cell death dependent on caspase (Saboo et al., 2023).

The disinfection solution may change the impression materials' properties(Taha et al., 2025).Research has shown that green tea extracts have antibacterial characteristics, specifically targeting many types of oral bacteria, including both gram positive and gram negative strains such as E. coli, Salmonella spp., Staphylococcus aureus, and Enterococcus spp (Salman et al., 2025).Research is now being conducted to explore the potential therapeutic use of essential oils (Al-Khafagi, K. S., & Mahmood, W. S.,2024).

Aims of the study: The main purpose of this research was to evaluate the effect of immersion of additional silicon impression material in tea tree oil and 2%glutrladehyde for 10 minutes on wettability of additional silicone impression materials.

Figure (1): Tea tree oil shrub (Melaleuca alternifolia)

The null hypothesis predicted that the wettability of the additional silicone impression material would not be significantly impacted. Whereas the alternative hypothesis proposed that, the wettability of the additional silicone impression material will be significantly impacted by the immersion of silicon impression material in tea tree oil solutions.

Materials and methods:

Additional silicone impression specimens were prepared. According to the ISO 4823:2015 standard for evaluating elastomeric impression materials.

The test specimens and procedures were prepared at 23 ± 2 ºC and with a relative humidity of 50 ± 10%. The equipment was conditioned at this temperature and humidity for at least 10 hours before testing (American Dental Association., 2004).

The testing solutions, distilled water, 1% TTO, and 2% glutaraldehyde were also in the same condition.

In a moisture-resistant container, the addition silicon impression was conditioned at a temperature of 23 ± 2 ºC.

According to the ADA specification No. 19 standard for evaluating elastomeric impression materials, an equipment was created and 3D printed with the software package 3D max 2022. The equipment is made up of four pieces. The first is a ruled test block that has five v-shaped lines engraved into it. Three vertical lines (A 50 m, B 20 m, and C 75 m) and two horizontal lines (D1 and D2) have a depth of 75 m. The length of the vertical lines between D1 and D2 is 25 mm, which is utilized to calculate the linear dimensional change. The second component is a ring mold that serves as a mold for a dental impression, while the third component is a riser as shown in figure (2) & (3).

