Effect of Immersion Timein Rosellatea (Hibiscus Sasabdarifa) on the Dimensional Change Ofheat-Curedacrylic Resin

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Abstract

Heat Cured acrylic resin had dimensional Changes when immersed into the liquid. One several characters of acrylic resin is absorbing the water which could influenced by composition duration and kinds of the soluble. The kinds of sour soluble such as rosella tea could made the erosion and decrease the superfisical strain of acrylic resin material which easier the penetration of liquid molecules. The study was aimed to analyze the effect of immersed duration of heat cured acrylic resin into the rosella tea drinks for 3,5,7, and 9 days on the dimensional changes. The specimens of this study was cylinder shape with 50 ± 1 mm diameter and $0,5 \pm 0,1$ mm thickness. Twenty specimen was immersed into distilled water for 24 hours to minimize the residual monomer thenwas dried using desiccators and the weight was measured before treatment(W1). All specimens were divided into 2 groups which 10 specimens was immersed in rosella tea and 10 specimens was immersed in distilled water (control) for 3, 5, 7 and 9 days. Then the final weight of each application was measured using analytic balance. The data was analyzed using repeated Anova and continued with pairwise Comparison. Based on analysis shown that there was significant different of dimensional changes after immersed in the rosella tea for 3,5,7 and 9 (p < 0,05) significant different of (P>0,05) dimensional changes between 3 to 9 days. It can be concluded that there was the effect of immersed duration heat cured acrylic resin into the rosella tea on the dimensional changes.

Keywords: Heat Cured Acrylic Resin in Rosella Tea on the dimensional changes.

Keywords: heat-curedacrylic resin, rosella tea, dimensional change

Introduction

Acrylic resins have been used in dentistry as an artificial denture base for more than six decades. Acrylic resins are colorless, transparent and solid polymers, commonly used in the manufacture of dentures, both partial and full dentures.¹However, heat-cured acrylic resins have the disadvantage in which they easily fracture when fallingon hard surfaces and when getting pressure of mastication in the mouth since they absorb water such as liquid and chemicals that interfere with their dimensional stability.³

Some studies indicate that acrylic resins have the characteristic to absorb water when soaked in a liquid resulting in their dimensional changes.⁴Based on the ADA (American Dental Association) specifications, it is recommended that the increase in weight of the polymer not exceed 0.8 mg/cm²from the surface after being immersed in water for 7 days at $37\pm1^{\circ}$ C. The absorption factor of the solution is strongly influenced by the slow duration over some period of time, in which this absorption occurs diffusionly in acrylic resins. Cury observed that the average water absorption that occurred in acrylic resins stored for 7 days was 0.010 mg/cm².⁴Poly methyl methacrylate absorbs water in a relatively small amount (0.69 mg/cm²) when placed in an aqueous environment such as in the mouth.^{5,6} Research by Al Nori*et al.* (2007) found that immersion of acrylic resins in distilled water for 7 days resulted in an increase in weight of 1.0168 gr and immersion of acrylic resins in distilled water for 1 month resulted in an increase in weight of 1.8221 gr.^{7,8}Another study by Ghanzabardeh*et al.* (2007) showed that by soaking a peg made of acrylic resin in distilled water for 24 hours at 25°C resulting in an increase in diameter of 0.873 mm and soaking for 48 hours resulted in an increase in diameter of 1.070 mm. The absorption of water molecules in the acrylic resin polymer has caused expansion and disrupted the polymer chains, thus affecting the physical properties of acrylic resins, one of which is the dimensional change.⁹

In Indonesia, rosella tea (*Hibiscus sabdariffa*) is known as a healthy drink consumed by people. According to Nurfaridah (2005), the more concentrated the red color on the rosella calyx is, the more acidic and the higher the content of anthocyanin (antioxidant) will be. The sour taste of the rosella calyx is due to the presence of vitamin C, citric acid and glycolic acid. Succinic acid and oxalic acid are counted as two organic acids in the rosella tea, and eighteen amino acids are also contained in the tea. The antioxidants that the tea contains include vitamin C, which reaches 244.4 mg in 100 grams of dried rosella calyces, while other antioxidants found are beta-carotene and anthocyanin.¹³

