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ISOTONIC BEVERAGE EFFECT ON SURFACE HARDNESS OF *BULK-FILL* TYPE COMPOSITE RESIN

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ABSTRACT
Background*: Bulk-fill composite resin is a restorative material that can be applied directly to a cavity with 4 mm thickness. This benefits the dentist because it can accelerate restoration process. Isotonic drinks are one of soft drink categories that are popular among Indonesian people. This drink has an acidic pH and there are several other chemical contents that may affect the surface hardness of bulk-fill type composite resin.* ***Purpose****: The purpose of the study was to analyze changes in the hardness of bulk-fill composite resin surface after the immersion in isotonic drinks.* ***Method****: The type of this research was a true experimental study with post-test only and control group design. The shape of bulk-fill composite resin samples was cylinder with 10 mm diameter and 4 mm thickness. The study consisted of 3 treatment groups. The first group was immersed in isotonic drink A, the second group was immersed in isotonic drink Mizone and the third group was immersed in steriled distilled water for 18 hours respectively. The surface hardness was then measured using Vickers Microhardness Tester.* ***Results****: The result of One Way ANOVA and Bonferroni Post-Hoc test showed p value < 0.05, which means that there is a significant difference in the hardness of bulk-fill composite resin surface after the immersion in isotonic drink A and isotonic drink Mizone.* ***Conclusion****: Bulk-fill composite resin immersed in Mizone has the lowest hardness value than those immersed in drink A and distilled water.*

Keywords: *Bulk-fill type composite resin, isotonic drinks, surface hardnes.*

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INTRODUCTION

In this modern era, public awareness on oral health has been risen. A good oral condition can increase self-confidence thus various efforts were made to improve the condition of the oral cavity. One of the treatments that are often carried out by the community is dental restoration.[1] The result of Nur Shabrina study at RSGM Unsyiah Banda Aceh in July-December showed 495 patients received dental care including dental restoration and more composite resin stools were used for around 239 cases (48,3%) compared to the use of Glass Ionomer Cement (27,3%) and amalgam (24,5%).[2] Composite resin is a restorative material that can be used for posterior and anterior teeth because of its adequate strength and color similarity with natural teeth so that it increases the aesthetic value. [3,1,4]

In 2010, a new composite resin material was introduced namely bulk-fill composite resin that can be applied into cavities up to 4 mm in thickness with bulk techniques.[5] Another advantage of bulk-fill composite resins is that they minimize shrinkage during polymerization thereby reducing microleakage, resulting in minimal water absorption, preventing porous formation , and having high elasticity that it is easy to apply with certain degree of translucency enabling bulk-fill composite resin to be cured in a thickness of 4 mm.[6]

Important indicators that are considered in the use of composite resins are surface hardness that affects material ability to resist chewing load.[7] The hardness of composite material needed to withstand normal chewing load which is around 314 N. Therefore, composite resin must have a greater hardness value than chewing load produced. The research report states that the highest hardness value is around 841.49 N / mm up to 332.87 N / mm.[1]

The surface hardness of composite resin material can change. This is due to various factors,

one of which is the exposure to chemicals obtained from the consumption of acid-containing soft drinks, for example, isotonic drinks.[4.7] The habitual consumption of acidic drinks may directly expose composite resin to chemicals material. Matrix degradation will subsequently happen and causes the decrease of surface hardness composite resin value.[8] Surface hardness of composite resin restoration material decreases after being exposed to acid solution for 1 year every day.[7]

These days, acidic drinks that are popular among Indonesian people are isotonic drinks with annual consumption up to 200 million liters.[9] It is a type of soft drinks that may improve body fitness by providing sugar, citric acid, and mineral contents.[10] Isotonic drinks have a pH of 2,4- 4.5 which is classified as critical acid.[11] The Ministry of Industry explained that the data for domestic isotonic drinks sale increased in 2012 by 20% (4.2 trillion rupiahs higher than sales in 2011 which was around 3.5 trillion rupiahs).[9] Along with the increase of public demand for these drinks, the beverage industry produces various types of isotonic drinks and one of them is isotonic drinks with fruit flavor variants.[12] Based on Susiani's research on composite resins soaked in isotonic drinks, it demonstrated that erosion was occured on composite resin fill material and cause matrix degradation which results in a decrease in the level of hardness.

The decrease in composite resin surface hardness value will cause failure, both in terms of aesthetics and restorative function.[8] This study was conducted to determine the effect of bulk-fill type composite resins immersion in isotonic drinks upon surface hardness.