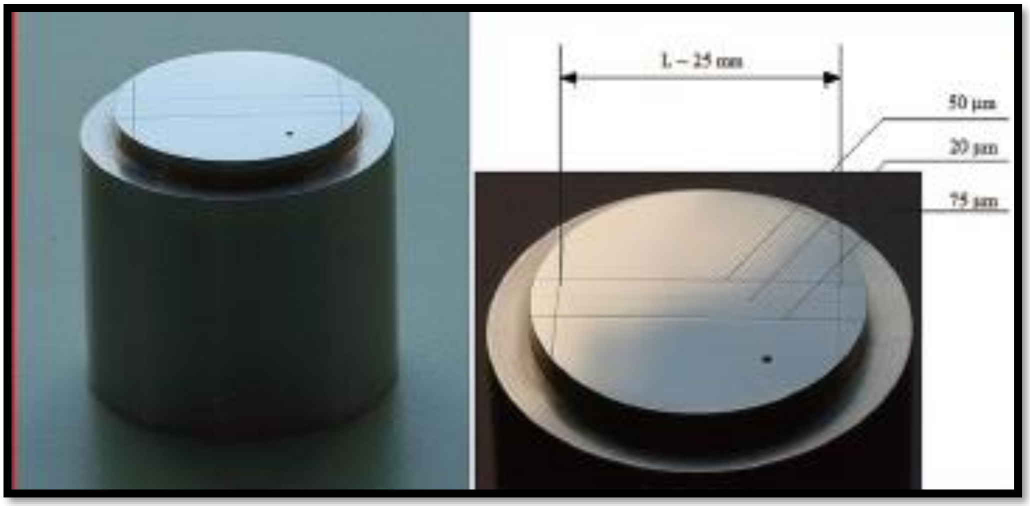

Figure (2) : Testing block

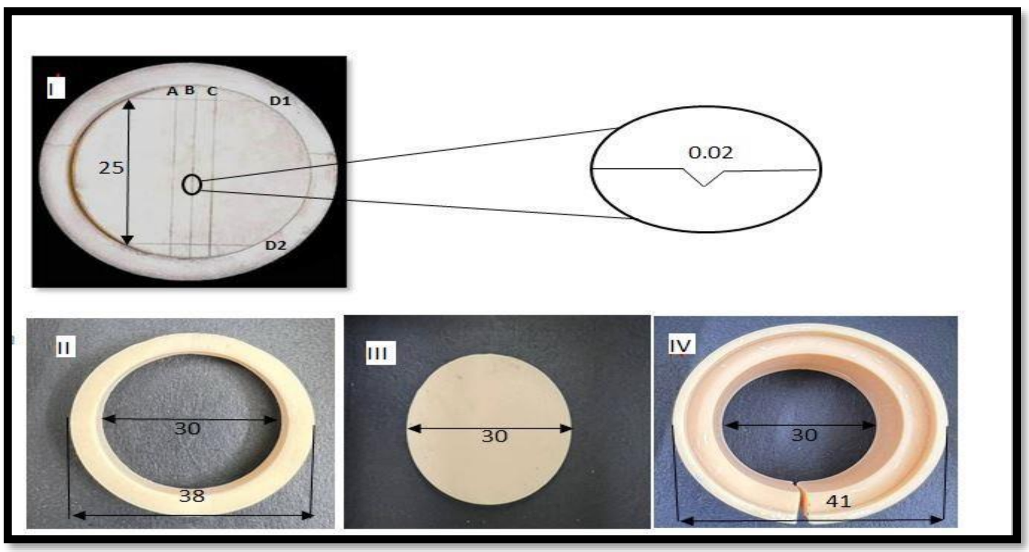

Figure (3): Testing apparatus

Addition silicon impression material (3M, USA) was prepared according to ADA specification No. 19and used as the test impression material. Before impression making, The test block was immersed in a water bath at 35°C for 15 minutes to ensure that the block temperature standardizes to intra-oral temperature as the ADA standards recommend. The ring was cleaned with solvent alcohol (Hema Pharmaceuticals, Tamil, India) and dried after soaking in cotton (Jayamari Enterprises, Tamil, India). The ring was placed on the test block after lubricating with petroleum jelly (Bharat Pharmaceuticals, Tamil, India)(American Dental Association., 2004).

Impressions were made in two steps (putty wash) technique. First, the square sheet of plastic wrap was placed over the impression surface of the test block, and then the impression ring was placed over the test block, mixing addition silicon putty by hand until gets mixture that has no streaks in it. When the putty was thoroughly mixed, it was placed over the impression ring, put the glass slab over it to produce a flat impression surface, and waited until it was completely set (3-5 minute). Then the impression mold with addition silicon putty was removed. And then replace the square sheet of plastic wrap with addition silicon light body mixed with an auto-mixing gun (china)(Al-Khafagi, K. S., & Mahmood, W. S.,2024) as shown in figure(4).

The ring was filled with putty and light body addition silicon impression material to achieve a three mm thickness. A glass slab (Star Labs, Star, India) was placed over the mold.

