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SURFACE ROUGHNESS OF BULK-FILL RESIN-BASED COMPOSITE RESTORATIVE MATERIALS AFTER IMMERSION IN PROBIOTIC MILK

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ABSTRACT
Background: *Dentists often restore posterior cavities caused by caries using the latest resin-based composite; i.e. bulk-fill resin-based composite. Probiotic milk may affect the surface roughness because the acid content may induce degradation of filler components resulted in roughness on the surface of bulk-fill resin-based composite.* ***Objective:*** *This study aims to determine the surface roughness of bulk-fill resin-based composite restorative materials after immersion in probiotic milk for 10 hours and 20 hours.* ***Method:*** *The study applied true experimental method using pretest and posttest with control group design. The research sample was obtained using simple random sampling. This study employed 8 samples which were included in 4 treatments. Thus, the total number of samples used was 32 samples.* ***Results:*** *The average value of surface roughness in group I was 0.2675 µm, group II was 0.4138 µm, group III was 0.0900 µm and group IV was 0.0938 µm. The results of One-Way ANOVA parametric test revealed p value = 0.000 (p < 0.05) and presented that the immersion of bulk-fill resin-based composite in probiotic milk for 20 hours obtained the highest average surface roughness value compared to the immersion in distilled water and probiotic milk for 10 hours.* ***Conclusion:*** *There is an increase in surface roughness of bulk-fill resin-based composite restorative material after immersion in probiotic milk for 10 hours and 20 hours.*

Keywords: *bulk-fill resin-based composite, probiotic milk, surface roughness*

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INTRODUCTION

Caries is a chronic infectious disease that often affects almost 95% of world population. Dental caries occurs due to tooth enamel damage caused by the presentation of *Streptococcus mutant* in dental plaque.[1] Microorganisms, substrates, hosts and time play an active role in the process of caries. There are several factors that are considered to be risk factors including the effect of oral hygiene, eating habits, general health conditions, as well as demographic or caries modification factors such as age, sex, social history, fluorine, number of bacteria and saliva.[2] Basic Health Research data in 2018 stated that the average percentage of Indonesian population experiencing dental and oral health problems is around 57.6% and 93% are children aged 5-6 with the value of dmf-t more than 6. The average percentage of dental and oral health problem in South Kalimantan province affecting nearly 60% of the population[3]

Dental practitioner frequently restores posterior cavities due to caries by utilizing restricted dental materials, one of which is resin-based composite material. Resin-based composite restorative materials can prevent the expansion of caries and can even maintain the integrity of the remaining teeth in the oral cavity and provide satisfactory results. The sixties was the first period in which resin-based composite restorative material emerged. These restorative materials are very popular and are even the top choice for anterior and posterior teeth restoration.[4,5] The use of resin-based composite restorative material demonstrates a

better result because the color of this material resembles that of natural tooth with aesthetic and resilience as it is one of community needs.[6] The risk of caries and the survival of resin-based composite restorative materials in the oral cavity shows good resistance. It is portrayed by 1.8% percentage of five-year average preserverance.[7]

Currently, the latest composite-based resins have been used; i.e. bulk-fill resin-based composite which has better properties than previous resin-based composite.[8] Bulk-fill resin-based composite is a resin-based composite that can be applied in cavities and can be irradiated with a thickness up to 4 mm.[8,9]

The nature of resin-based composite facilitates gradual water absorption over a period of time.[10] Food and beverages consumed by patients on a daily basis will directly make contact on the surface of the tooth which can cause water absorption in resin-based composite and give an effect on aesthetics and its resistance; hence, it can cause changes in surface roughness.[10] Another factor that is assumed to cause roughness on restorative resin-based composite surfaces is the effect of pH because polymers in resin-based composite have unstable bonds; so, it will be easily degraded by low pH.[11] In an acidic or low pH environment, it can cause roughness on the surface of resin-based composite and increase erosion in the polymer.[12]

