



THE EFFECT OF CARBONATED, ISOTONIC AND YOGHURT DRINKS IMMERSION ON THE ROUGHNESS OF BULK-FILL COMPOSITE RESIN

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ABSTRACT

Background: Composite resins are dental restorative materials that are widely used and have high aesthetic value compared to other materials. However, acidic environmental conditions can degrade the composite resins, resulting in increased surface roughness of the resin, and consequently lead to an increased risk of caries. **Objective:** the purpose of this study was to evaluate the effect of immersion in acidic drinks on the surface roughness of composite resins, **Method:** In this study 24 samples of bulk fillTM composite resins were used. Samples were divided into four groups. Each sample was immersed for 5 seconds in either artificial saliva (control), carbonated beverage, isotonic, or yogurt, and followed by 5 seconds immersion in saliva. This cycle was repeated for 20 times for 14 consecutive days. The roughness of composite resin before and after 14 days immersion was measured by using a profilometer. Microscopic structures were analyzed by Scanning electron Microscope (SEM). Statistical analysis was used paired t-test, Anova and Post Hoc LSD. **Results:** Data from each sample group was normally distributed- with $p > 0.05$. The paired t-test for each group showed a p-value < 0.05 , which indicates there was a significant difference between surface roughness before and after immersion. ANOVA analysis revealed that there was a difference in the surface roughness between groups LSD test, showed that there was difference in the surface roughness between artificial saliva with carbonated drink, isotonic drink with carbonated drink, yoghurt drink with carbonated drink ($p < 0.0001$), between artificial saliva group with yoghurt drink, yoghurt drink with carbonated drink, yoghurt drink with isotonic drink ($p < 0.05$) which means there was a significant difference between group. Meanwhile, the isotonic drinks with artificial saliva obtained results ($p > 0.05$), which means there is no significant difference. **Conclusion:** Exposure of carbonated drinks, yoghurt drinks, and isotonic drinks can significantly increase the roughness of the surface Bulk Fill resin composite compared to exposure of artificial saliva.

Keywords: Composite resin, Bulk Fill, Surface Roughness, Acid

INTRODUCTION

Composite resins are restorative materials that have been used for more than 50 years in dentistry.¹ Recently, composite resins are dental restorative materials widely used to restore caries, enamel abrasion and have a high aesthetic value compared to other restorative materials. One composite resin that has been developed is a Bulk-Fill type composite resin for posterior tooth restoration which has been introduced since 2010.^{2,3} Bulk fill type composite resin has the advantage of being polymerized with a 4 mm irradiation depth in 20 seconds, so as to streamline its processing time. and minimize the occurrence of shrinkage.^{4,5}

The resilience of composite resins as dental restorative materials can be influenced by acidic beverages or foods.⁶ Carbonated, isotonic, yogurt drinks, orange juice and tomyam are known to affect the pH of the oral cavity to become acidic so as to cause demineralization of tooth enamel and erode composite resin.^{7,8} Erosion on composite resins can affect the surface of composite resins and reduce the

aesthetic quality of composite resins. In addition, exposure to beverages with a low pH can result in degradation of the polymer resin composite network.^{9,10} Degradation of the matrix causes the breakdown of methacrylate group in Bis-GMA and finally it produce residual monomers, which in turn contribute to increase surface roughness of the composite resin.^{2,10}

Teeth surface roughness and restorative materials can cause microorganisms retention.¹¹ Increased surface roughness can accelerate the colonization of microorganisms on the surface and cause plaque maturation thereby increasing the risk of caries.¹⁰

Based on the National Socio-Economic Survey (SUSENA) in 1996-2014, the consumption of sugar-sweetened beverages in Indonesian society continued to go through significant increase. The consumption of sweetened drinks is divided into four categories, such as bottled tea drinks, carbonated soft drinks, packaged fruit juices and health / energy drinks.¹² Based on the description above, the author



wanted to know the effect of carbonated, isotonic, and yogurt drinks immersion on the roughness of the surface of Bulk Fill composite resin.

