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SURFACE HARDNESS EVALUATION OF BULK-FILL COMPOSITE RESIN AFTER IMMERSION IN PROBIOTIC DRINKS AND CARBONATED DRINKS

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ABSTRACT
Background: *Probiotic drinks and carbonated drinks can affect the surface hardness of bulk-fill composite resin due to its acidic property. The acid may interfere with matrix and filler bonding in composite resin and will result in the dissolution of resin matrix and the decrease in hardness value of bulk-fill composite resin surface.* ***Objective:*** *The purpose of this study was to analyze the differences in bulk-fill composite resin surface hardness after the submergence in probiotic drinks and carbonated drinks.* ***Methods:*** *This study used pure laboratory experimental method (true experimental) with a post-test only and control group design. One Way ANOVA test followed by the Bonferroni Post Hoc test was performed to analyze the significance from each treatment. A total of 27 samples was divided into 3 groups, namely group 1 of bulk-fill composite resin soaked in probiotic drinks, group 2 soaked in carbonated drinks and group 3 soaked in sterile distilled water. The measurement of sample surface hardness was using Vickers Microhardness Tester.* ***Results:*** *The average value of surface hardness in group 1 was 61.41 Kg / mm^2, group 2 was 57.62 Kg / mm^2 and group 3 was 65.85 Kg / mm^2. The results of One Way ANOVA parametric test obtained p = 0,000 (p <0.05) and continued with Bonferroni Post Hoc test which showed significant differences between each group (p<0.05).* ***Conclusion:*** *There is a lower effect of bulk-fill composite resin submergence in probiotic drinks on surface hardness than those immersed in carbonated drinks.*

Keywords: *Bulk-fill composite resin, carbonated drinks, probiotic drinks, surface hardness*

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INTRODUCTION

Restorative materials used for teeth reservation must be safe and must resemble the color of natural teeth. Composite resin is a restorative material composed of chemical components with a color similar to natural teeth. Composite resin is one of the most commonly used materials in dentistry and was first announced by Bowlen in 1962.[1,2] Composite resins have several components, namely inorganic fillers, resins containing organic polymers and adhesive materials (couplings) that can bind to the organic matrix to promote equal pressure distribution upon the receiving loads.[3]

The development of composite resins is increased along with technological developments. One of the developments is the presence of composite resin type that can be cured to a thickness of 4 mm. This composite resin is a bulk-fill type composite resin.[4] Bulk-fill composite resin has a longer polymer bond and shorter inter-monomer space to reduce the shringkage of polymerization .[5]

Bulk-fill composite resin was applied by inserting composite resin on the cavity at once to a depth of 4 mm. Bulk-fill composite resin contains an initiator in the form of camphoroquinone which is then added with polymerization accelerator in the form of ivocerin.[6] Ivocerin can absorb rays better, thereby accelerating the polymerization to the bottom of the cavity. Bulk-fill composite resin has several advantages, namely easy application,

microleakage reduction due to low polymerization shrinkage, and pressure shrinkage reduction due to its high elasticity.[7]

Composite resins have several physical properties including polymerization shrinkage, water absorption, surface roughness, solubility and mechanical properties in the form of flexural strength, Young's modulus and material surface hardness.[8] One of the composite resin properties used as a parameter to determine the durability and restrict material wear and abrasion is surface hardness.[6] Surface hardness will determine composite resin duration when residing in the oral cavity. In general, composite resins can survive in the oral cavity for around 5 years.[9,10] If the hardness of the composite resin surface is not maximal, it will cause the cracking and the detachment of material due to its inability in withstanding the chewing load. One of the factors that affect the surface hardness of composite resin is one that contains acidic drinks.[2]

