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RESEARCH ARTICLE

EFFECT OF GLAZE COATINGS ON SURFACE ROUGHNESS OF ACRYLIC RESIN, RESILIENT LINER AND TISSUE CONDITIONER: A COMPARATIVE *IN VITRO* STUDY

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ABSTRACT:

Rough surface of denture base resins and soft liner promote adhesion of microorganisms and plaque formation, which results in denture stomatitis. It is therefore important to know how different polishing systems and glazes affects surface roughness of denture base acrylic resins and soft liner. The purpose of this study was to evaluate the effect of glazing on the roughness of the dental resins, resilient liner and tissue conditioner.

Key words: acrylic, glazing, polishing, roughness, soft liner

INTRODUCTION

Acrylic resin is widely used in dentistry for the fabrication of various dental prostheses that not only rehabilitate masticatory function, esthetics, and phonetics but also exert its effect on the underlying tissue health.[1]

Denture-induced stomatitis, the most common pathologic finding of the oral mucosa in patients wearing dentures, has a very high prevalence and its pathogenesis is of multifactorial nature.[2] Among the etiologic factors, trauma from illfitting dentures and microbial infection are considered the major ones, and it is well established that bacterial

colonization is promoted on the tissue surface of the denture.[3,4,5]The properties of denture base material, in particular, surface roughness and the surface free energy play a key role during this process.[6,7,8]Ideally, a material should possess a smooth, polished surface so that plaque accumulation is minimized or prevented.[1,9]

Studies have suggested a threshold level of surface roughness (Ra = 0.2 mm) below which no further reduction in plaque accumulation occurs.[8,10,11] An increase in roughness of surface beyond this borderline level, however, resulted in a simultaneous increase in plaque accumulation.[11]

Traditionally in a dental laboratory, acrylic resin is finished and polished by mechanical procedures using felt-cones and slurry of fine pumice and water followed by felt-cones with chalk powder and water. Results of several studies have indicated that surface roughness of acrylic resin polished with prophylactic pastes, rubber polishers, abrasive stones, and pumices still exceeds the threshold at Ra of 0.2 μm.[5,9,12]

A denture glaze makes the acrylic resin surface smoother, preserve the surface integrity and softness of resilient liners thereby decreasing accumulation of residual food and plaque adhesion, and providing improved oral hygiene conditions.[12]The use of glaze coating is a viable approach to reduce microbial growth. Since there are less number of studies about denture glaze, the aim of this study is to improve our understanding and knowledge about denture glaze and to evaluate the effect of glaze coatings on surface roughness of acrylic resins, resilient liner and tissue conditioner.

MATERIALS & METHODOLOGY

The materials evaluated in this study are shown in Table 1. These materials are representative of different denture base material.

There were 20 specimens (50mmx25mmx3mm) per each material. Two rectangular patterns (50mmx25mmx3mm) of base plate wax were invested in a metal flask with dental stone to prepare a mould.(Fig.1) Polymerisation of self cure acrylic resin (RR Cold Cure, DPI Co. Ltd, India) and heat cure acrylic resin (Heat Cure, DPI Co. Ltd., India)was done according to the manufacturer's instructions. The upper and lower half of the flask were closed and 2000 lbs of pressure for 30 min was maintained. (Fig.9)The flask was removed from the hydraulic press and bench cured for 150 min. The curing procedure employed by placing the flasks in water bath at 160^{o} F for 9 hr. The processed specimen were retrieved and stored in water at room temperature for 24hr.[39]

For fabricating resilient liner specimen (Molloplast B, Gm& BH and Co.KG), a heat cure base (DPI Co. Ltd., India) was prepared of dimensions 1.5mmx25mmx50mm. Grooves were cut evenly into the base to ensure proper bonding with Molloplast B. Base plate wax of dimensions 1.5mmx25mmx50mm were adapted over the base and flasking was done to guarantee a standardised relining space for all specimens. After dewaxing the halves of the flasks were separated, the wax patterns removed leaving behind denture base. Caution was taken that wax residue must not penetrate or adhere to plaster. Primo

adhesive was applied once on the base and allowed to dry for 60-90 min. Molloplast B was taken with a clean spatula from the jar and applied evenly onto the mould space created. Flasks were closed and placed under hydraulic press for 4 min, excess flash was removed and bench pressed for 15min at 100lbs. The curing was done by placing flask at 212^{o} F for 2 hrs. After polymerisation, the flask was bench cooled and the specimens were retrieved carefully.[44]

