

An Assessment of The Impact Of L.Salvadora Persica and G.Tea on the Surface Roughness and Hardness of Heat-Cured Acrylic-Based Denture Soft Liners

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Received: 3 May 2023; Accepted: 20 June 2023; Published: 28 June 2023

Abstract

Aim of the study: Soft denture liners are a type of dental prosthesis that functions as a cushioning material, alleviating the stress induced by the act of chewing. They offer relief to persons who encounter discomfort when wearing complete or partial dentures, particularly when these dentures are situated on rigid surfaces that support the denture. The objective of this study is to assess the effects of including L.Salvadora persica. and green tea (G.Tea) extract powders on the surface roughness and hardness characteristics of acrylic-based soft liners.

Material and method: 30 specimens were constructed using wax molds and acrylic-based heat-cured denture soft lining material. The standard curing procedure was used. The samples were separated into three equal groups: group A, the control group, with no additives in the soft-liner material; group B, with 5.12% weight percent L.salvadora persica extract powder; and group C, with 5.12% weight present green tea (G.Tea) extract powder. The samples were then prepared for surface hardness and roughness testing.

Results: The results revealed that there was a non-significant rise in the mean values of surface roughness for both group B and group C, group B having the highest mean values followed by group C. When compared to the control group, the results showed a considerable rise in the mean values of surface hardness in group (B), which had the highest mean value for surface hardness, followed by group (C).

Conclusion: The results of this study indicate that the incorporation of L.salvadora persica at a concentration of 1.024g and green tea (G.Tea) extract powders at a concentration of 1.024g shown a positive impact on the surface hardness of denture soft lining materials. However, no significant influence was observed on the surface roughness of these materials.

Keywords: heat-cured denture soft liner,L.Salvadora persica, G.Tea ,surface hardness, surface roughness.

Introduction

Since 1869, Twichell has utilized natural rubbers in order to develop the initial soft lining material inside the realm of dental applications ([Alaa'a, 2013](#)). Subsequently, a discernible progression in dental materials has occurred, resulting in the emergence of diverse soft lining material categories, each with distinct merits and drawbacks ([Haywood et al., 2003](#)). The presence of chronic stressors can give rise to pathological alterations in oral tissues, ultimately leading to a diminished ability of dentures to properly adapt and function([Chen et al., 2015](#)). Soft

denture liners are commonly applied on the hard surface of dentures to alleviate discomfort experienced by patients wearing partial or complete dentures. These liners serve as cushions that absorb the forces generated during chewing, reducing the potentially harmful effects of occlusal force. By distributing the load evenly, they enhance the overall comfort of denture wearers ([Demir et al., 2017](#)). Green tea is widely recognized as one of the most prevalent and popular beverages globally.The plant is widely recognized for its several advantageous effects on human health due to



its diverse array of biologically active constituents. Green tea is derived from the fresh leaves of the *Camellia sinensis* (L.) kuntze plant. The extraction process involves steaming and heat drying the leaves ([Bancirova, 2010](#)). The utilization of *L.Salvadora persica*, also known as chewing sticks, has been a longstanding practice among those residing in rural regions. This traditional method of oral hygiene, especially prevalent among the younger population, continues to be more commonly employed than commercially available toothpastes and toothbrushes. The primary purpose of these chewing sticks is to promote dental health by maintaining a visually pleasing white appearance of the teeth ([Goyal et al., 2011](#)). The antibacterial efficacy of an aqueous extract derived from *L.Salvadora persica* has been observed against many oral bacteria, including *S. mutans*, *S. mitis*, and *S. aureus* ([Löe, 2000](#)). This study aimed to examine the impact of green tea and *L.Salvadora persica* on the surface roughness and hardness of heat-cured acrylic base soft liners.

Materials and methods

A. Extraction of green tea (G.Tea)

G.Tea in 100 g for the maceration process, dried leaves was dissolved in 1000 ml of deionized distilled water. One gram of the plant was mixed with 10ml of solvent, and the combination was left to stand at room temperature for three days. After removing large plant particles from the G.Tea aqueous extract using filter paper, the extract was centrifuged for 15 minutes at 10,000 rpm. The dried extracts were then baked for three hours at 40°C to produce a powdered green

tea extract. To be employed in the experiment later, the produced powder has been kept at room temperature in a dry, clean glass container ([Aboud et al., 2018](#)).

B. Extraction of *L.Salvadora persica*

The root sticks of *L.Salvadora persica* depicted in figure (1) were trimmed to a length of 1 cm using sharp scissors. Subsequently, these trimmed sections were ground into fine particles using an electrical grinder set to speed 5 for duration of 10 minutes. The extraction method involved the grinding of the plant raw material into small particles in order to increase the contact surface area between the material and the solvent, thereby accelerating the extraction rate ([Ezoddini-Ardakani, 2010](#)).

