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The Effect Of Cuka Pempek On Color Stability Of Heat-Cured Acrylic Resin As A Base For Removable Dentures

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Abstract : Heat-cured acrylic resin is one of the dental materials commonly used for making denture bases. Color stability in acrylic resin is one of the most important clinical signs of aging or deterioration indicators of materials after prolonged use that can affect aesthetics. Factors that can affect the color stability of heat-cured acrylic resin are acidic foods/drinks. Cuka pempek is a side sauce for pempek that is often consumed by the public and has a low pH. Purpose: This study aims to determine the effect of cuka pempek and soaking time on the color stability of heat-cured acrylic resin as a removable denture base. Method: This study is an experimental laboratory study with a pre-test and post-test group design. A total of 24 samples of heat-cured acrylic resin measuring 65mm x 10mm x 2.5mm were divided into 6 groups, namely 3 groups soaked in cuka pempek solution and 3 groups soaked in distilled water for 3, 5, and 7 days. Color stability was measured using a colorimeter. Statistical tests were performed using paired T-test and Post hoc LSD. Results: Paired T-test showed that each group experienced a significant change in the degree of lightness and darkness (ΔL*) after immersion. The largest mean value of the change in the degree of darkness was found in the group soaked in vinegar solution for 7 days (mean=17.59). The smallest mean value of the change in the degree of darkness was found in the group soaked in distilled water for 3 days (mean=11.02). Conclusion: Cuka pempek can cause color changes in heat-cured acrylic resin and the longer the immersion in cuka pempek solution, the greater the level of color change.

***Keywords*:** Heat-cured acrylic resin, Color Stability, Removable Denture

INTRODUCTION

Removable dentures are prostheses made as a replacement for one or more missing natural teeth and supported by a denture base that functions as a mucosal tissue and can be removed and reattached by the patient. Removable dentures consist of removable partial dentures (RPDs) and complete dentures (CD) that have an acrylic base.1 The type of denture base material used greatly influences the properties and durability of the denture base.2 To date, heat-cured acrylic resin is the most commonly used type of non-metallic denture base material.3

Hot polymerization acrylic resin has several advantages such as the material is easy to obtain, the manufacturing procedure is easy, low toxicity, biocompatible with tissue, strong enough to withstand chewing loads, and easy to repair if damaged or broken.4,5 However, heat-cured acrylic resin also has disadvantages, including easy porosity and easy absorption of liquids which have an impact on the color stability after some time of usege in the mouth.6 The porosity and easy absorption of liquids in acrylic resin can trigger the process of absorption of dyes from a solution into acrylic resin. This can occur due to the diffusion process of chemical reactions between color pigments or chemicals from a solution with acrylic resin materials so that the dyes attached to the surface of the acrylic resin will be gradually absorbed and spread to the acrylic resin structure through microporosity. 7,8

Color stability in acrylic resin is the ability of acrylic resin to maintain its original color without changing or fading over time. 9 Color changes that occur in the denture base are clinical indicators of aging or deterioration to the material after prolonged usege and can affect aesthetics. The causes of color changes in the denture base can be grouped into 2 factors, namely intrinsic and extrinsic factors. 10 Intrinsic factors come from the acrylic resin material itself such as composition, structure, polymerization process, and chemical properties of acrylic resin, while extrinsic factors are the appearance of stains due to absorption of compounds in tea, coffee, acidic soft drinks, and vinegar solutions. 7,10