MATERIALS AND METHODS

Categorized as true experimental study, this research was conducted with a post-test only with control group design to determine the surface hardness of bulk-fill composite resin after immersion in the isotonic beverage brand *Pocari Sweat* (A) and isotonic beverage brand *Mizone* (B). Research was carried out on January 2019 at Wet Laboratory of FKG, University of Lambung Mangkurat Banjarmasin, FKG Integrated Research Laboratory, Gadjah Mada University, Yogyakarta and Technical Materials Laboratory, Department of Mechanical and Industrial Engineering, Faculty of Engineering, Gadjah Mada University, Yogyakarta. This study used a cylindrical bulk-fill composite resin and 10 mm diameter and a 4 mm thickness as the sample. According to the unpaired numerical categorical analytic formula, the total number for research samples was 27 which were splitted into 3 groups.[14] The first group was immersed in isotonic drinks A, the second group was immersed in isotonic drinks B and the third group was immersed in *steriled distilled water* (control). All immersion procedure are carried out for 18 hours in the incubator.

This research utilized several tools, namely sample prints made of transparent acrylic with a diameter of 10 mm and 4 mm thickness, *plastic filling instruments*, condensers, *celluloid strips*, glass slides, tweezers, neirbekken, Light Curing Units with an intensity > 1000m /Wcm^2, Bekker glass, measuring tube, pipette, black marker, pH meter, incubator and *Vickers Microhardness Tester* hardness test. The materials used in the study were Tetric N-Ceram® Bulk Fill color IVA composite bulk fill resin, artificial saliva, isotonic drinks A and B, and *steriled distilled water* .

The research was initiated by fabricating the sample into the shape and size that has been determined using plastic filling instruments and immediately applied into the mold. The sample surface was covered with celluloid strips and glass slides to obtain a smooth sample surface. The sample was cured with LCU for 10 seconds with a radiation distance of 1mm, after which the sample was removed from the mold and put into artificial saliva for 24 hours as a model for oral environment. All samples were divided into 3 groups, where each group consisted of 9 samples which would be put into a glass container containing their respective immersion solution. A total of 400 ml solution was used for immersion media so that all samples were submerged. Bekker glass then put into an incubator at 37^{o}C temperature for 18 hours which was assumed to be equivalent to 1 year consumption of isotonic drinks every day. The last stage was the measurement of surface hardness in all samples using a *Vickers Microhardness* Tester with a 100gf load for 10 seconds. The result was obtained from the size of lesion produced after being pressurized by an indenter with a pyramidal diamond eye where the opposite side forms an angle of 136^o. The trace produced after the pressure is removed and measured by a microscope. The result of this test was then calculated using Vickers formula:[15]

$$d = \frac{d1 + d2}{d}$$

$$VHN = \frac{1{,}854\ F}{d_2}$$

Formula description:
F = Load (gf)
d = Diagonal average length of d1 and d2 (mm)
VHN = *Vickers Hardness Number*

The data obtained from the calculation of Vickers formula was then evaluated using SPSS. Firstly, the statistical analysis was perfomed with

Shapiro-Wilk Test normality test and the *Levene's* Test homogeneity test. Had the results normally distributed and homogenous, hypothesis test was continued to *One Way ANOVA* parametric test with confidence level 95% ($\alpha = 0.005$). To determine the value of significance between treatment groups, it was followed by the *Bonferroni Post-Hoc test*.

RESULT

The study of surface hardness on bulk-fill composite resin after immersion in isotonic drinks A and B was resulted as follows:

Group	Mean ± Standard Deviation (Kg/mm^2)
Group 1	57,63 ± 2,34
Group 2	46,81 ± 4,92
Group 3	65,35 ± 2,61

Table 1. Mean and Standard Deviation of Surface Hardness Value in Bulk-Fill Composite Resin After Immersion in A and B Isotonic Drink.

Table 1 shows that the surface hardness value in bulk-fill type composite resin soaked in isotonic beverage group B had the lowest average (46.81 Kg / mm^2), followed by the group of isotonic drinks A (57.63 Kg / mm^2) and sterile distilled water group with the highest surface hardness to be observed (65.35 Kg / mm^2). Mean value and standard deviation of bulk-fill composite resin surface hardness in each group was presented in bar diagram which can be seen in Figure 1.

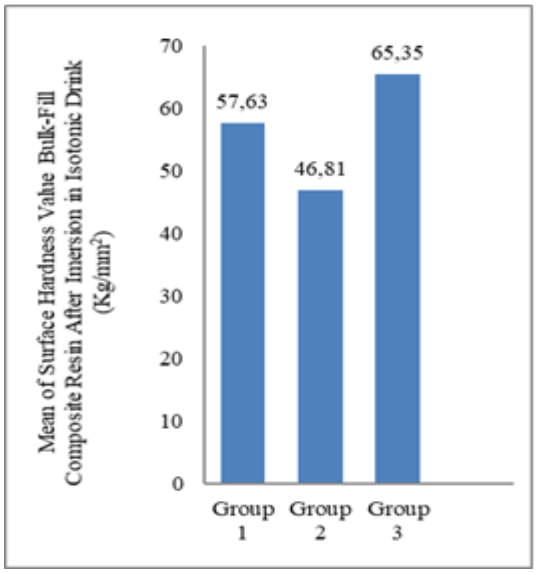

Figure 1. Mean of Surface Hardness Value in Bulk-Fill Composite Resin After the Immersion in Isotonic Drink.