METHODS

Composite Resin Samples Making

This research was an experimental laboratory type with a pretest and posttest design and used control group. The object of this research was Bulk-Fill composite resin (Filtek™ Bulk-Fill) which is formed by using a metal mold ring with a diameter of 10mm and a thickness of 4mm. A total of 24 composite resin samples have been made, divided into 4 groups so that each group contains 6 samples. Each sample in each group was immersed in artificial saliva, yogurt drinks, isotonic drinks or carbonated drinks. Resin samples in each group were immersed in drinks that were tested for 5 seconds and continued by immersed for 5 seconds in artificial saliva. The process was repeated for 20 cycles and then stored in artificial saliva and then repeated the next day, for 14 consecutive days. Surface roughness of samples before and after 14 days of treatment was determined by using a profilometer. Determination of the roughness of the composite resin was calculated at 3 different points and then was averaged. The microscopic structure of the composite resin after immersion treatment was analyzed by Scanning Electrone Microscope (SEM).

Statistic Analysis

Paired T test was used to see the difference in roughness level of composite resins before and

after immersion treatment. One Way Anova was used to analyze differences in changes in the surface roughness of the composite resin between groups, and continued with the Post Hoc LSD test to find out the difference in the increase in the roughness of the composite resin between the treatment groups. Statistical analysis was performed on IBM SPSS Statistics 23 software.

RESULTS

Surface Roughness Composite Resin Measurement

The roughness levels of composite resins before and after treatment for each group are shown in Table 1. Based on the data in Table 1 the roughness of composite resins before and after immersion, respectively, was $0.61 \pm 0.188\mu\text{m}$ and $0.71 \pm 0.175 \mu\text{m}$ (artificial saliva), $0.90 \pm 0.212 \mu\text{m}$ and $1.29 \pm 0.102 \mu\text{m}$ (yogurt drinks), $0.98 \pm 0.121 \mu\text{m}$ and $1.13 \pm 0.426 \mu\text{m}$ (isotonic drinks), and $0.91 \pm 0.195 \mu\text{m}$ and $1.55 \pm 0.094 \mu\text{m}$ (carbonated drinks). Based on paired t-test, before and after immersion in all treatment groups, a p value <0.05 indicated that there was a significant difference between the surface roughness of the Bulk-Fill composite resin before and after immersion. In the ANOVA test results, it was found that there were significant differences in roughness changes between groups of artificial saliva, yoghurt, isotonic and carbonated drinks with a significant value of $p < 0.001$.

Table 1. The result of roughness measurements of Bulk-Fill composite resins before and after immersion in artificial saliva, yogurt drinks, isotonic drinks, carbonated drinks for 14 days, roughness changes and different tests.

Groups	Roughness measurement of Bulk-Fill composite resins			
	Pretest (μm)	Post test (μm)	Difference (μm)	Pair T test Sig (2-tailed)
Groups I (artificial saliva)	$0,61 \pm 0.188$	0.71 ± 0.175	0.10 ± 0.013	0.011*
Group II (yoghurt drink)	0.90 ± 0.212	1.29 ± 0.102	0.39 ± 0.110	0.002*
Group III (isotonic drink)	0.98 ± 0.121	1.18 ± 0.042	0.20 ± 0.079	0.004*
Group IV (carbonated drink)	0.91 ± 0.195	1.55 ± 0.094	0.64 ± 0.101	0.000**



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Furthermore, the least significant different (LSD) test was performed to test the differences between treatment groups with one another group. Based on the least significant different test results (LSD) shown in Table 2, the results obtained between groups of artificial saliva with carbonated drinks, isotonic drinks with carbonated drinks (p

<0.001), between the artificial saliva groups with yogurt drinks, yogurt drinks with carbonated drinks, isotonic drinks and yogurt drinks (p <0.05), which means that there were significant differences between groups. Meanwhile, the isotonic drinks with artificial saliva obtained results (p> 0.05), which means there was no significant difference.

Table 2. Least significant different test results (LSD) between groups.

groups	Artificial saliva	Yoghurt drink	Isotonic drink	Carbonated drink
Artificial saliva	-	.001*	.180	.000**
Yoghurt drink	.001*	-	.033*	.001*
Isotonic drink	.180	.033*	-	.000**

Scanning Electron Microscopy (SEM) Results

Photomicrograph scanning electron microscope (SEM) of bulk-fill composite resin after being immersed for 14 days in artificial saliva, carbonated drinks, isotonic drinks or yogurt drinks is shown in Figure 1. In the composite resin which

was immersed in artificial saliva obtained a smoother surface with porosity smaller compared to composite resins exposed to acidic agents such as yogurt drinks, isotonic drinks, and carbonated drinks.