Rosella petals have the efficacy and benefits as anti-inflammatory, anticancer, and anti-bacterial as well as to improve stamina, making rosella tea widely consumed by many people.¹³However, denture users who often consumerosella tea should take note on the side effects of the tea. Drinking rosella tea regularly will cause dimensional changes in the base of the denture which results in the users being uncomfortable due to the nature of the acrylic resin which is porous and absorbs liquid.¹⁴In addition, the acidity and the duration of immersion of acrylic resins in solutions can also affect changes in their dimensions. Research conducted by Soraya (2007) showed that immersion of acrylic resins in an orange juice solution for 7 days caused a weight increase of 0.4408% wt.¹⁵

Departing from above discussions, this present study tried to obtain information on the effects of immersion time in rosella tea (*Hibiscus sabdariffa*) on the dimensional changes of heat-cured acrylic resins. The question posed in this study was: "Is there any effect of the duration of immersion of heat-cured acrylic resins in rosella tea for 3,5,7 and 9 days on their dimensional changes?, and the research objective was to investigate the effects of immersion time of heat-cured acrylic resins in rosella tea for 3, 5, 7 and 9 days on their dimensional changes.

Methods

This study employed the laboratory experiment. The study was carried out at the Laboratory of SMTI (Industrial Engineering Vocational High School) Banda Aceh fromAugust 18 to August 21, 2014. The specimens used as the sample of the study was 20. There were 10 specimens immersed in distilled water for 3,5,7 and 9 days, while another 10 specimens immersed in the rosella tea for 3,5,7 and 9 days.

Procedures. The specimens were made in a cylindrical shape with a diameter of 51 ± 1 mm and a thickness of 1 \pm 0.5 mm. The size was made slightly larger so that the acrylic resin specimens obtained could be smoothed to reach a diameter of 50 ± 1 mm and a thickness of 0.5 ± 0.1 mm. The specimenswere made as many as 20 specimens in accordance with the specified amounts.¹⁸The immersion solution used was rosella tea made of dried red rosella calyces. As many as 1.5 g of dried rosella calyces were brewed with 200 ml water at 90°C and allowed to steep for 6 minutes. The pH measurement of rosella tea and distilled water was done by using a pH meter. First, the pH meter was calibrated by dipping the electrode into distilled water so that it reached a neutral pH (pH 7). Then, the electrode was dipped in the rosella tea solution to get its pH value. The pH measurement was carried out three times at room temperature of 25°C, and later the average was calculated. Afterwards, 10 specimens were immersed in the rosella tea and 10 specimens in distilled water, with each specimen in a different container. The immersion media was changed every day and the dimensional changes were measured on days 3,5,7 and 9. The duration of the immersion was determined or converted based on the average time a person drinks the rosella tea for 5 minutes and drinks the rosella tea three times a day. In other words, the person has generally exposed his oral cavity for 15 minutes per day withrosella tea. The immersion of heat-curedacrylic resins in the rosella tea for 1 day x 24 hours was equal to 1,440 minutes, in which it was equivalent to someone drinking the rosella tea for three months (1,440 minutes/15 minutes x 1 day = 96 days = 3 months). The immersion for 3 days was equivalent to 9.5 months, the immersion for 5 days equaled to 16 months, the immersion for 7 days was equivalent to 22 months, and the immersion for 9 days was equivalent to 28 months. The dimensions were measured before and after immersion. The dimensional measurements before immersion included the initial weight (W1) and the specimen surface area (L). After immersion, all specimens weretaken out of the rosella tea by using a tweezer and dried with a tissue. Afterwards, the specimens were dried in the

open air for 5 minutes and their dimensional changes were measured for 1 minute. The measurement of the dimensions after immersion wasmarked as the final weight (W2) by using the analytical balance. The measurement results were collected and tabulated according to each group, and later analyzed using the SPSS with repeated ANOVA with a significance value of p<0.05 to see the effects of immersion time of heat-curedacrylic resins in rosella tea after immersion for 3,5,7 and 9 days.

Results. The studyfound the mean and standard deviation of the dimensional changes in the heat-curedacrylic resins after immersion in the rosella tea and distilled waterbeing controlled for 3,5,7 and 9 days. The dimensional changes increased after the acrylic resins were immersed for 3 days to $0.580 \pm 0.083 \text{ mg/cm}^2$. Then, the changes in day 5immersion became $0.773 \pm 0.072 \text{ mg/cm}^2$. The immersion value after 7 days began to decline to $0.767 \pm 0.040 \text{ mg/cm}^2$ and after immersion for 9 days it dropped to $0.596 \pm 0.093 \text{ mg/cm}^2$ with the average standard deviation of changes in dimensions. The changes in the dimensions of the heat-curedacrylic resins after being immersed in the rosella tea solution for 3 days were $0.781 \pm 0.077 \text{ mg/cm}^2$. The value of dimensional changes increased on immersion for 5 days to $0.871 \pm 0.080 \text{ mg/cm}^2$. Then, the immersion value for 7 and 9 days decreased respectively to $0.826 \pm 0.073 \text{ mg/cm}^2$ and $0.710 \pm 0.093 \text{ mg/cm}^2$. The results of the study showed that the mean of the dimensional changes of the heat-curedacrylic resins in the rosella tea was greater than that after immersion in the distilled water.

