THE SURFACE ROUGHNESS VALUE ALTERATION OF ACRYLIC RESIN IMMERSED IN 10% CINNAMON EXTRACT AS A DISINFECTING MATERIAL

(PERUBAHAN NILAI KEKASARAN PERMUKAAN RESIN AKRILIK YANG DIRENDAM DALAM EKSTRAK KAYU MANIS 10% SEBAGAI BAHAN DISINFEKSI)

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ABSTRACT

The surface roughness of acrylic denture bases can be a reservoir for food debris and microorganisms. Surface roughness can result from disinfection procedures. Cinnamon (*Cinnamomum burmanii)* is a spice-producing tree which has aroma and taste and contains active substances that most act as antimicrobials, namely cinnamaldehyde and eugenol, which can be used as disinfectants. The purpose of this study was to determine the change in the value of the surface roughness of acrylic resin after being immersed in 10% cinnamon extract and 0.5% sodium hypochlorite as a disinfectant. The research was experimental. The samples were heat-polymerized acrylic resin plates immersed in 10% cinnamon extract, 0.5% sodium hypochlorite, and distilled water. The results showed a significant difference in the degree of roughness of the acrylic plate immersed in 0.5% sodium hypochlorite solution compared to 10% cinnamon extract. The acrylic plate immersed in cinnamon extract had a minor level of roughness (0,37 µm) compared to the plate immersed in 0.5% sodium hypochlorite solution (0,20 µm). A cinnamon extract of 10% did not affect the roughness of the acrylic plate.

Keywords: acrylic resin; cinnamon; disinfectant; surface roughness value

ABSTRAK

Basis gigi tiruan akrilik yang mengalami kekasaran permukaan dapat berperan sebagai reservoir sisa makanan dan mikroorganisme. Kekasaran permukaan dapat diakibatkan oleh prosedur desinfeksi. Kayu manis (Cinnamomum burmanii) merupakan pohon penghasil rempah-rempah yang memiliki aroma, rasa dan mengandung zat aktif yang paling berperan sebagai antimikroba yaitu cinnamaldehyde dan eugenol yang dapat digunakan sebagai desinfektan. Tujuan dari penelitian ini adalah untuk mengetahui perubahan nilai kekasaran permukaan resin akrilik setelah direndam dalam ekstrak kayu manis 10% dan sodium hipoklorit 0,5% sebagai desinfektan. Jenis penelitian ini adalah eksperimen. Sampel yang digunakan adalah pelat resin akrilik polimerisasi panas yang direndam dalam larutan ekstrak kayu manis 10%, natrium hipoklorit 0,5%, dan air suling. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang signifikan derajat kekasaran pelat akrilik yang direndam dalam larutan natrium hipoklorit 0,5% dibandingkan ekstrak kayu manis 10%. Plat akrilik yang direndam dalam ekstrak kayu manis memiliki tingkat kekasaran paling kecil (0,37 µm) dibandingkan dengan plat yang direndam dalam larutan natrium hipoklorit 0,5% (0,20 µm). Ekstrak kayu manis 10% tidak mempengaruhi kekasaran pelat akrilik.

Kata kunci: *desinfektan; kayu manis; nilai kekasaran permukaan*

INTRODUCTION

Loss of teeth results in tooth displacement, alveolar bone resorption, reduced chewing efficiency, overclosure of the jaws, temporomandibular joint disorders due to bad habits, and eccentric jaw relation. Missing teeth can be treated using removable dentures, fixed dentures, and dental implants.[1,2]

The survey results on the use of dentures in several countries, including Indonesia, are still low. In Indonesia, based on survey results in 2007, only 4.5% of the Indonesian population used dentures.[3,4]

Removable dentures are often the choice because they are easy to clean. One component of the removable denture is the base. Heat-cured acrylic resin denture base material is often used because of its color, which resembles gingiva, is easy to process, has relatively small dimensional changes, is relatively affordable, has aesthetic value, is relatively economical, and has color stability. Acrylic resin has physical properties such as polymerization shrinkage, porosity, water absorption, crazing, solubility, pressing process, strength, creep, and roughness. [5,6,7]

Surface roughness must be considered because it becomes the attachment medium for food debris on the denture. Surface roughness caused by disinfection procedures occurs due to mechanical and chemical immersion. Chemical immersion with effervescent solutions such as sodium perborate can oxidize the denture surface. Denture cleaners, especially denture bases made of acrylic resin, have water-absorbing properties. Effervescent tablets containing sodium perborate can cause roughness on the surface of acrylic resin, so an alternative denture cleanser is needed. The government recommends using traditional plant cultivation to make it more environmentally friendly. Many ingredients from medicinal plants are used as traditional disinfection materials in Indonesia so many traditional plants can be used as alternative denture cleaning materials. Cinnamon is one of the ingredients that can be used as an alternative denture cleaner in Indonesia (*Cinnamomum burmanii)*. Cinnamon is one of the most researched spices because of its extensive use in medicine as an anticancer, antifungal, antibacterial, antispasmodic, and blood pressure-lowering agent and has a pleasant aroma so users of this ingredient can feel comfortable, especially its use as a denture cleaning agent.[5,8,9]

This study aimed to observe changes in the surface roughness value of acrylic resin immersed in 10% cinnamon extract as a disinfectant.