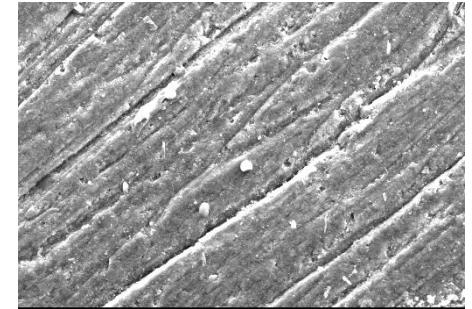
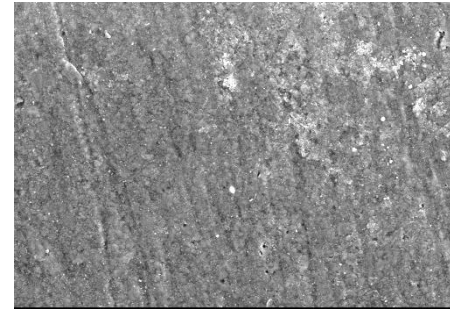
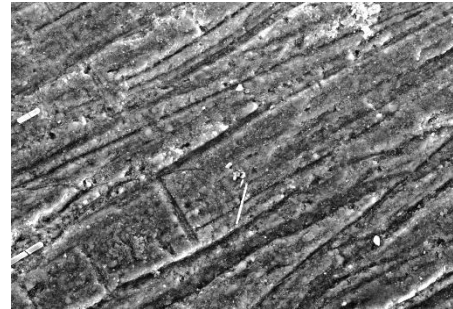
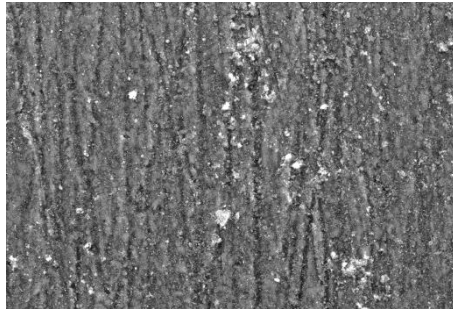
1. Artificial saliva

2. Yoghurt drink

3. Isotonic drink

4. Carbonated drink

A



B

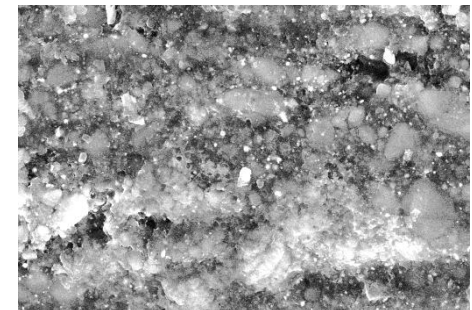
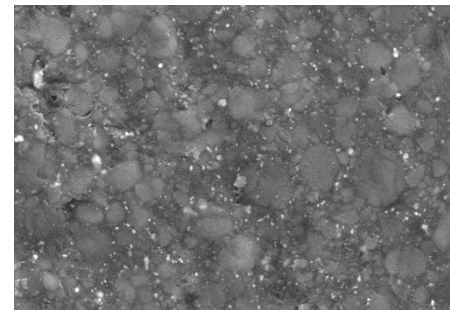
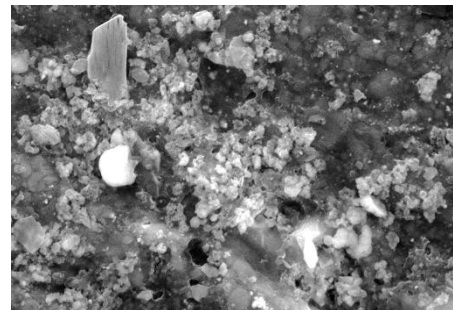
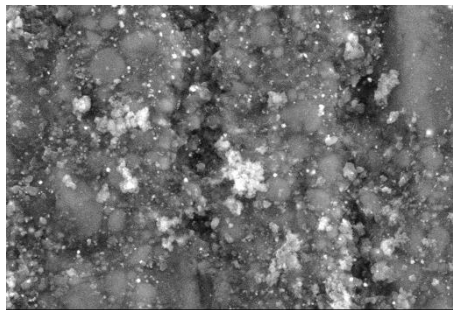