Consumption of acidic foods or drinks can cause the composite resin matrix to degrad as the composite resin polymer bonds become unstable so that the composite resin surface hardness decreases.[11] Probiotic drinks is categorized as one of the acidic drinks. They are also called as lactic acid fermentation drink because the content of lactic acid bacteria (LAB) used in maintaining the balance of intestinal microflora with the average pH of 2.86. In addition to probiotic drinks, carbonated drinks are also widely consumed by the public including acidic drinks consumption with a pH of around 2.5. According to the data from World Health Organization (WHO), many people consume probiotic drinks every day as an additional supplement. Probiotic drinks that are often consumed are Yakult and Yogurt.[12,13] Meanwhile, the average sales of carbonated drinks in Indonesia in 2004 - 2009 reached 7.2% per year and it was increased in 2010 by 1.8% .[14]

Based on previous research survey, the sales rate of Yakult in Makassar City has the highest increase than other brands of probiotic drinks, which amounted to 8.50% .[15] In addition, Yakult was rising in the top brands ranking of fermented milk in Indonesia in 2012-2016 and so does Coca-cola which also ranked one in the list of top brand carbonated drinks in Indonesia in 2013-2014.[15,16]

The estimated length of exposure to drinks consumed in the oral cavity is about 1 minute. If one consumes a bottle of acidic drinks per day in 5 years, then it is equivalent to 30 hours of immersion time.[17]

People frequently consume probiotic drinks and carbonated drinks despite of the fact that acid content in those drinks is thought to degrade composite resin matrix which will reduce the surface hardness. Researchers are interested in conducting a study on bulk-fill composite resin surface hardness after immersion in probiotic drinks and carbonated drinks so that after the research is carried out, it is expected to add insight to dentists and provide information to the public about the effects of probiotic drinks and carbonated drinks on the surface hardness of bulk-fill composite resin material.

MATERIALS AND METHODS

This research had passed the ethical feasibility tests that it obtained research permit published by Faculty of Dentistry, University of Lambung Mangkurat No.167 / KEPKG-FKGULM / EC / I / 2019. This study employed pure laboratory experimental research (true experimental) using a post-test only with control group design. This research was conducted at Wet Laboratory of FKG Universitas Lambung Mangkurat for samples fabricationand immersion in artificial saliva.

Sample immersion in test solutions and control solutions was conducted in an incubator at Integrated Research Laboratory, FKG Gadjah Mada University, Yogyakarta. The sample surface hardness tests were then carried out at the Engineering Materials Laboratory of the Mechanical Engineering Department and Industrial Faculty of Engineering, Gadjah Mada University, Yogyakarta in January 2019. The number of study sample was defined using simple random sampling technique consisting of 3 treatment groups, namely group 1 of sample immersion for 30 hours in probiotic drinks, group 2 of sample immersion in carbonated drinks for 30 hours and group 3 of sample immersion for 30 hours in sterile distilled water.

This research began with tools and materials preparation for the fabrication of composite resin samples. Sample was fabricated using transparent acrylic molds with 4 mm thickness and 10 mm diameter. Acrylic mold was placed on the top of glass plate, then composite resin was applied to the sampling mold using plastic filling instruments and was condensed using a condenser to obtain condensed composite resin. On the surface of the sample, celluloid strips and glass slides were placed to obtain a flat sample surface. The composite resin was polymerized for 10 seconds using a light cure LED unit with a radiation distance of 1 mm against the composite resin surface. Composite resin samples with a thickness of 4 mm and a

diameter of 10 mm were removed from the mold. After that, composite resin samples were immersed in artificial saliva and placed in a glass cup to be incubated for 24 hours at 37°C.

After the samples were incubated for 24 hours, the samples were divided into 3 groups with 9 samples for each treatment. All samples were put into a beaker based on each respective group containing three different solutions, namely probiotic drinks, carbonated drinks and sterile distilled water. The samples were then incubated for 30 hours at 37°C and removed after 30 hours by taking the samples using tweezers and placed in nierbekken before the value of surface hardness from each sample was measured.