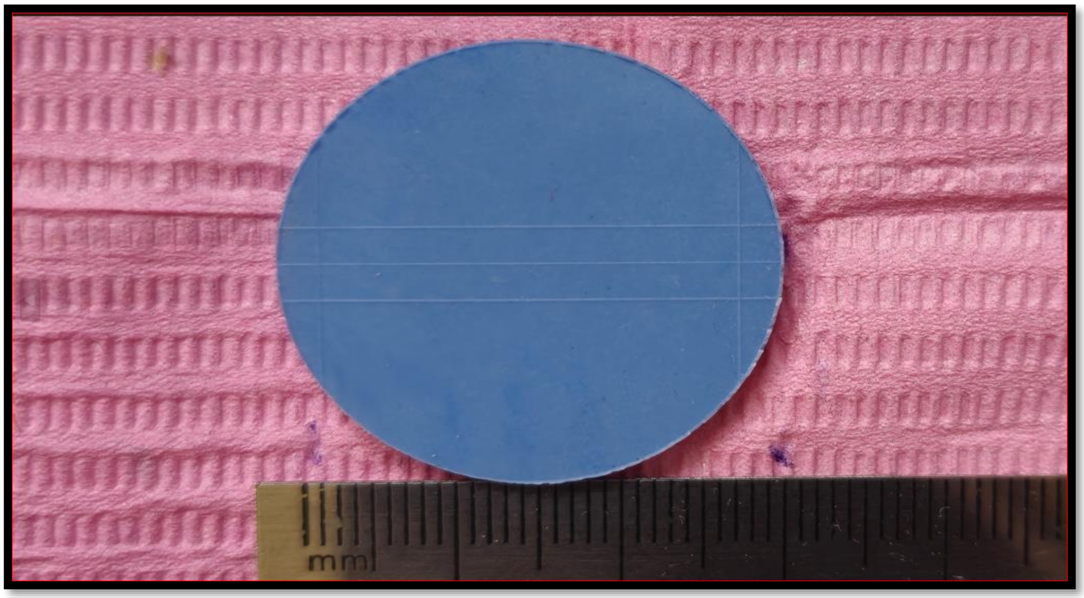

Figure (4) : Addition silicon impression specimen image after transferred from camera to personal computer.

Specimen grouping:

A total number of 60 impression specimens, which divided into six test groups of 20 Specimens each. The testing groups were

Group 1: 20 addition silicon specimens were immersed for 10 minutes in 1% TTO

Group 2: 20 addition silicon specimens were immersed for 10 minutes in distilled water (Negative control)

Group 3: 20 addition silicon specimens were immersed for 10 minutes in 2% Glutaraldehyde as advised by the ADA (positive control).

Preparation of TTO Solution:

Tea Tree pure Essential Oil (Now Foods, Bloomingdale, IL 60108, USA) as shown in figure(5) TTO solution was prepared by combining it (according to the specimen groups) with 1% Tween 80 as an emulsifier using a magnetic stirrer and distilled water.

Figure (5): organic essential tea tree oil (Melaleuca alternifolia)

TTO solution was prepared in Chemistry Lab, Department of Dentistry,university of karbala. Tea tree oil , Tween 80® and distilled water were used to prepare the solution., 1:1 ratio of tea tree and tween 80 were selected, and 1% tea tree oil was prepared using magnetic stirrer device under 300 round per minute (rpm) (Stuart- Hotplate & Stirrers) at room temperature (28 ±5 ºC). at first tween 80 surfactant is added to the container and then tea tree oil was added and let them sterr for couple of minutes in a 100 ml glass container then distilled water is added drop by drop and till 100ml volume is reached then it is let to be stirred for about 10 minutes . Prepared tea tree oil solution were stored at room temperature (28 ±5 ºC) to get the best condition of tea tree oil for future studies.

The specimens were conditioned in water bath at 35c for 10 minutes to mimic mouth temperature during impression taking and then immersed in the prepared glass containers of each group for 10 minutes and then removed and rinsed by distilled water and stored at room temperature. After 24 hour these specimens were tested for wettability.

Evaluation of wettability:

The contact angles of each surface of the impression specimens were measured using a VINO Contact Angle Goniometer. Prior to taking the measurement the specimens were stored at room temperature, each specimen was set up on the goniometer's movable mechanical stage, a drop of distilled water which has an average size of (0.5-2) ul was used as the wetting liquid on the specimen surface which is located at distance of 3mm from specimens surface as shown in (Figure-6).