Figure 1. Electrone microscope surface scanning results of Bulk-Fill composite resin with magnification of 500x (A) and magnification of 3000x (B) for artificial saliva (1A, 1B), Yoghurt drinks (2A, 2B), Isotonic drinks (3A, 3B), and Carbonated Drinks (4A, 4B)



DISCUSSION

Changes in the level of composite resins roughness after immersion in each group obtained the greatest changes experienced by the immersion group in carbonated drinks ($0.64 \pm 0.101 \mu\text{m}$), followed by yogurt drinks ($0.39 \pm 0.110 \mu\text{m}$), isotonic drinks ($0.20 \pm 0.079 \mu\text{m}$) and saliva artificial ($0.10 \pm 0.013 \mu\text{m}$). In this case, it showed that saliva immersion with a pH close to the physiological pH gives the smallest change in roughness. The paired t-test results obtained p value <0.05 which indicates that there are significant differences. Anova showed that there were significant differences in roughness changes between groups in this study with $p < 0.001$. This is consistent with the research hypothesis that there is an effect of immersion acidic drinks, in this case is yogurt, isotonic and carbonated to the roughness of the Bulk-Fill composite resin.

Post Hoc Test least significant different showed that there were significant differences between the saliva group with yogurt drinks ($p = 0.001$), saliva with carbonated drinks ($p < 0.001$), yogurt drinks with carbonated drinks ($p = 0.001$), drinks isotonic with carbonated drinks ($p < 0.001$), and yogurt with isotonic drinks ($p = 0.033$). Acidic beverages can cause matrix degradation in composite resins resulting in increased surface roughness of composite resins. While the artificial saliva treatment group with isotonic drinks ($p = 0.180$), did not have a significant difference because the value of $p > 0.05$. That was because the acidic conditions in isotonic drinks cannot induce monomer release and cannot react to penetrate into the composite resin matrix, resulting in a lower surface roughness value.¹⁶

The sample immersion in carbonated beverages (Coca cola™ pH 2.6) increased the roughness of the composite resin ($p < 0.001$). This is consistent with previous research that acidic drinks can increase the surface roughness of composite resins.¹³ Carbonated drinks containing H_2CO_3 can release H^+ ions.¹⁴ H^+ ions can break the polymer chain resulting in matrix degradation of the composite resin. Through the same mechanism, immersion of composite resins in yogurt and isotonic drinks can also increase the roughness of composite resins.¹⁰ This is consistent with previous research that acidic foods and beverages can increase the surface roughness of Bulk-Fill composite resins. The more acidic food or beverage groups showed a more significant increase in the surface roughness of the

composite resin. This is because low pH can cause erosion of dental restorative material.^{10,13}

Among the three packaged sweetened drinks tested, it was seen that the increase in roughness, respectively, occurred in the group of carbonated drinks (pH 2.6), yogurt drinks (pH 4) and isotonic drinks (pH 3.5). Carbonated drinks have the lowest pH so that it gives the highest effect on the surface roughness of the composite resin. Isotonic drinks have a slightly lower pH than yogurt, so they should contribute more to changes in the level of surface roughness of the resin. The incompatibility of the results obtained with the initial prediction due to acidic conditions in isotonic drinks cannot encourage the release of monomers and cannot react to penetrate into the composite resin matrix, resulting in a lower surface roughness value than yogurt drinks.¹⁵ Thus, even though the pH of yogurt drinks higher than isotonic drinks the effect on increasing the roughness of composite resins was higher than that of isotonic drinks.

CONCLUSION

The composite resin immersion in acidic drinks can increase the roughness of the composite resin. The highest level of roughness of composite resin occurs in the immersion of carbonated drinks, followed by yogurt, isotonic drinks and artificial saliva with significant difference values. The degree of roughness of the composite resin is related to the pH of the drink.

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