For preparation of tissue conditioner specimen, wooden block with internal diameter of 50mmx25mmx3mm was used and lubricated with the separator provided along with the tissue conditioner. The material mixed in a ratio of 1 measure powder (3g) and 1 measure liquid (2ml) for 30 sec, poured in the wooden block and pressed between two glass slab for 10 min. to get a flat surface for testing. (Fig.2)

After deflasking all specimens except resilient liner and tissue conditioner were finished with a tungsten carbide bur at 45,000 rpm and polished using a conventional laboratory polishing method: coarse pumice, water and lathebristlebrush for 90 seconds at a rate of 2800 rpm (Unident India Pvt. Ltd.) and soft leather polishing wheel for 90 seconds at a rate of 6500 rpm (Unident India Pvt. Ltd.).

After polishing the specimens, the half surface of GROUP I specimens were glazed with MONOPOLY and GROUP II specimen were glazed with PALASEAL.[40]

The surface roughness (Ra) values were measured using a profilometer (TESA 10G RUGOSURF) (Fig.3) .Three 0.5 mm scans were performed on each study sample after manually approximating its centre point. (Fig.4) A 2 mm distance separated each reading. Measurements were calculated over the entire length of the scan.

RESULTS

The surface roughness of the acrylic resins, tissue conditioner and soft liner glazed with light cure glaze and cold cure glaze were evaluated using contact profilometer. On each specimen three reading were performed and the mean Ra of these three reading was used for statistical analysis.

Table 2 shows the comparison of surface roughness between Control and Glaze surface of Group I specimens. For cold cure specimen there was a significant difference (p value-0.03) between the mean values of control (0.44) and glaze (0.22). For heat cure specimen there was a significant difference (p value-0.01) with mean values of control (0.32) compared to glaze (0.14). Resilient liner and tissue conditioner also showed same pattern of reduction in surface roughness with significant difference (p value-0.003) between control (2.41 for resilient liner and 4.87 for tissue conditioner) and glaze (1.43 for resilient liner and 2.74 for tissue conditioner). (Graph 1)

Table 3 shows the comparison of surface roughness between Control and Study of Group II specimens. For cold cure specimen there was a significant difference (p value-0.001) between the mean values of control (0.43) and glaze (0.11). For heat cure specimen there was again a significant difference (p value-0.001) with mean values of

control (0.35) compared to glaze (0.07). Resilient liner and tissue conditioner also showed same pattern of reduction in surface roughness with significant difference (p value-0.003) between control (2.54 for resilient liner and 4.98 for tissue conditioner) and glaze (1.12 for resilient liner and 2.30 for tissue conditioner). (Graph 2)

