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The Effect of Vitamin C 1000 mg Beverages on Surface Roughness of Heat Cured Acrylic Resin

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Abstract

Introduction: Consumption of vitamin C 1000 mg beverages regularly can increased surface roughness of heat cured acrylic resin which caused by chemical reaction between acids in the beverages and heat cured acrylic resin. This caused by the acidic state in oral cavity and affect the surface roughness of heat cured acrylic resin. **Objective:** To determine the effect of vitamin C 1000 mg beverage on surface roughness of heat cured acrylic resin. **Methods:** Forty-four samples of heat cured acrylic resin sized 2 cm x 2 cm x 3 mm were divided into 4 groups. Samples were tested using surface roughness tester (Handysurf, Japan). Afterwards, group I immersed in You C1000 lemon, group II in You C1000 orange, group III in You C1000 apple, and control group in aquadest. Immersion was carried out for 3 days in a 37^{o}C incubator with solutions replacement every 24 hours. Then, carried out the last measurement of surface roughness (post-test) of resin acrylic heat cured. Statistical test used in this study were paired t-test and one way ANOVA. **Results:** Paired t-test on group I, II and III showed that there were significant increase on surface roughness. One way ANOVA welch showed that there was a significant difference. Post hoc Games-Howell showed that there was a significant difference on control group compared to group I, II and III. **Conclusion:** There was an effect of vitamin C 1000 mg beverage on surface roughness of heat cured acrylic resin.

Keywords: Surface roughness, heat cured acrylic resin, vitamin C 1000 mg.

Introduction

Health has been the driving force behind trends and innovation in the food and beverage industry.[1] One of the beverages commonly consumed is a health drink. It generally contains vitamins that have specific health functions. Riset Kesehatan Dasar (Riskesdas) in 2013 reported an increase in sales of beverages aimed at improving health.[2] One of them is healthy drink containing 1000 mg of vitamin C that has functions such as to promote immunity, strength, avoid flu, and other health functions.[1,3]

Vitamin C 1000 mg are generally sold in tablets packed in glass bottles. It is also served in the form of a drink in various flavors such as lemon, orange, and apple.[3] One of the brands available in the Indonesian market is You C1000.[4] The acid content of the 1000 mg vitamin C drink is generally ascorbic acid and an acidity regulator. (acidulant).[3] The pH examination on vitamin c 1000 mg showed an acidic value, around 3,6 to 3,7. Acidic solutions or

beverages (pH<5) are known to affect the physical properties of dental material, such as denture base.[5,6] One of the physical properties that could be affectd is surface roughness of the denture base.[7,8]

One of the materials widely used for the fabrication of a denture base is acrylic resin.[8] Based on the polymerization activation, acrylic resins are divided into heat-cured, chemically cured, and light-cured.[6,9] Heat-cured acrylic resin is commonly used as a denture base. However, the acrylic resin can absorb water when placed in a wet environment, such as the oral cavity.[6]

Regular consumption of acidic solution could result in the decrease of pH value of the oral cavity that lead to an increase in the surface roughness value of the acrylic resin.[7,8] Sofya et al. reported the increase in surface roughness of acrylic resin after immersion for 2 days in soft drinks which has acidic pH value.7 Kodir et al. also reported that acidic solutions cause disturbance on chemical bonds of acrylic resins.[8] The clinically accepted surface roughness value is 0.2 µm, and if the value exceeds 0.2 µm, this can lead to increase plaque adhesion.[8,10]

Based on data in Riskesdas in 2007, the use of dentures can be found in the age group of children (5-11 years old) to late elderly (> 65 years old). The adolescent age group had a prevalence rate of 6.2%[11] The adolescent age group has a high consumption of 1000 mg vitamin C.[4] This study was conducted to determine the effect of 1000 mg vitamin C beverages on denture surface roughness of acrylic resin heat cured.

Methods

This was a quasi-experimental study with a pretest and post-test with control group. This study was conducted at the Laboratory of Dentistry Sriwijaya University and the Laboratory of Mechanical Engineering Sriwijaya University.

Baseplate wax was used to make molds for acrylic resin specimens with 20 mm of length, 20 mm of width, and 3 mm of thickness. The polymerization of heat-cured acrylic resin was done by following the manufacturer's instruction. The acrylic resin specimens must be flat, non-porous, and smooth. The number of specimens used in this study was 44 specimens, divided into 4 groups with each group having 11 specimens. Group I was immersed with vitamin C 1000 mg with lemon flavor, group II with orange flavor, group III with apple flavor, and control group with distilled water.

Each treatment group has 2 petri dishes containing 5-6 specimens and will be immersed in 60 ml solution. Each solution was first examined with a pH measurement using a digital pH meter (Hanna Instrument, Romania). Then the specimen's surface is given 3 dots with a black marker as a measurement guide. The surface roughness of all specimens was measured using Surface Roughness Tester (Handysurf, Japan) with an accuracy of 0.01 μm to 1 mm.

Samples were immersed for 3 days (72 hours) to stimulate the average of beverages daily consumption habits for 20 minutes per day and six months of use (20 minutes x 180 days = 3600 minutes = 60 hours = 2.5 days). The specimens were in an incubator with a temperature of 37oC. The immersion media was changed every 24 hours. After immersion, the specimens were rinsed with distilled water and dried.