One of the food complements that is acidic is cuka pempek. Cuka pempek is a traditional, blackish brown sauce served as a complimentary to pempek which has a distinctive taste because it combines sweet, sour, spicy and savory flavors in one taste.11 The sour taste of cuka pempek comes from the composition of the ingredients, namely acetic acid or vinegar. Cuka pempek has a low pH and its value varies between 4.52 - 4.63.12 Low pH in acidic foods and beverages can affect the color change of acrylic resin because H+ ions can damage the resin bonds, resulting in color degradation in acrylic resin. In addition, longer contact time between acrylic resin and acidic solutions causes greater color changes.7,13 This has been proven in research by Elin and Nadya (2022) stated that boiled lemongrass water containing acidic phenol compounds causes color changes in heat-cured acrylic resin soaked for 3, 5, and 7 days, where soaking for 7 days has a greater color change value than soaking for 3 and 5 days.14 In a study conducted

by Zulkarnain (2014), it was proven that 5% white vinegar solution causes color changes in heat-cured acrylic resin soaked for 1.5 years (92 hours).7 This study aims to assess the effect of cuka pempek and soaking time on the color stability of heat-cured acrylic resin as a removable denture base.

METHODS

This study is an experimental laboratory study with a pre-test and post-test group design. A total of 24 samples of heat-cured acrylic resin (Triplex Hot) measuring 65mm x 10mm x 2.5mm (ADA no.12) were divided into 6 groups, namely 3 groups soaked in cuka pempek solution as the control group and 3 groups soaked in distilled water as the treatment group and each group was soaked for 3, 5, and 7 days. The sample surface is flat, even, smooth, and non-porous.

The sample color is homogeneous, translucent, and shiny. The soaking solution in the form of distilled water (pH 7.1) and cuka pempek (pH 3.5) based on acetic acid (Dua Belibis) which is placed in a 9 cm diameter petri dish. each petri dish contains 20 ml. Color changes were measured using an NH310 colorimeter. Statistical tests were conducted using the paired T-test to determine whether there was a significant difference between the pre-test and post-test data of each group, then a Post hoc LSD test was conducted to further determine the differences in color change values between groups**.**

RESULT

The color changes in the heat-cured acrylic resin plate samples before and after being soaked in distilled water for 3, 5, and 7 days can be seen in Figures 1(A) and 1(B). The color changes in the heat-cured acrylic resin plate samples before and after being soaked in cuka pempek solution for 3, 5, and 7 days can be seen in Figures 2(A) and 2(B).

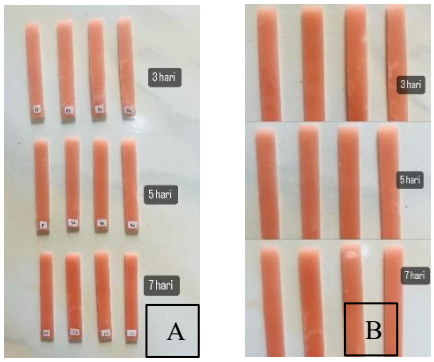

Figure 1. Acrylic resin plate soaked with distilled water, (A) before and (B) after

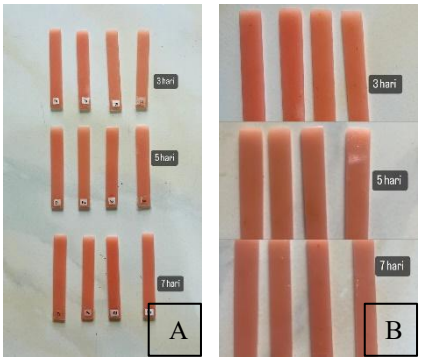

Figure 2. Acrylic resin plate soaked with cuka pempek, (A) before and (B) after

Table 1. Results of the Paired T-test for Changes in the Degree of Lightness and Darkness (ΔL*)

Group	*Pre-test*	*Post-test*	*Mean*difference	*Std. deviation*	*P value*
ΔL* KK 1	70.08	59.06	11.02	0.59	0.00*
ΔL* KK 2	72.18	60.72	11.46	1.10	0.00*
ΔL* KK 3	70.52	59.00	11.52	0.26	0.00*
ΔL* KP 1	72.34	59.95	12.39	0.90	0.00*
ΔL* KP 2	70.50	56.80	13.70	1.02	0.00*
ΔL* KP 3	71.24	53.65	17.59	0.41	0.00*