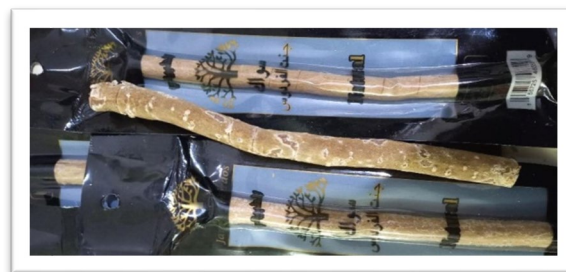


Figure 1: *L.Salvadora persica* root sticks that were used for the study.

Then, 100 g of *L.Salvadora persica* powder were placed into 1000 mL of deionized distilled water for the maceration process; the mixing ratio was 1 g plant / 10 mL solvent. Then, the *L.Salvadora persica* aqueous extracts were filtered with filter paper to

exclude coarse plant particles and centrifuged at 10000 rpm for 15 minutes. The extract was dried in an oven at 40°C for 3 hours to get a dry *L.Salvadora persica* powder, which is shown in figure (2). The *L.Salvadora persica* extract powder was stored in a glass container at room temperature to be used for the experiment method. ([Aboud et al., 2018](#)).



Figure 2: G.Tea and *L.Salvadora persica* centrifuged extracts in the oven.

Grouping of specimen

30 specimens were used for the study, they were divided into 3 groups each group includes 10 specimens.

1. Group A: control group that has no additives.
2. Group B: 5.12% of *L.Salvadora persica* to the heat cure acrylic soft liner.
3. Group C: 5.12% of G.Tea to the heat cure acrylic soft liner.

Wax pattern preparation

Metal patterns that have the following dimensions: 3mm thick and 3cm in diameter ([Hummudi, 2017](#)). In order to create wax pattern molds, metal disks were imprinted with silicone impression material (see figure 3). The molten wax from the base plate was

then loaded into the silicone impression procedure-produced mold. Once the molten wax has entirely solidified, it is removed with care from the mold in order to extract 30 disks containing wax patterns. Following this, we utilized a digital micrometer to verify the dimensions of every wax pattern disk in preparation for the flasking procedure.



Figure 3: Silicone mold for the wax pattern fabrication.

Flasking procedure of the wax pattern

The specimens were subjected to a normal flasking procedure in order to facilitate the whole denture preparation. The dental flask was filled with a layer of dental plaster, prepared in accordance with the manufacturer's guidelines (water-to-plaster ratio: 50 mL/100 g). This was followed by another layer of dental stone, also prepared according to the manufacturer's instructions (water-to-stone ratio: 25 mL/100 g). Subsequently, the wax patterns were partially immersed in dental stone, reaching half of the thickness of the wax patterns, as depicted in figure 4.



Figure 4: wax pattern for the stone mold.

Once the initial layer of dental stone has been poured into the flask, a separating medium is applied before placing the other half of the flask. Another layer of dental stone is then poured, followed by dental plaster. The flasks are subsequently covered with their respective covers. The flask is secured in a clamp and allowed to set for one hour.

2.6 Wax elimination of the wax pattern:

After the material was set, the clamp was put into boiling water (100°C) for to eliminate the wax for 10 minutes then it was opened and washed with hot water and detergent to remove all the remaining of wax.

2.7 Specimens Preparation

1-Mixing of heat cure acrylic soft liner (Control group A):

Soft liners made of heat-cured acrylic are available in both powder and liquid form. The mixture ratio of volume to weight was maintained at 1 mL liquid to 1.7g powder, as specified by the manufacturer. A volume of 12 mL of liquid was combined with 20g of

powder to form the control group's 10 specimens, which were then covered and allowed to rise to the dough stage as table 1.

2-Mixing of heat cure acrylic soft liner (Group B):

Addition of L. Salvadoria Persica

1.024g of L.Salvadora persica extract powder was accomplished with an electronic balance. After combining the particles with 12 ml of monomer liquid in a clean, dry glass container using the magnetic stirring device depicted in Figure 5 for three minutes, the particles were reduced in size and dispersed throughout the monomer liquid ([Halasz et al., 2007](#)). Following thorough mixing with 18.976g of soft lining material powder as table 1, the mixture was allowed to reach the dough stage before being packed into the mold. After applying a separating medium to both halves, the upper and lower halves of the flask were brought into intimate contact. The flask was then clamped, pressed, and cured in accordance with the manufacturer's instructions. Once the flasks had completely cooled, they were opened to reveal the 10 specimens that were prepared for the testing procedures.