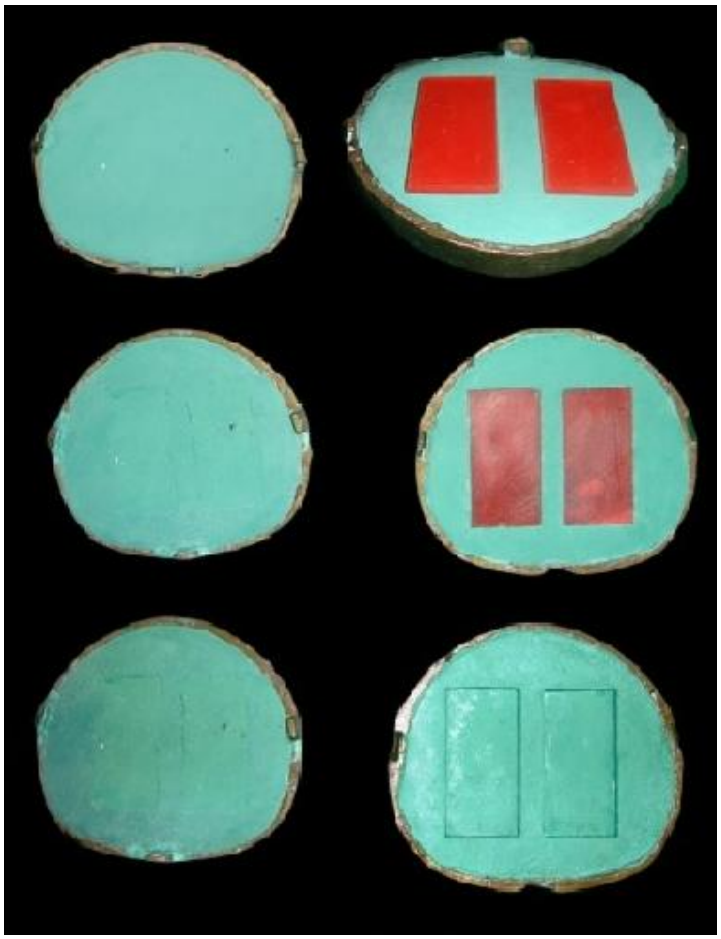


Figure 1 Preparation of Mould

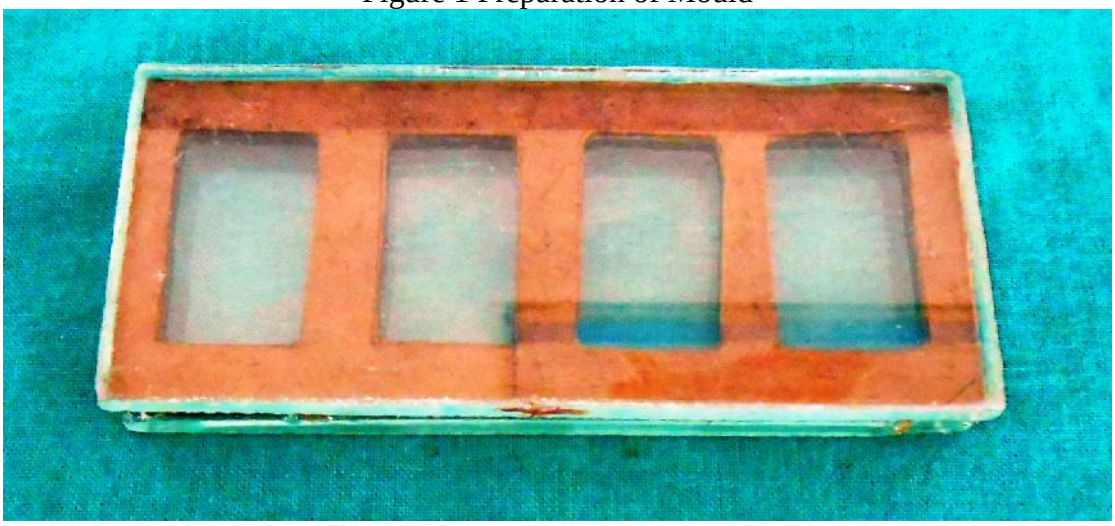


Figure 2 Preparation of Tissue conditioner specimens

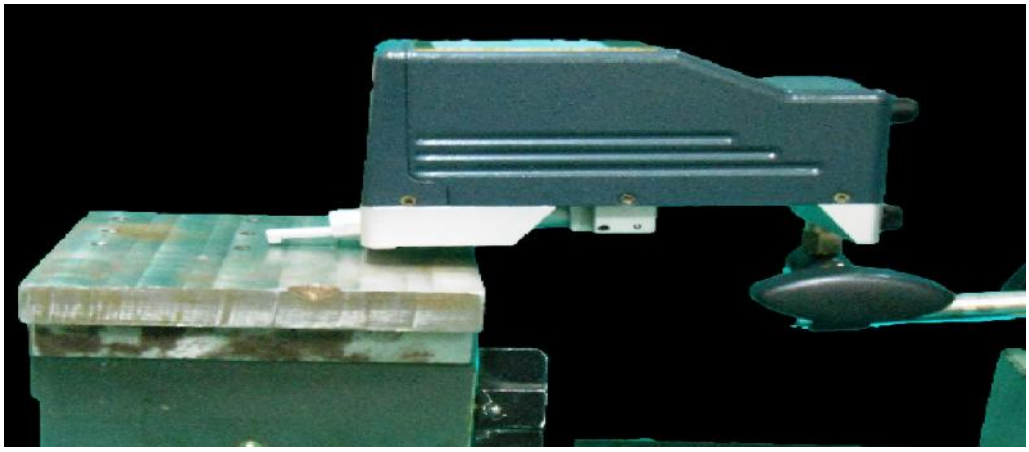


Figure 3 Surface Profilometer

Figure 4 Testing of Specimens

Table 1 Materials

Code	Material	Batch No	Manufacturer
HC	Heat cure resin	7102	(Heat Cure DPI Co. Ltd., India)
CC	Self cure resin	8133	**(**RR Cold Cure DPI Co. Ltd., India)
RL	Resilient heat cure resin	151002	(Molloplast B DetaxGmBH and Co. KG,Germany)
TC	Tissue conditioner	1111001322	(ViscogelDentsply International Inc., NewYork, USA)