Measurement of surface hardness was carried out using Vickers Microhardness Tester. The surface of composite resin samples was given an indentation load of 100 gf for 15 seconds by a pyramid-shaped diamond with a peak angle of 1360. The diagonal length of the indentation was subsequently calculated to obtain surface hardness value. Calculation of surface hardness with Vickers Microhardness Test used the following formula: [3]

$$d = \frac{d_1 + d_2}{2}$$

$$VHN = \frac{1{,}854\ F}{d^2}$$

Formula description:
F = Load (gf)
D = Diagonal average length of d_1 and d_2 (mm)
VHN = Vickers Hardness Number

Data normality and homogeneity was evaluated by Shapiro-Wilk test and Levene's test. Parametric analysis was performed using One way ANOVA hypothesis test with a confidence level of 95% ($\alpha = 0.05$), then followed by Post Hoc Bonferroni analysis to determine the value of significance.

RESULT

The results for surface hardness study after immersion in probiotic drinks compared to carbonated drinks and sterile distilled water are described in table 1.

Table 1. Mean ± standard deviation of bulk-fill composite resin surface hardness after immersion in probiotic drinks, carbonated drinks and sterile distilled water

Group	Mean ± Standard Deviation
Probiotic drinks	61,41±1,95
Carbonated drinks	57,62±2,64
Sterile distilled water	65,85±2,59

Based on Table 1, it can be seen that the lowest average value of surface hardness was found in carbonated drinks immersion group with a value of 57.62 ± 2.64, while the highest average of surface hardness value was presented in distilled water group with a value of (65.85 ± 2.59). The diagram of surface hardness average value obtained from the samples after immersion in probiotic drinks, carbonated drinks and sterile distilled water can be observed in Figure 1.

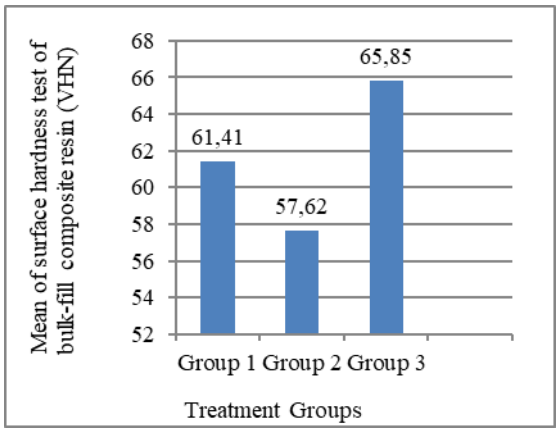

Figure 1. Mean diagram of surface hardness test of bulk-fill composite resin samples after immersion in probiotic drinks, carbonated drinks and sterile distilled water

The normality test was performed using Saphiro-Wilk test. The results of normality test demonstrated significance result in each group where p> 0.05. This means that the data was normally distributed. Data analysis was continued by homogeneity test using Leven's test. The data homogeneity test results obtained p > 0.05, which means the data demonstrated a homogeneous variant. After normality and homogeinity testing, parametric test in the form of One Way ANOVA were carried out with a confidence level of 95%.

The results of One Way ANOVA parametric test obtained p = 0,000 (p <0.05)

which demonstrates the presence of significant differences. The data was then analyzed using Bonferroni Post Hoc test to find out which groups had significant differences. The results of Post Hoc Bonferroni test showed significancy or significant differences among all treatment groups. The first highest significant difference was presented in carbonated beverage group in comparison to sterile distilled water group with p = 0,000 (<0.05) and the second highest significant difference was found in the group of probiotic drinks in comparison to sterile distilled water group with p = 0.002 (<0.05). The smallest significant difference was found in the group of probiotic drinks in comparison to carbonated beverage group with p = 0.008 (<0.05).