Statistical Analysis Results. The dimensional changes of heat-curedacrylic resins after being immersed in the rosella tea was tested for normality using Shapiro-Wilk test. The normality test showed the mean of the dimensional changes after immersion in the rosella tea solution for 3,5,7 and 9 days had a value of p > 0.05, indicating that the mean was normal. On the other hand, the difference in the dimensional changes of heat-curedacrylic resinsacross varied immersion time was analyzed usingrepeated ANOVA. The ANOVA analysis showed that there was a significant difference in the dimensional changes of heat-curedacrylic resins after immersion in the rosella tea for 3,5,7 and 9 days (p = 0.000). Then, this result was further tested using post hoc pairwise comparison determine the mean difference in the dimensional changes between treatment groups. It was found that there were significant differences in the dimensions of heat-curedacrylic resins after immersion in the rosella tea for 3,5,7 and 9 days in each treatment group. However, no significant difference was found in the mean of the dimensional changes of heat-curedacrylic resins after immersion in the rosella tea for 3,5,7 and 9 days in each treatment group. However, no significant difference was found in the mean of the dimensional changes of heat-curedacrylic resins after immersion for 3 days and 9 days with a value of p > 0.05.

The pH measurement of the rosella tea solution was done three times by using a pH meter. The result of the first pH measurement was 2.66, the second measurement was2.64 and the third measurement was 2.64. These pH test results were then averaged, obtaining the mean pH of rosella tea of 2.64.

Discussions

From the results of the ANOVA test, it was revealed that there were significant differences in the average change in the dimensions when immersed in liquid. The dimensional changes occur usually in dental materialsdue to expansion by heating and contraction by cooling. The changes generally cause a disruption of adaptation of dentures in the oral cavity. In this study, the results of the dimensional changes obtained can be seen in Figure 1 of the controlgroup and Figure 2 of the dimensional changes in the immersion of rosella tea. The dimensional changesemerge after immersion in distilled water or rosella tea. Moreover, the changes can also be caused by several factors such as the composition of heat-cured acrylic resins, and the type and duration of ethylene glycol dimethacrylate, both of which will form a functional group in the form of an ester group, which makes acrylic resins easy to absorb solutions. In Ferracane's research, it is stated that materials containing ester and ether groups have hydrophilic properties which cause the materials to easily absorb the surrounding solutions.²⁷Acrylic resins have one characteristic which is to absorb water slowly over a period of timethrough the mechanism of water diffusion. This water absorption characteristic causes the heat-curedacrylic resins to undergo dimensional changes.⁴

The dimensional changes of heat-cured acrylic resins affected by the absorption of solutions can be influenced by the type of immersion solution used, for example acidic solutions (e.g. rosella tea with a pH of 2.64). This study

found that there were differences in the dimensions of heat-curedacrylic resins immersed in the rosella tea and distilled water in which the dimensions ofheat-curedacrylic resins in the rosella tea were higher than those in distilled water after immersion for 3,5,7 and 9 days. This difference can occur because there are some acid contents in rosella tea such as vitamin C, citric acid, glycolic acid, ascorbic acid and eighteen amino acids.^{23,28}Acid compounds contain many H⁺ions which can reduce the surface tension of heat-curedacrylic resins so that the molecules in the solution are easy to penetrate between the acrylic resin molecules, making diffusion happen faster; thus, the dimensional changes of acrylic resins in the rosella tea are greater than those in distilled water (neutral pH of 7).²²

The dimensional changes of heat-cured acrylic resins caused by the absorption of solution can be affected by the immersion time. The absorption of the solution which is affected by the immersion time occurs diffusionly withinheat-cured acrylic resins, meaning that the molecules in the solution can penetrate the poly methyl methacrylate density and will eventually form porous in the acrylic resins. The longer the immersion time, the more time it takes for the solution molecules to penetrate into the polymer chains, leading to greater dimensional changes. This condition has been conformed by the research of Al Nori*et al.* which showed that immersion of acrylic resins in distilled water for 7 days yielding an increase in weight of 1.0168 gr and immersion of acrylic resins in distilled water for 1 month resulted in an increase in weight of 1.8221 gr.⁴However, in this study the graphic patterns that occurred in immersion in distilled water for 3,5,7 and 9 days. The similar graphic patterns were also depicted after immersion in rosella tea for 3,5,7 and 9 days. ⁵After being immersed for 3 and 5 days, the acrylic resins experienced an increase in their dimensions.