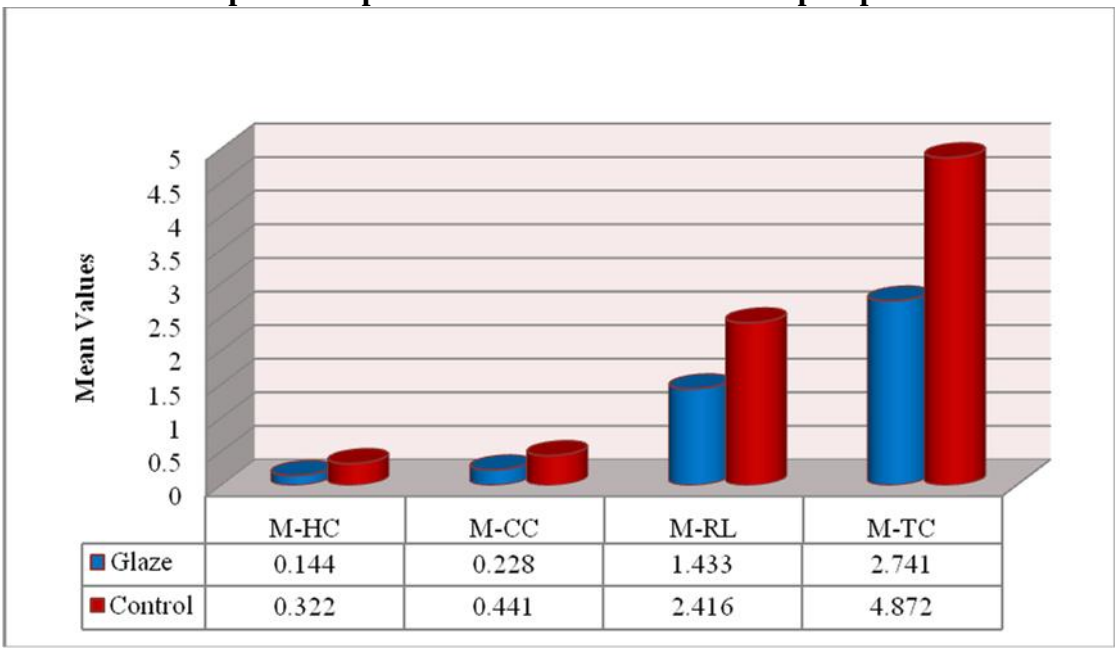
Table 2 Comparing surface roughness between Control and Glaze surface of Group I specimens

		N	Mean	Std. Deviation	P value
M-CC	Control	20	0.4412	0.16841	0.03*
	Glaze	20	0.2283	0.03194	
M-HC	Control	20	0.322	0.172	0.01*
	Glaze	20	0.1444	0.027	
M-RL	Control	20	2.4161	0.475	0.001*
	Glaze	20	1.4335	0.280	
M-TC	Control	20	4.8724	0.862	0.001*
	Glaze	20	2.7415	0.431	

Table 3 Comparison of surface roughness between Control and Glaze surface of Group II specimens