*)The difference is significant ($p<0.05$)

KK 1 = group soaked in distilled water solution for 3 days

KK 2 = group soaked in distilled water solution for 5 days

KK 3 = group soaked in distilled water solution for 7 days

KP 1 = group soaked in cuka solution for 3 days

KP 2 = group soaked in cuka solution for 5 days

KP 3 = group soaked in cuka solution for 7 days

Based on the results of the paired T-test in Table 1, the pre-test and post-test data for each group showed significant differences in color. Smaller values in the post-test data indicate that the color change that occurs becomes darker because the value is closer to 0. The largest average value of the color change in the degree of lightness and darkness was found in the group soaked in cuka pempek solution for 7 days (17.59 0.41) while the smallest average value of the change in the degree of dark to light color was found in the group soaked in distilled water for 3 days (11.02). 0.59).

Table 2. Results of the LSD Post Hoc Test of the Value of Changes in the Degree of Lightness and Darkness (ΔL*)

Group	KK 1	KK 2	KK 3	KP 1	KP 2	KP 3
KK 1	-	0.38	0.31	**0.01***	**0.00***	**0.00***
KK 2	0.38	-	0.89	0.06	**0.00***	**0.00***
KK 3	0.31	0.89	-	0.08	**0.00***	**0.00***
KP 1				-	**0.00***	**0.00***
KP 2					-	**0.00***
KP 3						-

Significant difference (p<0.05)

The results of the LSD Post Hoc Test can be seen in Table 2. All groups soaked in distilled water showed insignificant differences in dark and light colors between groups. Each group soaked in distilled water showed significant differences in dark and light colors against each group soaked in cuka pempek, only the distilled water group soaked for 5 days and 7 days did not show significant color differences against the group soaked in cuka pempek for 3 days. All groups soaked in cuka pempek showed significant differences in dark and light colors between groups.

Table 3. Results of the Post Hoc LSD Test of Total Color Change Value (ΔEab*)

Group	KK 1	KK 2	KK 3	KP 1	KP 2	KP 3
KK 1	-	0.69	0.31	**0.03***	**0.00***	**0.00***
KK 2	0.69	-	0.53	0.06	**0.00***	**0.00***
KK 3	0.31	0.53	-	0.21	**0.00***	**0.00***
KP 1				-	**0.00***	**0.00***
KP 2					-	**0.00***
KP 3						-

*)

Significant difference (p<0.05)

Table 3 shows that all groups soaked in distilled water showed no significant difference in total color between groups. Each group soaked in distilled water showed a significant difference in total color to each group soaked in cuka pempek, only the distilled water group soaked for 5 days and 7 days did not show a significant difference in color to the group soaked in cuka pempek for 3 days. All groups soaked in cuka pempek showed a significant difference in total color between groups.

DISCUSSION

The color change of heat-cured acrylic resin in this study was measured using a colorimeter with a CIELAB color scale that will produce the parameters of ΔL*, Δa*, Δb*, and ΔEab* values. The total color change of the hot polymerized acrylic resin plate in this study is represented by the ΔEab* value.

The results of this study indicate that there is a significant change in the degree of dark and lightness color on the acrylic resin plate before and after immersion in distilled water and cuka pempek solution. The color change in this study was caused by the natural properties of hot polymerized acrylic resin which is able to absorb liquid. Over time, acrylic resin absorbs water continuously and slowly.[15,16] Liquid absorption is caused by polymethyl methacrylate molecules which are one of the compositions of heat-cured acrylic resin. Polymethyl methacrylate is a polar group that has hydrophilic properties so that it can absorb liquid.[15]