The acquired data (before and after immersion) of surface roughness measurements were analyzed using statistical software SPSS. The normality test was carried out by using the Saphiro-Wilk test, and continued with the homogeneity test with the Levene's Test. Next, data were analyzed using Paired t-test to determine whether there was a significant difference in the paired group, continued with One Way ANOVA test ($p \leq 0.05$) to determine whether there was a significant difference in surface roughness in each groups. The Games-Howell Post Hoc test was performed to determine the difference value between each groups.

Results

The pH measurement of each solution was tested using a digital pH meter (Hanna Instrument, Romania). The results of pH measurements from each solution can be seen in Table 1.

Table 1. Result of pH measurement of each solution.

Groups	pH
I (You C1000 *lemon*)	3,7
II (You C1000 *orange*)	3,6
III (You C1000 *apple*)	3,6
IV (Control)	7,1

Measurement of surface roughness of heat-cured acrylic resin before (pretest) and after immersion (post-test) in each solution can be seen in Table 2. The normality test showed the data are normally distributed ($p > 0.05$). Hence, the Paired t-test was done to see the

significance of surface roughness of heat-cured acrylic resin in one group before and after immersion.

Table 2. The mean surface roughness of acrylic resin and the results of paired t-test

Group	N	Surface Roughness (µm) Mean ± SD		Sig.
		Pretest	*Post-test*	
I (You C1000 *lemon*)	11	0,0998±0,01761	0.1621±0,05607	0.003
II (You C1000 *orange*)	11	0,0935±0,02699	0.1615±0,05085	0.000
III (You C1000 *apple*)	11	0,0955±0,01864	0.1618±0,03963	0.000
IV (Control)	11	0.0945±0,02339	0.1044±0,01502	0.084

As shown in Table 2, group I, II, and III showed a probability value of $p < 0.05$. It means that there were significant differences before and after immersion in 1000 mg of vitamin C beverages. Meanwhile, the control group showed a probability of 0.084 ($p > 0.05$) which means that there was no significant difference before and after immersion. These results indicate the hypothesis in this study is accepted. There is a significant difference in surface roughness of heat-cured acrylic resin after immersion in 1000 mg vitamin C beverages.

Furthermore, Levene's test of Variance results showed that the data was not homogeneous. So, the one way ANOVA Welch test was done. The results showed a probability value of 0.006 ($p < 0.05$) which means that there is a difference in the surface roughness of the heat-cured acrylic resin between groups. The test continued with the Post Hoc Games-Howell to determine the significance of the difference in the mean surface roughness values of heat-cured acrylic resin between groups. As showed in Table 3, there was a significant difference between the test group and the control group. Meanwhile, there was no significant difference between the test groups.

Table 3. The results of Post Hoc Gomes-Howell test

Group	I (You C1000 *lemon*)	II (You C1000 *orange*)	III (You C1000 *apple*)	IV (Control)
I (You C1000 *lemon*)		1,000	1,000	0.030*
II (You C1000 *orange*)			1,000	0.017*
III (You C1000 *apple*)				0.003*
IV (Control)				

*: there was a significant difference

Discussions

This study was conducted to determine whether there is an effect of 1000 mg of vitamin C beverages on surface roughness of heat-cured acrylic resin. The results showed that there were significant differences before and after immersion in the 1000 mg vitamin C beverages group, but the control group (distilled water) showed insignificant values. This can be related to the degree of acidity of each group of solution. Vitamin C 1000 mg beverages shows an acidic pH (3.6-3.7) when compared to the pH in distilled water with neutral pH. This result was in line with the study by Kodir et al. and Sofya et al. that a solution having an acidic pH increases the surface roughness of acrylic resin.[7,8]

Vitamin C 1000 mg beverages contain acids such as ascorbic acid and citric acid. Ascorbic acid (vitamin C) is a water-soluble substance that is useful for enzyme activation, reduce oxidative stress, and immune function. This substance can be found in fruits such as oranges. Research conducted by Bahal et al. demonstrated the enamel erosion in patients taking vitamin C regularly and for a prolonged period.12 Research conducted by Danalakshimi et al. showed a decrease in salivary pH in subjects who had taken vitamin C tablets.[13] The level of erosion that occurs in each individual depends on several factors such as the level of acid content in the tablets, the pH degree of saliva for each individual, and the frequency of consumption. Ascorbic acid tablets of 60mg, 250 mg, or 500 mg can lower the pH of saliva.[12] Giunta et al. cited by Bahal et al. stated that ascorbic acid shows higher erosive properties when compared to citric acid commonly found in carbonated beverages.[12]

Citric acid acts as an acidity regulator and preservative commonly used in packaged drinks. Research conducted by Erdemir et al. states that drinks containing citric acid have a high erosive potential.[14] The high erosive properties of ascorbic acid and citric acid in 1000

mg of vitamin C beverages are considered as the cause for the increase in surface roughness of heat-cured acrylic resin. Based on the theory of "corrosive wear", acidic solutions have corrosive properties that can cause the degradation of chemical bonds.8 Acrylic resin surface roughness can be affected by the increased acid concentration or low pH that will weaken the acrylic resin polymer bonds.[7,8,15]

This study showed an increase in surface roughness of heat-cured acrylic resin after immersion in a 1000 mg vitamin C beverage. Although there was an increase, the surface roughness value of heat-cured acrylic resin showed a clinically acceptable value of 0.2 µm, which is in line with research conducted by Abuzar et al.10 This shows that the beverages are still safe to be consumed once a day for six months.

Conclusion

Based on the results, it can be concluded that there was increases in surface roughness of heat cured resin acrylic after the immersion in 1000 mg vitamin C beverages.

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