Figure 5: Magnetic stirrer.

3-Mixing of heat cure acrylic soft liner (Group C):

Addition of green tea (G.Tea)

Additionally, 12 ml of monomer liquid was mixed with 1.024g of G.Tea. Extract powder using a magnetic stirring device for three

minutes. After thoroughly combining the mixture with 18.976g of soft lining material powder as table 1, we proceeded with the addition of green tea as opposed to *L.Salvadora persica*, as previously described. The thirty specimens were illustrated in figure 6.



Figure 6: The three testing groups of soft liner specimens.

Table 1: Proportion of the heat cure acrylic soft liner used in the study

Groups	Amount of <i>Salvadora persica</i> L (g)	Amount of green tea (g)	Amount of acrylic powder (g)	Amount of monomer (ml)
Group (A)	0	0	20	12
Group (B) 5.12% <i>Salvadora persica</i> L	1.024	0	18.976	12
Group (C) 5.12% green tea	0	1.024	18.976	12

2.8 Packing and Curing Procedure:

Separating medium was applied on both halves of the flask then kept for drying. After the soft liner reached dough stage it has been packed in a mold then the flask was closed and pressed until the halves were in intimate contact and the excessive material was out.

The clamped flask was placed in boiling water 100°C for 20 minutes (Issa and Abdul-Fattah, 2015).According to manufacturer instructions of the soft liner. Then it was left to completely cool down before opening.

Test

3. 1. Surface Hardness Test

Soft liner hardness was determined for each of the three groups (control, *Salvadora persica*, and green tea) using Shore A durometer devices. The testing value was

calculated by averaging multiple readings obtained directly from the durometer's scale using the pointed dibbing instrument, as illustrated in figure (7).

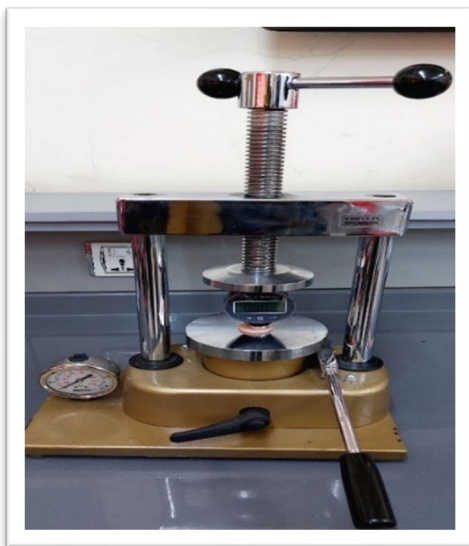


Figure 7: Soft liner specimen under Shore (A) surface hardness test

3.2. Surface roughness Test

The surface roughness of each specimen in the three groups was assessed using the TR220 surface roughness tester instrument.

The surface roughness was quantified using the Ra value, which represents the average depressions and peaks on the surface, as depicted in figure 8.



Figure 8: Soft liner specimen under surface roughness test

4. Results.

Table 2 and Figure 9 present descriptive

statistics for the surface roughness test, including the mean, standard deviation,

minimum, and maximum values. According to the findings, group B exhibited the highest mean value (3.0611+0.8671), followed by

group C (2.5957+0.71038). In contrast, the control group had the lowest mean value of (2.472 + 0.9527).

Table 2: Descriptive surface roughness statistics for every tested group.

Study Groups	Mean	Std. Deviation	N	Maxi	Mini
(A) Control group	2.4725	.95277	10	4.495	1.098
(B) <i>Salvadora persica</i>	3.0611	.86771	10	4.169	1.541
(C) Green tea	2.5957	.71038	10	3.418	1.302
Total	2.7098	.85934	30		