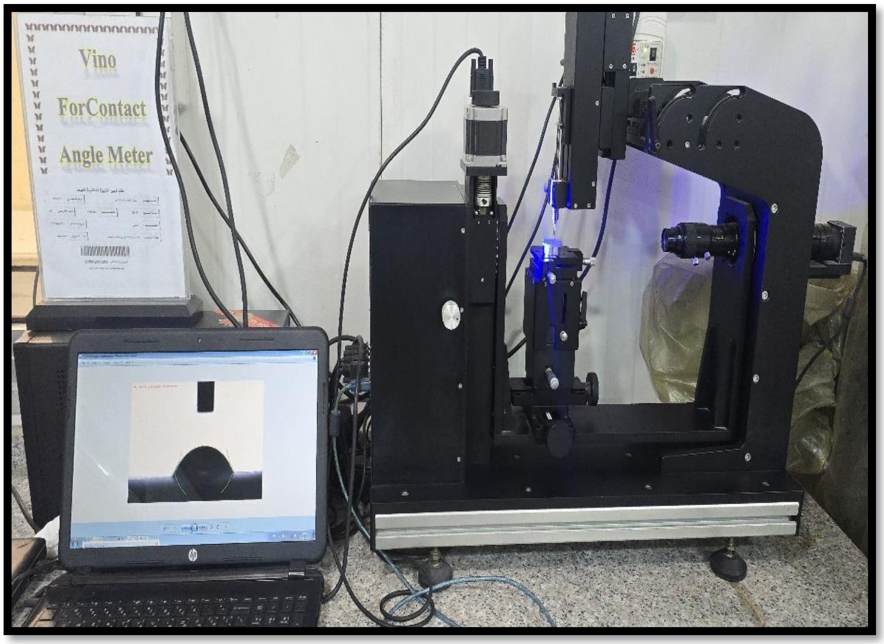

Figure -6: Contact angle (Goniometer) with digital video camera and computer.

A high-definition video camera was part of an optical apparatus used to monitor the spilled water. The contact angle was measured (30) seconds after touching the PVS impression surface. For every drop, two contact angle measurements were made at the drop's right and left ends of the image. The final contact angle reading for each specimen was determined by averaging the two readings (Alsmael, M. A. R.,2018).).A computer software was used to record contact angle measurements at five distinct locations for each specimen. The mean was then computed, as illustrated in (Figure -7 and 8).

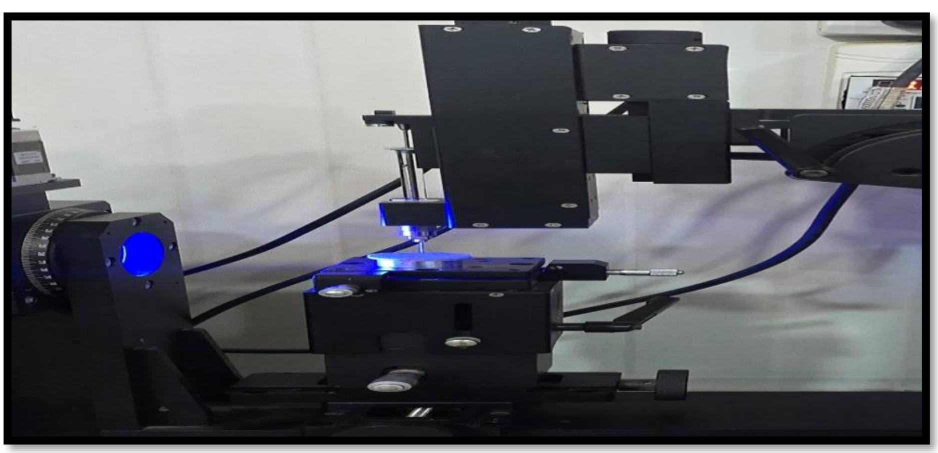

Figure -7: Addition silicone specimen placed on the adjustable stage then a drop of distilled water injected by the instilled syringe.