Acrylic resin can absorb liquid through the diffusion process. Polymethyl methacrylate polymer contained in acrylic resin has a non-crystalline structure with high internal energy, which allows diffusion into acrylic resin. The diffusion mechanism is responsible for the entry of liquid into acrylic resin. When liquid molecules penetrate into the polymethyl methacrylate bonds of acrylic resin, the molecules of the liquid will occupy the space between the polymer chain bonds. The ingress of liquid into the acrylic resin has the effect of breaking the bonds of the polymer chains that function as plasticizers. Continuously induced damage to the polymer chain bonds causes the bonds to separate.[15]

This study proves that the groups soaked in cuka pempek solution (KP1, KP2, and KP3) have a darker degree of color change compared to the groups soaked in distilled water (KK1, KK2, and KK3) in the same soaking time (Figures 2B and 1B). The darker color change after being soaked in cuka pempek solution is caused by the accumulation of color pigment attachment from the cuka pempek solution, namely blackish brown from palm sugar. The blackish brown color of palm sugar is caused by the heating process that activates the Maillard reaction, which is the reaction between sugar and amino acids in the sap.[17]

The change in the degree of darkness and lightness and total color change occurred faster in the acrylic resin group soaked in cuka pempek solution. Tables 6 and 7 show that

the changes that occurred in the group soaked in cuka pempek for 3 days (KP1) were the same as the changes that occurred in the group soaked in distilled water for 5 days (KK2) and 7 days (KK3). This occurs because the cuka pempek solution has a low pH of 3.5 which comes from acetic acid. H+ ions from acetic acid will cause the release of monomers and damage the resistance of the acrylic resin polymer matrix. Furthermore, the polymer bonds will degrade which causes the polymer bonds to break away and separate. With the release of polymer bonds, empty spaces between the polymer matrices will form, making it easier for the diffusion of liquid from the outside to the inside of the resin.[18]

In this study, the duration of immersion with distilled water in the control group (KK1, KK2, and KK3) showed no significant difference in color changes between control groups as stated in the Post Hoc LSD test (Table 7). This occurs because distilled water comes from pure distilled water (H2O) and does not contain dyes that can accelerate the color change of hot polymerized acrylic resin.[16] The distilled water solution in this study had a pH of 7.1 which is a neutral compound. The same concentration of H+ ions and OH- ions causes distilled water to be unable to accelerate the color change of acrylic resin as occurred in the group soaked in cuka pempek solution.

The results of this study are in accordance with the results of research of Zulkarnain (2014) which proved that a 5% white vinegar solution causes color changes in heat-cured acrylic resin soaked for 4 days (92 hours).[7] The results of this study are not in accordance with the research of Castro RD and Mota AC (2015) which proved that alcohol vinegar does not significantly affect the color stability of heat-cured acrylic resin soaked for 30, 60, 120, and 180 minutes.[19] This is because the contact time is not too long between the soaking solution and the acrylic resin plate so that there is no significant color change.[19] In this study, researcher soaked heat-cured acrylic resin samples in cuka pempek solution for 3, 5, and 7 days so that longer contact times will cause greater color changes. The length of contact time between hot polymerized acrylic resin and the soaking solution containing dyes is directly proportional to the color change. The longer the sample is soaked in a solution containing dyes, the higher the sample absorbs the dye so that it can affect greater color changes. This confirms that the length of time of soaking in the cuka pempek solution affects the color change of the heat-cured acrylic resin.

CONCLUSION

There is an effect of cuka pempek which is made from acetic acid on the color stability of heat-cured acrylic resin plates as a base for removable dentures and the length of time of soaking with cuka pempek solution affects the level of color change on heat-cured acrylic resin plates (the longer the soaking, the greater the color change that occurs).

This study is expected to be a means of information for the people of Palembang, especially users of removable dentures to reduce the consumption of cuka pempek made from acetic acid and can be a medium of counselling for dentists and dental students regarding the effects of cuka pempek made from acetic acid on the color stability of hot polymerized acrylic resin. Users of removable dentures are advised to drink mineral water and rinse their mouths after consuming cuka pempek, and clean their removable dentures 3 times a day after breakfast, lunch, and dinner to produce longer denture durability/life.

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