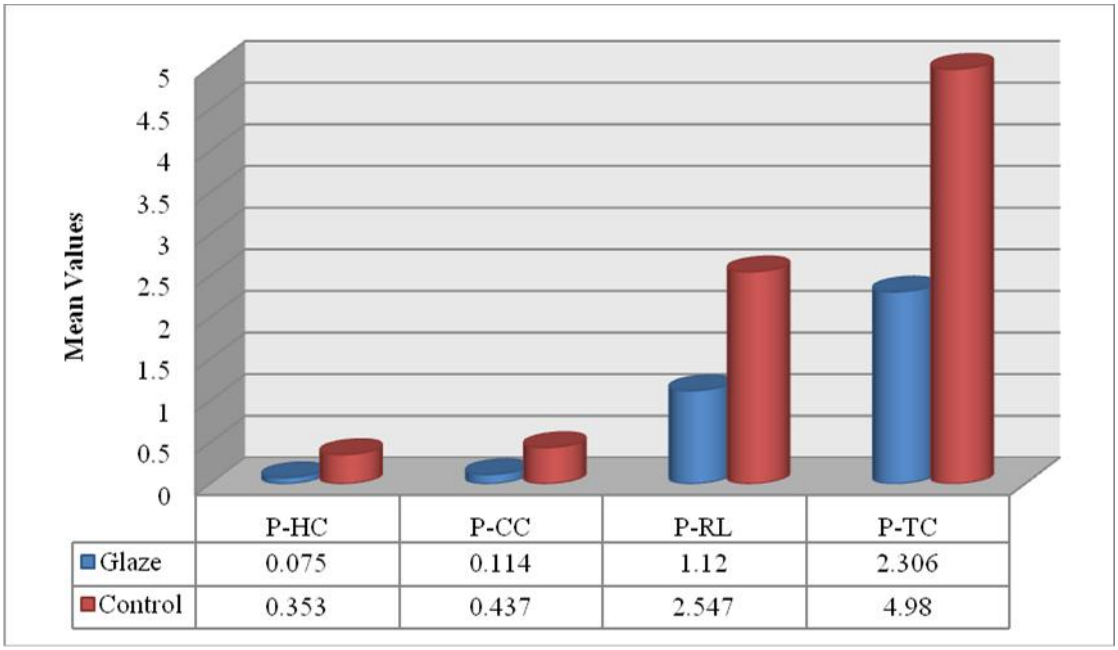
		N	Mean	Std. Deviation	P value
P-CC	Control	20	0.4371	0.164	0.001*
	Glaze	20	0.1146	0.104	
P-HC	Control	20	0.3532	0.222	0.001*
	Glaze	20	0.0705	0.022	
P-RL	Control	20	2.5479	0.464	0.003*
	Glaze	20	1.1206	0.133	
P-TC	Control	20	4.9808	1.046	0.003*

Graph 1 Comparison of Mean Values of Group-I specimens



	M-HC	M-CC	M-RL	M-TC
Glaze	0.144	0.228	1.433	2.741
Control	0.322	0.441	2.416	4.872

Graph 2 Comparison of mean values of Group-II specimens



	P-HC	P-CC	P-RL	P-TC
Glaze	0.075	0.114	1.12	2.306
Control	0.353	0.437	2.547	4.98

DISCUSSION

Surface roughness is the measure of the finer irregularities of the surface texture that are inherent in the materials. Surface roughness average (Ra) is rated as the arithmetic average deviation of the surface valleys and peaks expressed in micro inches or

micrometers. If these deviations are large, the surface is rough; if they are small, the surface is smooth.[33,39]

According to Quirynen[10] and Bollen[11], rough surfaces of bridges, implant abutments and denture bases accumulate and retain more dental plaque than smooth surfaces. Radfort[21] and Taylor[49] confirmed this hypothesis when they detected an increase in microbial adhesion to rougher surfaces. The threshold surface roughness for microbial attachment is reported to be 0.2 µm[8]. Surface roughness values more than 0.2 µm promote plaque formation.

The surface roughness of control surfaces of Group I and Group II that were conventionally polished ranged from 0.32 µm to 0.44 µm. These values agree with the range reported by Busscher (1984)[50], Oliveira (2008)[51] and Radford (1999)[22]. The surface roughness of glazed surfaces of Group I and Group II ranged from 0.2 µm to 0.07 µm. The present study verified that glazing reduces optimal surface roughness with values below even that of the threshold cited by Quirynen[10] and demonstrated significant surface smoothness.

A mean surface roughness value significantly below the threshold Ra=0.2 µm level, was produced by conventional laboratory polishing techniques combined with glazing of the heat cure and cold cure samples. This finding are in accordance with the study done by Vitalariu in 2010.[40]

Furthermore, the results of this study demonstrated that the surface roughness of HC acrylic resin (Ra=0.07-0.35 µm) were less compared to CC acrylic resin (Ra=0.11-0.44 µm) due to higher degree of conversion of monomer to polymer leading to superior surface characteristics of HC acrylic resin compared to CC acrylic resin which is concurring with that of Oliveira (2008).[51]

Resilient liners and tissue conditioners surfaces have more porosities, irregularities compared to acrylic resin which can cause some difficulties for the patients to maintain good hygiene and avoid biofilm accumulation and yeast contamination[20,26]. Moreover the wet environment of the oral cavity allows the ethanol and ester plasticizers leach into saliva and water leading to gradual hardening and affect its properties such as surface integrity and visco-elasticity and decrease its longevity.[32] The use of denture glaze on the surface of soft liners reduces the degradation caused by the contact with saliva, food, disinfection solutions, and mechanical brushing[32,34]. This is clinically important as temporary liners sometimes are used for longer periods than recommended due to costs and material availability.