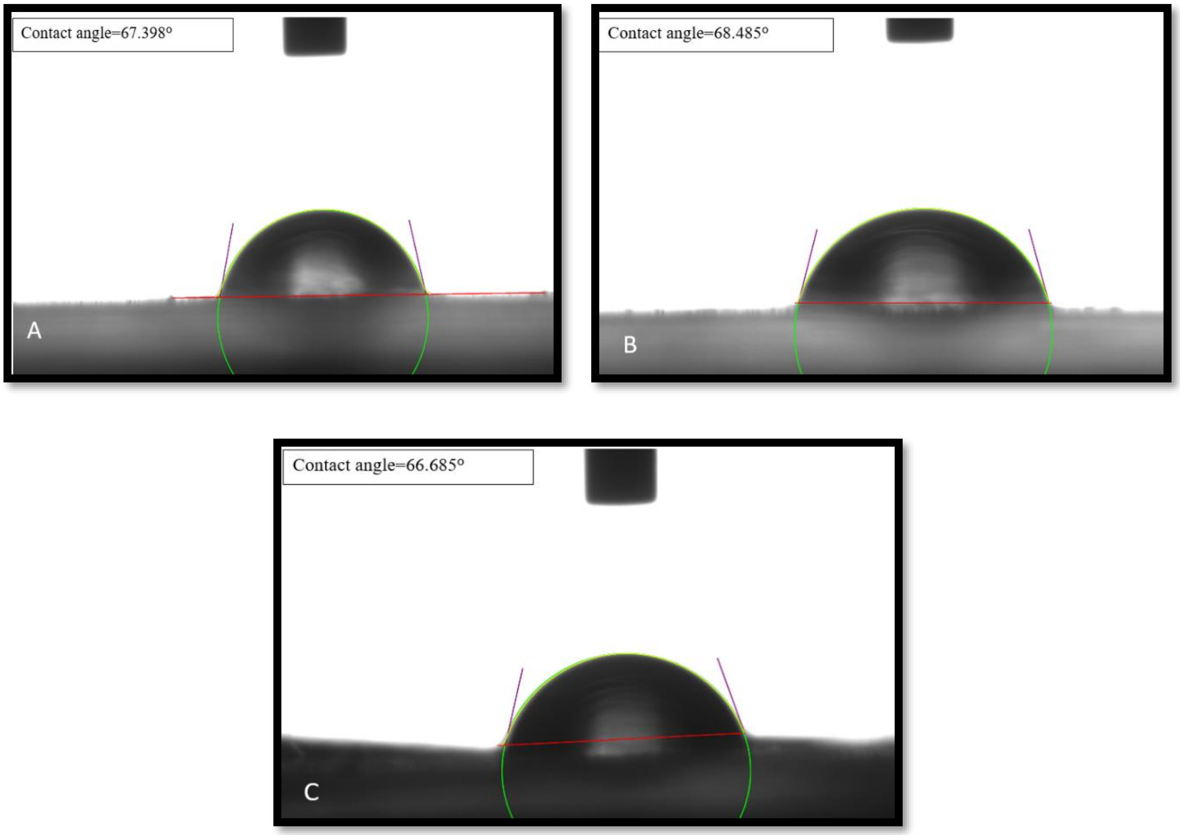

Figure -8: Measurements of contact angles. A: 1% TTO specimen B: 2% GA group specimen, and C: control (DW) group specimen.

Statistical analysis:

The mean contact angle values for the control group GA group, and TTO group are displayed in (Table -1) and (Figure -9). According to (Table -2), the ANOVA test showed that there was a non-significant difference in between the three groups at ($p > 0.05$).

Table -1: Descriptive statistics of wettability (°) for all test groups.

Groupings	Number of specimens	Min.	Max.	Mean	SD	SE
Control	10	63.05	67.60	65.39	1.628	0.5148
GA	10	60.88	68.37	65.01	2.242	0.8434
TTO	10	61.89	68.96	65.11	2.667	0.7091