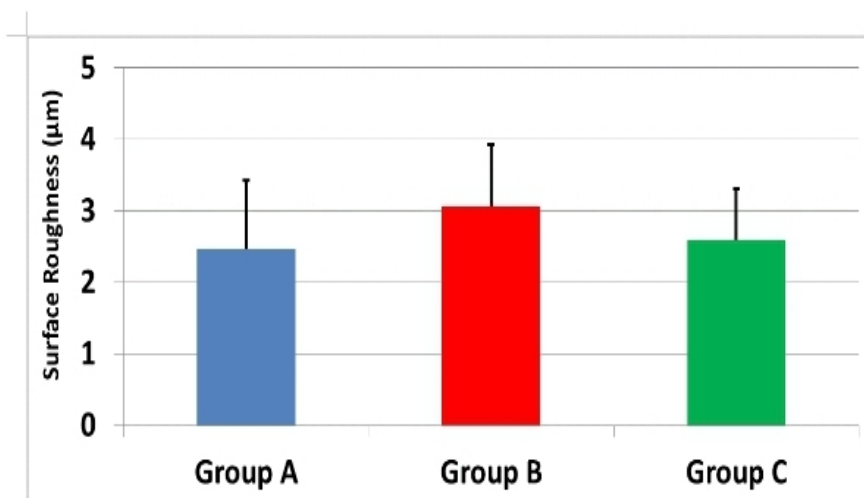


Figure 9: Mean distribution of surface roughness among control, group B and group C

The means of detection that differ significantly between groups were identified using ANOVA-Tukey HSD-Surface Roughness or Tukey's honest significance test, a single-step multiple comparison

procedure, and a statistical test. According to table 3, the ANOVA test between the groups under investigation revealed no significant difference ($p < 0.05$).

Table 3: ANOVA- Tukey HSD-Surface Roughness test for all tested

(J) Study Groups	Sig.	95% Confidence Interval

(I) Study Groups		Mean Difference (I-J)	P-Value		Lower Bound	Upper Bound
A	B	-.5886	.285	NS	-1.5306	.3534
	C	-.1232	.944	NS	-1.0652	.8188
B	C	.4654	.449	NS	-.4766	1.4074

The surface hardness test's descriptive statistics, including the mean, standard deviation, minimum, and maximum values, are presented in Table 3 and Figure 10. The findings indicate that (group B) had the

highest mean value (30.5000±06.74537), followed by (group C) with (4.54148±27.2500). Conversely, the control group had the lowest mean value (19.9500±2.26630), as presented in Table 4.

Table 4: Descriptive Statistics for Surface Hardness for all tested groups

Study Groups	Mean	Std. Deviation	N	Maxi	Mini
(A) Control group	19.9500	2.26630	10	25	18
(B) <i>Salvadora persica</i>	30.5000	6.74537	10	43	25
(C) Green tea	27.2500	4.54148	10	35	22.5
Total	25.9000	6.49987	30		

LSD-ANOVA-Surface Hardness

A level of significance of 0.05 was applied to the least significant difference (LSD) test in order to compare the means of the two groups. The results of the test indicated that

there was a significant mean difference ($p < 0.05$) between group A (control) and group B (*L.Salvadora persica*); similarly, there was no significant mean difference ($p > 0.05$) between group B and group C (Green Tea), as presented in table 5.

Table 5: ANOVA (LSD). Test of surface hardness for all tested group

(I) Study Groups	(J) Study Groups	Mean Difference (I-J)	P-Value	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	-10.5500*	.000	S	-15.0222	-6.0778
	C	-7.3000*	.002	S	-11.7722	-2.8278
B	C	3.2500	.148	NS	-1.2222	7.7222

*. The mean difference is significant at the 0.05 level.

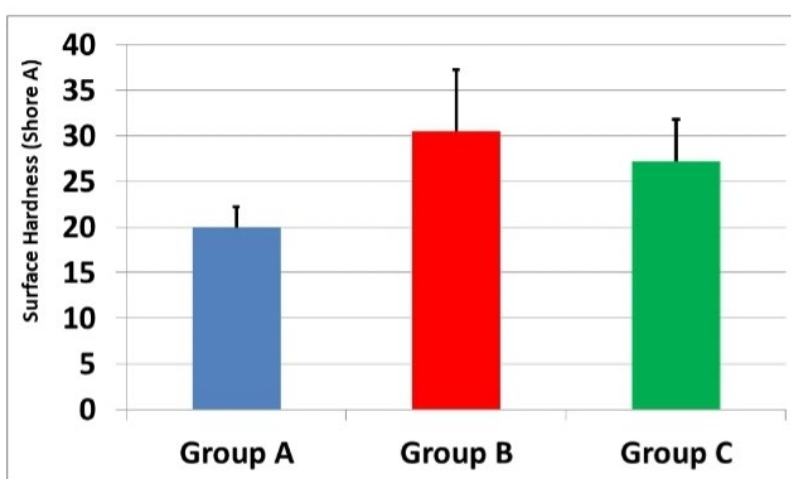


Figure 10: Mean distribution of surface hardness among control, group B and group C.