Low pH conditions in acidic beverages can lead to changes in the roughness of resin-based composite surface.[12] One example of a beverage that has a low pH and is often consumed by people with high consumption levels is fermented milk.[13,14] Fermented milk is defined as dairy products that involve microbes. Fermented milk products commonly consumed by public are Yakult and yogurt. What distinguishes each of these products is the type of microbes that ferment them. The types of microbes that play an important role in milk fermentation are groups of lactic acid bacteria. The bacteria in Yakult is *Lactobacillus casei* while in yogurt is *L. bulgaricus* and *Streptococcus thermophilus*.[15] Fermented milk drinks are popular among people because they have specific taste and are believed to have advantages in prolonging lifespan, treating various diseases, and preventing obesity.[16] In 2012-2016, the first rank for fermented milk in the top brand index Indonesia was Yakult.[17] The average consumption of fermented milk is after dinner and it takes about 1 minute to spend 1 bottle (100 mg/ml).[18] The research results showed that the best strain that produced probiotic drinks and fulfilled the requirements is *Lactobacillus casei*. It produces probiotic drinks with a pH value of 3.54 which is most abundant in the Yakult fermented beverage.[14,15]

Based on the description above, it requires research on the effect of immersion in probiotic milk on the surface roughness of bulk-fill resin-based composite. The immersion was carried out for 20 hours which is estimated to be equivalent to 5-year process in the oral cavity and for 10 hours which is equivalent to Yakult consumption for 2.5 years.

MATERIALS AND METHODS

This study had obtained ethical feasibility letter published by Faculty of Dentistry, Lambung Mangkurat University No. 154/KEPKGFKGULM/EC/I/2019. This study applied true experimental method with a pre-test, post-test and control group design; i.e. a research to determine the effect of bulk-fill resin-based composite immersion in probiotic milk and distilled water as control solution with 10 hours and 20 hours duration on the roughness of the surface.

The population of this study involved samples of bulk-fill resin-based composite in the form of discs with a diameter of 10 mm and 4 mm thickness.[19] It was made using transparent acrylic molds into predetermined size and flat smooth surface with no porous persist.[20] This study consisted of 4 treatment groups. The sample was acquired using simple random sampling technique consisting of 4 treatments: the bulk-fill resin-based composite immersed in probiotic milk for 10 hours and 20 hours and bulk-fill resin-based composite immersed in distilled water for 10 hours and 20 hours as a control solution. The duration of immersion in this study was 10 hours and 20 hours.

The research instruments was including printed samples of transparent acrylic material, light curing units (LED) with a minimum beam intensity of 1000 mW/cm^2, glass plates, celluloid strips, measuring tubes, plastic filling instruments, glass slides, stopwatches, incubators, condensers, tweezers, beaker glasses, nierbekken and surface roughness tester.

The study began by fabricating samples at Wet Laboratory, Faculty of Dentistry, Lambung Mangkurat University Banjarmasin. The samples were then immersed in a glass cup containing artificial saliva and stored in an incubator at 37°C temperature for 24 hours. Sample measurement was performed using a surface roughness tester to obtain surface roughness value of bulk-fill resin-based

composite expressed in µm units at the Integrated Research Laboratory, Faculty of Dentistry, Gadjah Mada University, Yogyakarta. The samples were then immersed in probiotic milk for 10 hours and 20 hours and distilled water as control solution for 10 hours and 20 hours in an incubator at 37°C. The study was continued by measuring surface roughness of bulk-fill resin-based composite restorative materials after treatment.

The data obtained from this study were collected based on the observations of bulk-fill resin-based composite surface roughness measurement before and after immersion in probiotic milk for 10 hours and 20 hours and in distilled water for 10 hours and 20 hours stored in an incubator at 37°C. Then, the difference in value from each sample was taken from each treatment group. The surface of the specimen was measured using a surface roughness tester. The data obtained from treatment groups and control group (sterile distilled water) was subsequently analyzed. The results of the analysis were then included in the predetermined formula. The data were then recorded.

The results of this study were statistically evaluated using SPSS software through Shapiro-Wilk normality test and the Leven's homogeneity test. The parametric analysis exerted One-way ANOVA hypothesis test with a confidence level of 95% ($\alpha = 0.05$). To find out the significance of each group, it was continued by the Post hoc Bonferroni test. If the data is not normally distributed or the variant is not homogenous, then data transformation will be preceded. If the data transformation test is carried out but the data yet obtain normal distribution, then the non-parametric test or alternative test of Kruskal Wallis is performed. Had any significant difference was obtained, Mann-Whitney Post hoc test is required.[21]

RESULT

Based on the results of the study, surface roughness of bulk-fill resin-based composite restorative materials after immersion in probiotic milk is presented as follows:

Table 1. The Results of Shapiro-Wilk Normality Test on Surface Roughness of Bulk-Fill Resin-Based Composite Material after the Immersion in Probiotic Milk.