METHOD

The design of this study was true-experimental, done by separating the control group and the experimental group using the in vitro Pretest–Post Test Control Group Design. This study had two controls, namely positive control and negative control. The positive control was the heat-polymerized acrylic resin group immersed in 0.5% sodium hypochlorite. The negative control was a heat-polymerized acrylic resin group immersed in distilled water. The treatment polymerized acrylic resin group immersed in 10% cinnamon extract.

This research was conducted at the Biochemistry Laboratory, Faculty of Medicine, Unjani and the Industrial Metrology Laboratory, FTMD ITB, with research time from December to January 2020-2021. The samples used were 27 plates with nine samples of heat-polymerized acrylic resin immersed in 10% cinnamon extract (treatment), nine samples of heat-polymerized acrylic resin immersed in distilled water (control), nine samples of heat polymerized acrylic resin immersed in sodium hypochlorite solution 0.5% (treatment) for seven days. The immersion time is determined for seven days because it is assumed to be the same as doing short-term immersion for two years.

For each sample, the surface roughness value was tested using a three-point surface roughness tester and the average value was taken. These measurements were made before and after immersion. The results of the research would then be analyzed statistically. Initially, data for normality was tested using the Shapiro-Wilks test because the sample was less than 50. If the data were normally distributed, a One-way ANOVA test and a Post Hoc Independent T-Test would be performed to determine the ratio of changes in each group.

RESULT

The mean value of surface roughness of heat-polymerized acrylic resin before immersion in 0.5% sodium hypochlorite served as a positive control, while 10% cinnamon extract and distilled water served as a negative control. The results of the average (mean) surface roughness of acrylic resin before immersion can be seen in Table 1.

Table 1. Results of the average values of surface roughness of heat polymerized acrylic resin before immersion.

Group	Mean (µm)	p-value
Sodium Hypochlorite	0,37	
Aquadest	0,27	0,028*
Cinnamon Extract	0,20	

**one way ANOVA test* ($p<0,05$)

The results of the surface roughness values of heat polymerized acrylic resin in Table 4.1 show that the highest mean value of acrylic resin before immersion was in the sodium hypochlorite group as a positive control of 0.37 µm and the lowest was in the cinnamon extract group of 0.20 µm.

The mean value of surface roughness of hot polymerized acrylic resin after immersion in 0.5% sodium hypochlorite served as a positive control, while 10% cinnamon extract and distilled water served as a negative control. The results of the average (mean) surface roughness of acrylic resin after immersion can be seen in Table 2.

Table 2. Results of the average values of surface roughness of acrylic resin after immersion.

Group	Mean (µm)	p-value
Sodium Hypochlorite	0,45	
Aquadest	0,54	0,019*
Cinnamon Extract	0,25	

**one way ANOVA test* (p<0,05)

The average surface roughness of heat-polymerized acrylic resin after being immersed in 10% cinnamon extract was compared with 0.5% sodium hypochlorite and distilled water with an independent t-test to see if there was a significant difference between each group. The results can be seen in Table 3.

Table 3. Comparison results of value changes of acrylic resin surface roughness after immersion between groups

Group	p-value	Interpretation
Cinnamon and Sodium Hypochlorite	0,046*	Differences
Cinnamon and Aquadest	0,034*	Differences

**Independent t-test* (p<0,05)

DISCUSSION

Table 2 shows that the surface roughness value of heat-polymerized acrylic resin immersed in 0.5% sodium hypochlorite was 0.45 µm, higher than that immersed in 10% cinnamon extract, which was 0.25 µm. It happens because of hypochlorous acid (HOCl-), which consists of (OCl-) and (H^+), which are free radicals and potent oxidizing agents. The content of H^+ ions in sodium hypochlorite is more than that of cinnamon. It is due to the nature of acrylic resin, which quickly absorbs water and has an acidic pH. The low pH value of sodium hypochlorite can trigger an increase in the surface roughness of acrylic resins because the acid content contains more H^+ ions which cause degradation of the polymer bonds so that some resin monomers are released and cause a lot of space between the polymer chains. [10-12]