The present study showed that Monopoly (Group I) and Palaseal (Group II) coating reduced the surface degradation of the tested soft liners (Ra = 1.1 µm. – 2.7 µm) and tissue conditioner (Ra = 2.3 µm – 4.8 µm). These findings corroborates with the report of Gardner and Parr[14], Loney[23], Maneiri[41], Dayrell[42] that the application of glaze coating with a brush smoothen the surface of the material. The reduced surface roughness after glaze coating can be attributed to reduced leaching out of the plasticizer, as well as the penetrant (alcohol) from resilient liner and tissue conditioner. However, because the experimental condition was not in the mouth and there was not any saliva as a solvent, the main factor seems to be the loss of ethanol in soft liners.[32]

For threshold of Ra value located at a score of 0.2 µm, no material (resilient liner and tissue conditioner) was found to accomplish this criterion exhibiting Ra values ranging from 2.3 µm to 4.3 µm (for tissue conditioner) and 1.1 µm to 2.5 µm (for resilient

liner). The surface roughness for tissue conditioner was more compared to soft liner. The chemical composition of the tested soft liners explains the differences of surface roughness. Viscogel is a methacrylate-based soft liner used as a temporary resilient reliner material that leaches residual monomer, whereas Molloplast-B is a permanent silicone-based liner having improved surface properties.[41]

When a direct comparison was made between the monopoly coated (Group I) and palaseal coated (Group II) specimen, the surface roughness results of monopoly coated surfaces was higher compared with palaseal coated for all specimen. The increase in the mean surface roughness values of the groups coated with monopoly may be due to leaching out of the monomer from the monopoly.[17] Moreover, photocure glaze (Palaseal) leads to reduced levels of residual monomer because of an increase in temperature during the curing cycle.[52]

There are some definite advantages of the glaze coating compared to that of the conventional polishing like chairside glazing when acrylic prosthesis are adjusted in the dental office during the insertion and subsequent follow up since conventional laboratory polishing setup are routinely not available in dental clinic[40], less time compared to the conventional polishing procedure[53],maintainance of softness of tissue conditioners and soft liner for a longer period.

The present study was conducted in an *in vitro* environment and other factors such as the presence of saliva, tissue surface irregularities, and microbial factors which would have an effect on the values obtained were not considered.

Although one operator was used throughout the study to eliminate any inadvertent bias and ensure a constant pressure when polishing, a calibrated machine could have been used as a mechanical "operator,'' to avoid any human error.

One more limitation of this study is the restricted generalization of results to other soft liners and tissue conditioner with different composition since only one brand of soft liner and tissue conditioner was used in the study.

The present study supports the use of sealer coating for the tested materials in an attempt to prolong their optimal characteristics. However, during clinical service in the oral cavity the materials may suffer additional stresses, such as thermal changes, pH variations, and deformation by occlusal loading, which may accelerate the degradation of the sealer coating and the material itself.

It is extremely important to consider the maintenance of surface roughness values after different acrylic resin treatments during the course of denture usage. Repeated aggressive brushing of dentures with abrasive cleansers will scratch even smooth denture surfaces. Additional studies are necessary to confirm the long-term behaviour of surface roughness after glazing.

Clinical studies need to be conducted to confirm that coated tissue conditioners treat inflammed or abused tissues as effectively as uncoated conditioners.

CONCLUSION

Surface roughness of denture materials is important, as it affects the oral health of tissues in direct contact with a denture. Most microorganisms that are present intraorally, especially those responsible for caries, periodontal disease, and denture related stomatitis, can only survive in the mouth if they adhere to oral surfaces and start forming

colonies.[46,47] Studies have shown that rough acrylic and soft liner surfaces are significantly more prone to bacterial accumulation and plaque formation than smooth surfaces.[8,9,11] Research has indicated that a decrease in the roughness of intraoral surfaces may result in reduced plaque formation.[6,8,11] In an attempt to achieve smooth surfaces, glazing after conventional finishing and polishing methods can be used to make denture material surfaces as smooth as possible, contributing to the prevention of micro-organisms' adhesion and the material's longevity[12,13]. For resilient liner and tissue conditioner the application glaze coating reduces plasticizer and ethanol loss leading to improvement in surface integrity, reduction of bacterial colonization and even improvement of the soft liners' resiliency[26,29].

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