Group	Mean ± SD (µm)
Group I	0,27 ± 0,03
Group II	0,41 ± 0,05
Group III	0,09 ± 0,02
Group IV	0,09 ± 0,02

Description:
Group I: bulk-fill resin-based composite with the immersion in probiotic milk for 10 hours.
Group II: bulk-fill resin-based composite with the immersion in probiotic milk for 20 hours.
Group III: bulk-fill resin-based composite with the immersion in sterile distilled water for 10 hours.
Group III: bulk-fill resin-based composite with the immersion in sterile distilled water for 20 hours.

Based on the data from table 1, the surface roughness of bulk-fill resin-based composite restorative materials after the immersion in probiotic milk shows an average value of 0.2675 µm in Group I, 0.4138 µm in Group II, 0.0900 µm in Group III, and 0.0938 µm in Group IV. If the four groups are compared, the mean value in the group of probiotic milk immersion for 20 hours is higher than those immersed in probiotic milk for 10 hours; in this case, the control group was immersed in distilled water as a control solution for 10 hours and 20 hours. The results of this study indicate that there is an increase in surface roughness value of bulk-fill resin-based composite restorative materials after the immersion in probiotic milk.

Data normality test was performed on the result of surface roughness measurement using Shapiro-Wilk test. It was revealed that the data was normally distributed because a significance value was obtained ($p > 0.05$) among the groups where $p = 0.688$ for Group I, $p = 0.997$ for Group II, $p = 0.521$ for Group III and $p = 0.200$ for Group IV. Statistical analysis was then continued with Levene's homogeneity of variance test which obtained homogeneous data variant as p value is greater than 0.05 namely $p = 0.066$.

After normal and homogeneous data distribution were obtained, One Way ANOVA parametric test was performed to determine the difference in surface roughness value of bulk fill resin-based composite after being immersed in probiotic milk. A result of $p=0.000$ ($p<0.05$) demonstrates that there is a significant

difference in surface roughness value of bulk-fill resin-based composite after the immersion in probiotic milk. To find out which groups have significant differences, Bonferroni Post-Hoc test was carried out.

The results of the Bonferroni Post-Hoc test showed that there were significant differences ($p < 0.05$) between Group I and Group II, Group III and Group IV, Group II and Group I, Group III and Group IV. Significant differences could also be observed between Group III and Group I compared to Group II. Group IV and Group I also differ significantly when compared with Group II. Different result was found between Group III and Group IV in which they did not show any significant difference.

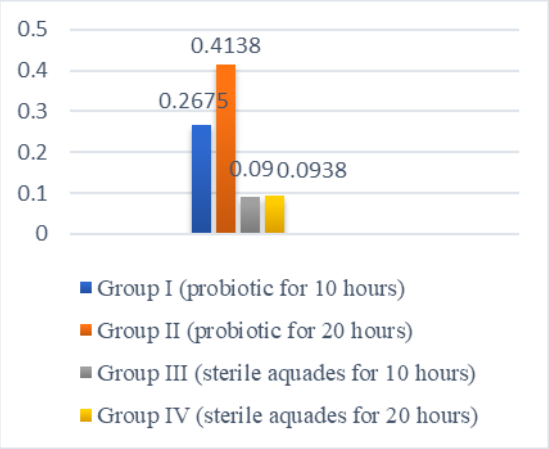

Figure 1. Diagram of Surface Roughness Value of Bulk-Fill Resin-Based Composite Restorative Materials After Immersion in Probiotic Milk.