Data obtained for bulk-fill type composite resin surface hardness were then analyzed statistically using SPSS 22. Data distribution was checked using Shapiro-Wilks test and subsequently investigated using Levene's test. Normality test result revealed that the isotonic beverage group A obtains a significance value ($p = 0.415$) while isotonic beverage group B obtains $p = 0.946$ and sterile distilled water group obtains $p = 0.460$. This result indicates that the data is normally distributed because $p > 0.05$. The homogeneity test result show a homogeneous data variant as $p = 0.081$ ($p > 0.05$).

The requirement for conducting parametric tests is the normal distribution and homogenous variant of the sample thus the data in this study can be proceeded to One Way ANOVA parametric test. The results of the test obtained $p = 0,000$ ($p < 0.05$) which means that there is a significant difference between the value of composite resin surface hardness soaked in isotonic drinks and those soaked in *sterile distilled water*. To find out the significant differences between the treatment groups, Bonferroni post hoc test was conducted. Based on the results, it was revealed that there is a significant difference among all treatment groups as presented in table 2.

Table 2. The Significance of Surface Hardness Value in Bulk-Fill Composite Resin After the Immersion in Isotonic Drink A and B for 18 hours.

Group	1	2	3
1		0,000*	0,000*
2	0,000*		0,000*
3	0,000*	0,000*	

DISCUSSION

The investigation of isotonic beverage effect on surface hardness of bulk-fill composite resin is resulted in significant differences in all treatment groups. The lowest hardness value was obtained in isotonik B soaking group, then followed by the group soaked in isotonic drinks A. This was caused by the acidic pH of beverage drink mixed with chemical content thus accelerates the decrease of composite resin hardness. It is known that the pH of isotonic drink B is 3.3 while the pH of isotonic drink A is 3.96. In line with the study of Poggio et al, the exposure of acid solutions with different acidity levels greatly influenced the hardness of composite resin.[10]

The low degree of acidity (pH) contains abundant H^+ ions so that it can cause a decrease in the surface hardness of composite resin via matrix

degradation process. The process will be initiated by water absorption in acidic environment where H^+ ions initiates diffusion into composite resin. This makes the chemical bonds in the composite resin become unstable and disconnected so that the organic matrix dissolves and decomposes.[16,8] Degradation of this matrix produces residual monomers thus promoting constant water absorption by blocking the crossbond of metal ions, especially Sr, Al, Si, Na, P, Ca which is released and diffuses out of the restoration material then dissolves in water.[17] In isotonic drinks, the release of H^+ ions in large amounts will bind siloxan chain and separate the bond faster.[7]

Other than pH, the decrease of surface hardness may also be caused by the presence of other chemical substances such as citric acid and sodium benzoate. These substances are found in isotonic drinks B causing the decrease of surface hardness value to occur faster. Meanwhile, isotonic beverage A contains citric acid which induces the decrease of hardness to occur later than isotonic drink B.[18]

Citric acid is an organic acid that can affect the restoration material due to matrix degradation. This degradation process makes Bis-GMA matrix to soften in which it microscopically shows a small porosity that describes the release of fillers as the result of chemical exposure to isotonic drinks. Prolonged matrix degradation may affect the stability of the bond between tooth and filling material.[16] Citric acid is presented in the form of solution which comprises the mixture of hydrogen ions and acid molecules combination that make citric acid has the dual ability to damage the surface of material.[19] Citric acid content is very erosive. This makes the pH of the beverage even lower and allows more reduction in the hardness of composite resin.[20]

Sodium benzoate is an acid that is used as a preservative in food ingredients to inhibit microbial growth. The activity of this preservative agent is optimum at pH 2.5 - 4 according to the acidity level of isotonic drinks. Sodium benzoate which is mixed with citric acid makes the drink to obtain high acidic taste, and affect the durability of the drink. This will have an affect on surface hardness of composite resin restoration material.[21]

The highest hardness value was found in sterile distilled water groups. This was caused by the relatively neutral pH that the reduction of surface hardness immersed in sterile distilled water tend to occur very slowly. Based on the results of Nuran Y (2009), it is found that composite resins soaked in acidic conditions were more micromorphologically damaged compared to the immersion in sterile distilled water or artificial saliva.[4] The pH value of distilled water is neutral, 7, as it contains no acidic property. The decrease was very small as H^+ ions are released in small quantities so that it takes a long time to experience a decrease in surface hardness.[7] In isotonic drinks A and B, H^+ ions release was higher because the pH is acidic and the citric acid content promotes faster matrix degradation. This is more likely to contribute in the lower decrease of surface hardness value in sterile distilled water groups than isotonic drinks. The results of this study demonstrate that bulk-fill composite resin soaked in isotonic drink B has the lowest hardness value compared to those soaking in isotonic beverage A and sterile distilled water.

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