DISCUSSION

The results showed that the average value for sample surface hardness after immersion in carbonated drinks was lower than those soaked in probiotic drinks and sterile distilled water. This is caused by the degree of acidity (pH) of carbonated drinks. The degree of acidity (pH) of carbonated drinks is higher than that of probiotic drinks and sterile distilled water, so they are presented in more acidic state. Composite resin material soaked in acidic solution can make the material components to dissolve easily causing erosion on the surface of materials. This will affect the wear properties of composite resin sample surface which can lead to a decrease in the surface hardness.[11] In accordance with the study of Bomfim et al. (2011), it is potrayed that drinks with higher degree of acidity (lower pH) would potentially cause greater erosion on the surface of a material. In addition to the high acidity (low pH) of carbonated drinks, the phosphoric acid content in carbonated drinks also promotes material erosion which will cause a decrease in the surface hardness of materials.[18] Other factors that affect the decrease in surface hardness of the material are carbon dioxide addition in the manufacture of carbonated drinks. It is intended to produce a sour taste yet increase H^+ ions content in the drinks.[19] Further, the high sugar content in carbonated drinks can affect the surface hardness of restorative materials because the microorganisms in the oral cavity will break down the sugar into acid and potentially cause erosion on the surface of the restoration.[18]

In accordance with Tanthanuch *et al*. (2014) study, the factors that have potential in promoting erosion may include the consumption of acidic drinks which is associated with the acidity (pH) of these drinks. Its acidity is due to the acid component within which may also induce the reduction of surface hardness value in a material. Carbonated drinks contain phosphoric acid which can soften and facilitate erosion on the surface of the material thus enhancing the hardness reduction of material surface.[20]

Unlike the group of samples soaked in probiotic drinks, the average surface hardness value obtained from the samples soaked in carbonated drinks was observed to be higher. This is caused by the acidity (pH) of the probiotic drink which is higher than that of the carbonated beverage presenting lower H^+ ions content in probiotic drinks than those in carbonated drinks. It is in accordance with Poggio (2012) study which showed that the acidity (pH) of a drink will influence the decline of composite resin surface hardness value. The lower the acidity level (pH) possessed by the beverage, the higher H^+ ion content dissolved.[21] This results in higher value of composite resin surface hardness in probiotic drink than that in carbonated drink. Lower degree of dissolved material was observed in samples soaked probiotic drink than those in carbonated drink. In addition, the presence of lactic acid in probiotic drinks will generate the formation of hydrogen bonds between organic matrices thus can interfere with the bonding between matrix and filler. This process will result in the dissolution of the resin matrix which will cause a decrease in surface hardness value in composite resin samples.[22]

Composite resin immersion in sterile distilled water group has the highest surface hardness value compared to the carbonated drinks and probiotic drinks. This is caused by the low acidity (pH) of sterile distilled water. It is in line with a research from Yanikoglu et al. (2009) which proved that composite resins will experience a greater decrease in surface hardness value when immersed in acidic drinks compared to the immersion in sterile distilled water. Higher H^+ content in acidic drinks contribute to this condition that the solution is easier to react to the surface of composite resin compared to those soaked in sterile distilled water with neutral acidity (pH). [23]

The decrease in surface hardness occurs when composite resin polymer material absorbs water, causing hydrolytic damage and disconnection between resin matrix and filler.[11] The acid content in a solution will increase the rate of of hydrolysis reaction, so that the concentration of residual monomer release causes the matrix to dissolve at higher acidic pH than neutral pH.[24] In accordance to the Silva et al. (2011) study, it is explained that composite resins have higher water absorption in acid solutions compared to those in neutral pH such as sterile distilled water.

The rate of water absorption from composite resin is influenced by the strength of hydrogen bonds with a resin matrix that will cause the bond between the resin matrix and filler to become unstable.[25] This causes a difference in the surface hardness value of sample soaked in probiotic drinks, carbonated drinks and sterile distilled water with different pH levels. Based on the description, it can be concluded that there is a lower effect of bulk-fill composite resin submergence in probiotic drinks on its surface hardness than those immersed in carbonated drinks.

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