The results of the analysis showed a significant difference (p < 0.05) in the 3-day group. This is presumably due to the specimens having an immersion treatment for 24 hours in distilled water to reduce the residual monomers prior to the immersion treatment for 3,5,7 and 9 days. The released monomers were likely to cause a large free space on the acrylic resins so that the resins had an increase in weight, and thus, could absorp a larger solution after 3 days.

The dimensional changes after 5 days experienced a significant improvement (p < 0.05). This was likely because the empty space in the acrylic resins began to be fully filled by the solution molecules absorbed and the remaining monomers released were smaller compared to in the first day; thus, the absorption of the solution occurred less and less. Water continued to diffuse in between the polymer chains which caused expansion thereby increasing the dimensional changes.

On the other hand, the dimensional changes after 7 and 9 days of immersion decreased, showing a significant difference (p < 0.05) after 5 days. This could be due to the acidic properties of rosella tea reacting with the acrylic resins, which led to chemical damage to the surface of the resins. The exposure to acid solutions can cause the release of ions contained in heat-curedacrylic resins, causing surface irregularity.²⁹An acidic rosella tea solution can erode the surface of heat-curedacrylic resins. In the Shakhashiri's research, it is stated that the erosive power of acids depends on the type of acid contained in drinks. The highest erosive power is citric acid, followed by malic acid and phosphoric acid. Therefore, it is highly likely that citric acid can erode faster.³⁰ This process is believed to develop porous in large quantities resulting in the dimensional changes in the form of weight loss in heat-curedacrylic resins. The changes in the dimensions of the heat-curedacrylic resins after 7 days immersion decreased significantly (p < 0.05) compared to immersion after 5 days. This condition happens presumably because after immersion for 7 days, theheat-curedacrylic resins have degraded. This finding corroborated the study byHuseyin which indicated that the dimensional change after immersion of the heatcuredacrylic resins in synthetic saliva for 7 days was 0.019 mg/cm²while immersion for 15 days showed a dimensional change of 0.015 mg/cm^{2,20}The changes were thought to be caused by a decomposed matrix polymer (lysis). The decomposition of the matrix might have reduced the number of matrices contained in the specimens, causing a decrease in the ability to absorb the saliva solution and a decrease in the dimensions of the resins.

The result of the further test showed a significant difference (p > 0.05), between the dimensional changes in 3 and 9 days. Such a difference was perhaps affected by the acid solution used, in which it could degrade the

acrylic resins. The matrix decomposition may occur due to hydrolysis of the matrix. Methacrylic acid has been yielded as a result of the degradation process due to the hydrolysis of the matrix polymers. The degradation process is related to the absorption of the solution and swelling of the matrix, in which the degradation leads to the release of organic matters and the mass loss, thereby having a decrease in the dimensional changes in acrylic resins.³¹

Conclusions

There are some conclusions that can be drawn from this study: First, the was an influence of immersion timein rosella teaon the dimensional changes f heat-cured acrylic resins after immersion for 3, 5, 7 and 9 days; Second, there was a dimensional change of the heat-cured acrylic resins on day 3 after immersion in rosella tea of 0.781 with a standard deviation of 0.77 while in distilled water was 0.580 with a standard deviation of 0.83; Third, there was a dimensional change of the heat-cured acrylic resins on day 5 after immersion in rosella tea of 0.871 with a standard deviation of 0.80 while in distilled water was 0.773 with a standard deviation of 0.72; Fourth, there was a dimensional change of the heat-cured acrylic resins on day 7 after immersion in rosella tea of 0.826 with a standard deviation of 0.73 while in distilled water was 0.767 with a standard deviation of 0.40; and Fifth, there was a dimensional change of the heat-cured acrylic resins on day 9 after immersion in rosella tea of 0.710 with a standard deviation of 0.93 while in distilled water was 0.596 with a standard deviation of 0.93.

Suggestions

It is recommended that dentures users not to consume rosella tea in a long period of time in order to maintain the stability of artificial teeth. In addition, further research should be conducted in order to examine the effects of immersion of acrylic resins with other solution materials.

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