DISCUSSION

One of the most widely used restorative materials for its good mechanical properties, especially in polishing results and is relatively resistant to abrasive forces compared to other aesthetic materials, is resin-based composite restorative materials.[6,22] Resin-based composite used in this study is a bulk-fill resin-based composite (Tetric N Ceram Bulk Fill) which can be polymerized to a thickness of 4 mm and contains Ivocerin material which has more light absorbent. Thus, the addition of Ivocerin helps to accelerate the polymerization to the bottom of the cavity.[23]

Low pH foods and beverages may be one of the reasons in the increase of surface roughness in resin-based composite restorative material as it can induce erosion in polymers.[16] Healthy lifestyle is a new trend in the world community by eating healthy foods and drinks. One of popular healthy drink is probiotic milk which has a pH of 3.54.[18,19]

Based on the results of the study, it was found that there is an increase in surface roughness value of bulk-fill resin-based composite restorative materials after being immersed in probiotic milk drink. Bulk-fill resin-based composite immersed in probiotic milk for 20 hours experienced higher surface roughness compared to the immersion in probiotic milk for 10 hours, in distilled water for 10 hours, and distilled water for 20 hours. This statement is in accordance with the research conducted by Nurmalasari in 2015. The study claimed that resin-based composite exposed to acid solutions will cause roughness on its surface.[16] This occurs due to the degradation of filler components caused by acid particles resulting in the decrease of mechanical properties and strength of bulk-fill resin-based composite.[24] These process will also induce surface roughness on bulk-fill resin-based composite restorative materials.[8,25] This shows a comparable result with the sample in this study. The more acidic or the lower the pH of a liquid, the greater the surface roughness value of bulk-fill resin-based composite restorative materials.

Water absorption by composite resin may occur as the resin contains Bis-GMA which has several disadvantages including high viscosity so that it requires the addition of a thinner, TEGDMA. This diluent monomer is added to the resin matrix to reduce viscosity and serve to facilitate the application of resin-based composite. However, it still causes water absorption in bulk-fill resin-based composite restorative materials.[23,24] Water diffuses into the resin-based composite and accumulates on the surface between resin matrix and filling material which causes degradation of filler particles and weakening of the bonding between resin matrix and filler particles. This can accelerate the hydrolytic degradation process in this material.[14] Resin will absorb a lot of water then slowly transform into plastic. This happens because the absorption of water prevents the formation of metal ions crosslinking process, especially Sr., Al, Si, Na, P, Ca. The ions are released and diffused out of the restorative materials, then dissolved in water.[12] The dissolve of composite matrix material will result in a decrease in mechanical properties in the form of roughness on bulk-fill resin-based composite surface.[24]

The measurement of sample surface immersed in probiotic milk for 20 hours resulted in higher degree of roughness than

those immersed in probiotic milk for 10 hours, distilled water for 10 hours and 20 hours. This means that bulk-fill resin-based composite has greater matrix solubility in acid solution. This also shows that high degree of surface roughness is influenced by lower pH property in probiotic milk compared to distilled water. The longer the immersion duration, the higher the increase of surface roughness on bulk-fill resin-based composite restorative materials before and after treatment will be. Probiotic milk has a low pH because of the lactic acid contained in them.[26] Excessive H^+ ions in acids cause disruption in polymer chain bonds. The disruption of polymer chain bonds and the occurrence of degradation is a result of double bonds breakdown in dimethacrylate caused by H^+ ions. [27] This causes the formation of micro cracks and micro voids between the matrix and resin-based composite filler.[26] There are a lot of empty spaces between polymer matrices which may facilitate the penetration of particles from surrounding environment.[27] The longer the immersion in probiotic milk, the more disconnection resulted in polymeric bonds of resin-based composite. Micro cracks and micro voids are the entry points for the penetration of liquid probiotic milk into resin-based composite. Probiotic milk can enter the edge of the restoration and accumulate within. Therefore, the longer the immersion of the composite resin, the more fluid absorption occurs; thus, the surface roughness of resin-based composite restorative materials increases.[10,28] This is authenticated by the results of this research where 10-hour immersion in distilled water solution has the lowest difference in the average value of surface roughness and 20-hour immersion in probiotic milk has the highest difference in the average value of surface roughness.

This study used the acidic pH of probiotic milk. Low pH content can affect the consistency of composite resin surface. Some residual monomers from the resin will escape which are accompanied by the release of nanoparticle fillers on the surface of the restoration and are resulted in the reduction of its mechanical resistance. As the result, the surface of restorative material will become rough.[11,29] It is concluded that the surface roughness of bulk-fill resin-based composite restorative materials increases after being immersed in probiotic milk for 10 hours and 20 hours.

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