The results of the surface roughness value of heat-polymerized acrylic resin before and after being immersed in 10% cinnamon solution had a difference of 0.05 µm, as seen in Table 3. The change in the surface roughness value of heat-polymerized acrylic resin in both solutions was caused by cinnamon extract containing cinnamaldehyde and eugenol compounds. Cinnamaldehyde is also a derivative of phenolic compounds and has a benzene group with the chemical formula (C_9H_8O). The H^+ ions contained in the cinnamaldehyde can also bind to CH_3O^- which is released from the ester group, and the benzene group in the cinnamaldehyde binds to RCO on the ester group because heat-cured acrylic resin consists of poly methyl methacrylate (PMMA) which has an ester group (R-COOR'). This ion exchange reaction causes the chemical bonding of the acrylic resin to become unstable, which is thought to result in the formation of many cavities on the surface of the acrylic resin. A large number of cavities on the surface of the acrylic resin results in an increase in the surface roughness of the acrylic resin.[7,13,14]

Eugenol is an acidic compound that belongs to cinnamon with the molecular formula $C_{10}H_{12}O_2$ which contains several functional groups, namely allyl (-CH_2-CH=CH_2), phenol (OH) and methoxyl (-OCH_3). Water absorption in the polyamide resin causes H^+ from phenol in eugenol to be released and react with the polyamide chain bonds. When the chain bonds are broken, structure and physical properties change. The ion exchange reaction causes the chemical bonding of the acrylic resin to become unstable, which is thought to result in the formation of many cavities on the surface of the acrylic resin, which results in porosity and roughness.[13-15]

Based on the surface roughness values of hot polymerized acrylic resin before and after immersion in 0.5% sodium hypochlorite, there is a difference of 0.08 µm, which can be seen in Table 4.3. It is caused by sodium hypochlorite consisting of (OCl-) and (H+), free radicals and strong oxidizing agents. Hydrogen is an acidic compound with a polarity that makes it more stable and does not bond easily with other compounds. High cross-linked materials, while acrylic resins with ester groups (R-COOR') have low polarity. When the ester group reacts with hydrogen peroxide, the H^+ ion in the hydrogen peroxide binds by reducing the absorption of liquid on the CH_2O, which is released from the ester group. At the same time, this absorbs more water than oxygen resin (O_2), which is a free radical with no partner electrons that bind to RCO from the ester group, so the oxidation process occurs. This ion exchange reaction causes the chemical bonding of the acrylic resin to become unstable and results in cavities (microporosity). The number of cavities on the surface of the acrylic resin results in roughness on the surface of the acrylic resin.[1,8,16-19]

The results showed that changes in the surface roughness value of acrylic resin immersed in 0.5% sodium hypochlorite and

10% cinnamon extract increased the surface roughness of heat-polymerized acrylic resin. It was due to the active compounds in 10% cinnamon extract and sodium hypochlorite 0.5. Both can cause the polymer chain in the heat polymerized acrylic resin to be unbalanced and increase porosity and surface roughness. However, 0.5% sodium hypochlorite has a more significant increase rate than 10% cinnamon extract. It is because the content of H^+ ions in sodium hypochlorite is more than that of cinnamon and due to the nature of acrylic resin, which quickly absorbs water and an acidic pH. The low pH value of sodium hypochlorite can trigger an increase in the surface roughness of acrylic resins because the acid content contains more H^+ions which causes degradation of the polymer bonds so that some resin monomers are released and causing a lot of space between the polymer chains. H^+ ions fill the gaps between the polymer chain bonds in the ester group (COOH), which damages the double bond from the C group (C=O) owned by the polymer chain. It causes the ester group to hydrolyze more efficiently, forming cracks.

These cracks make the surface of the acrylic resin irregular and increase the surface roughness of the acrylic resin. From the results of this study, the method of disinfection of heat polymerized acrylic resin is better when using 10% cinnamon extract because it has a change in roughness value of 0.05 μm compared to 0.5% sodium hypochlorite which can increase the surface roughness of acrylic resin by 0.08 μm.[10-12]

CONCLUSION

Based on the results of research on the comparison of changes in the surface roughness value of heat-polymerized acrylic resin immersed in 10% cinnamon extract, distilled water, and 0.5% sodium hypochlorite, it was concluded that 10% cinnamon extract did not affect the roughness of the acrylic plate so that it could be considered as a denture disinfectant solution.

CONFLICT OF INTEREST

We declare no potential conflict of interest in the scientific articles we write.

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