5. Discussion

Relining a patient's denture is a critical step in the treatment of denture stomatitis. Antifungal agents must be used to control infections within the patient's mouth if the denture is contaminated with bacteria and fungi or if the injury occurred after maxillofacial surgeries (immediate or definitive obturators). This study investigated the effects of including G.Tea and L.Salvadora persica on the surface hardness and roughness of soft lining materials. A comparative analysis was conducted to assess the impact of these additives. The selection of G.Tea and L.Salvadora persica for this

investigation was based on their recognized antibacterial properties and biocompatibility, as well as their documented medical and dental health benefits as reported in many studies. The technique of maceration was chosen as a suitable method for the extraction of G.Tea and L.Salvadora persica raw material plants. The primary principle underlying maceration involves the extraction of soluble plant constituents from a hard plant matrix by immersing it in an appropriate solvent at ambient temperature (Seidel, 2012). A study was conducted by Yoda et al. (Yoda et al., 2004). Study has provided evidence that higher doses of green tea extracts have the ability to impede the

growth of *Streptococcus pyogenes* and *Staphylococcus aureus*. The evaluation of hardness in complete denture liners is a multifaceted consideration, given that most soft liner materials demonstrate instability when subjected to moisture, such as the conditions present in the oral cavity. In this study, the measurement of surface hardness was performed using the Shore A durometer, and the collected data were subjected to analysis. The introduction of *G. Tea* and *L. Salvadora persica* extracts resulted in a significant augmentation of surface hardness across all experimental groups in comparison to the control groups. The observed improvement in surface hardness following the incorporation of *G. Tea* extract can be attributed to the presence of polyphenols, specifically catechins, within the extract. These polyphenols undergo degradation under conditions of elevated temperature and pH, which may impact the plasticizing ability of the extract to permeate the polymeric chains. Consequently, this affects the formation of a soft gel and can serve as a filler, thereby increasing the hardness of the soft liner material and enhancing its resistance when distributed within it. This discovery is in line with the findings reported by Zeng et al (Zeng et al., 2017). Additionally, the results demonstrated a substantial increase in surface hardness subsequent to the integration of *L. Salvadora persica*. As the mechanism of hardness is associated with the orderly three-dimensional arrangement and structure of elements at the atomic level, the microstructure of a substance is regarded as the most significant factor influencing hardness. The elevated hardness observed in *L. Salvadora persica* in comparison to other

groups may be primarily attributed to the docking of molecules and the strong interaction and binding between the molecules of certain chemical components and the flexible liner (Halawany, 2012). The results of this study contradicted the conclusions of previous research conducted by Godil, which stated that the incorporation of *Ocimum sanctum* oil into soft denture liners did not affect the hardness of the softlining material (Godil et al., 2021).

The assessment of surface roughness was conducted by measuring the Ra value, which quantifies the average height of surface irregularities. This parameter allows for the evaluation of the potential for bacterial colonization in the given area. The selection of this measure was based on its prevalence in existing literature, hence facilitating comparisons with the findings of the present study. The findings the study observed a lack of statistically significant increase in surface roughness for both the *L. Salvadora persica* and *G. Tea* groups. The observed change in surface roughness following the addition of *L. Salvadora persica* and *G. Tea* may be attributed to a combination of chemical reactions and mechanical actions between the soft liner and the chemical components of *L. Salvadora persica* and *G. Tea*. These interactions may result in the generation of bubbles caused by the release of oxygen, potentially leading to an increase in the

surface roughness of the material. This observation aligns with the outcomes reported by Nikawa et al and Jin et al (Nikawa et al., 2003, Jin et al., 2003). The study discussed changes in the surface roughness of soft lining materials following immersion in effervescent alkaline solutions. It concluded that not only the active component but also other constituents of the cleansing chemical agent, as well as the pH level, can potentially induce material damage and alter surface roughness. Moreover, researchers have discovered that the combination of G.Tea and extracts from *L.Salvadora persica* possesses certain components that have the ability to improve the overall condition of oral health. These compositions exhibit enhanced biological and synergistic activity, particularly when they are combined (Bansal et al., 2013).

Conclusion: The control group possesses Surface roughness and surface hardness has the lowest mean values. The addition of *L.Salvadora persica* extract powder at a concentration of 1.024g resulted in the highest mean values for surface roughness and surface hardness compared to all other groups. This incorporation led to a statistically insignificant increase in surface

roughness and a statistically significant increase in the surface hardness of the denture soft lining material. The addition of a small amount 1.024g of G.Tea extract powder led to a statistically insignificant rise in surface roughness, but there was a statistically significant increase in the surface hardness of the denture soft lining material.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Funding

This research received no external funding.

Data Availability Statement

Data are available from the authors upon reasonable request.

Acknowledgments

The authors would like to thank College of Health and Medical Technologies, Middle Technical University, Baghdad, Iraq.

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