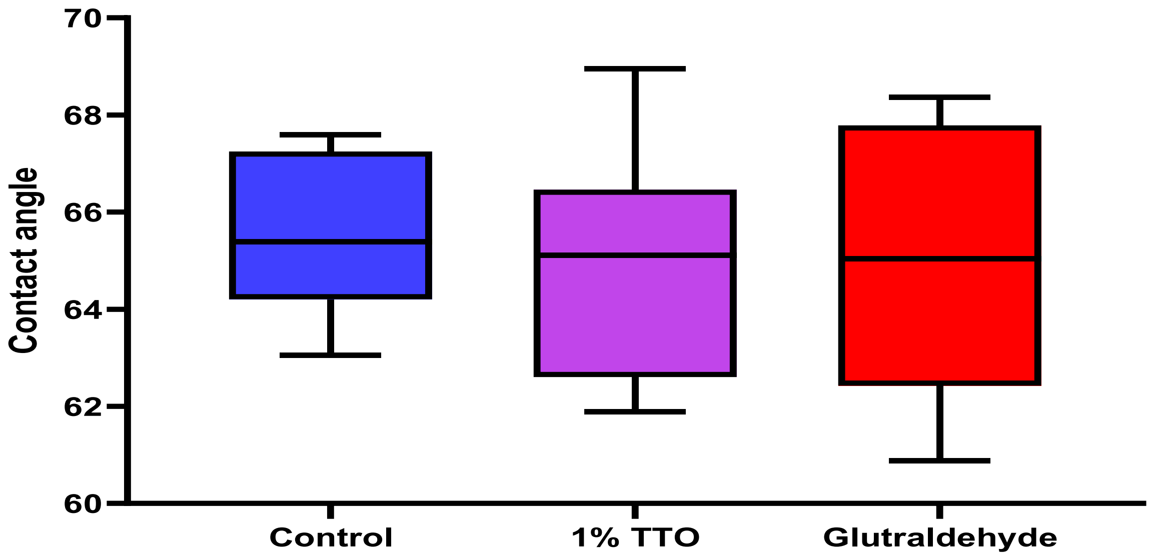

Figure-8: Boxplot chart of wettability (°) test all test groups.

Table -2: Comparing wettability among different test groups using one way ANOVA.

ANOVA table	Sum square	df	Mean square	F	P value
Between groupings	2.648	2	1.324	0.2685	0.7665
Within groupings	133.1	27	4.931		
Total	135.8	29			

Results:

Immersion of addition silicon impression material in different concentrations of tea tree oil for 10 min showed non-significant change in wettability in comparison to control group.

Discussion:

Wettability is defined, as the ability of a particular liquid to moisten a surface and its propensity to spread across it. The viscosity of the liquid, surface imperfections and contaminants all affect a surface's wettability (Yuan, Y., & Lee, T. R. 2013). Since hydrophobic aliphatic hydrocarbon groups surround the siloxane bond, the chemical structure of VPS materials explains their known inherent hydrophobicity. In order to create hydrophilic or even ultra-hydrophilic impression materials, a surfactant is added to addition silicone materials (Luo, F et al., 2018).

How long the impression left in disinfectant, and the type of disinfectant used are important factors in preserving the physical characteristics of the impression material. The impact of impression disinfection on wettability of the impression material is also very important because wettability has a direct impact on the size and quantity of air bubbles that can form in stone models created from impressions (Ozmen, M. F., 2020).

The disinfection process may also change the chemical composition and surface characteristics of the material by absorbing or diluting the impression material's surfactant by long-term immersion disinfection (Ozdogan et al., 2020) .Hence Ten minutes, immersion time in TTO did not affect addition silicone impression wettability. A surface's ability to be wetted by a particular liquid is determined by the increasing contact angle. Air will be more likely to gather on the surface at higher contact angles, which could result in stumps or voids in the impression (Chandrakala et al., 2019).

This study determined that 10 minutes immersion of addition silicone in impression specimens 1% TTO did not affect the wettability of the impression specimens. The fact that addition silicone impression retained its wettability even after immersion in TTO this indicates that its surface energy and hydrophilic character were not altered by short-term exposure to TTO.

This outcome agrees with research by Kotha et al. who examined the effects of autoclaving, microwave sterilization, and chemical disinfection on a number of important elastomer properties. None of the disinfection or sterilization methods had a significant impact on wettability (Kotha et al., 2017).

The results of wettability test in this study showed a non-significant difference between all the test groups, so the null hypothesis was accepted.

Conclusion:

With in the parametrers of this study it was shown that Additional silicone impression material can be safely disinfected by immersion in TTO for ten minutes without affecting the wettability of the impression.

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Conflicts of Interest Statement………………………………………………

Assessment of the wettability of addition silicone
Impression material following short term immersion in tea tree oil
solution

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Author names:

1.samir samier hammed
2.aseel mohammed alkafagi
Department of prosthodontics, College of Dentistry, University of Baghdad, Baghdad, Iraq

The authors whose names are listed immediately below report the following details of affiliation or involvement in an organization or entity with a financial or non-financial interest in the subject matter or materials discussed in this manuscript. Please specify the nature of the conflict on a separate sheet of paper if the space below is inadequate.

Author names:

This statement is signed by all the authors to indicate agreement that the above information is true and correct (a photocopy of this form may be used if there are more than 10 authors):

1.samir samier hammed
2.aseel mohammed alkafagi
Department of prosthodontics, College of Dentistry, University of Baghdad, Baghdad, Iraq

Author's name (typed)

Samir Samier hammed
Author's signature

aseel mohammed alkafagi

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