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**DIFFERENCES OF BIOACTIVE COMPOSITE RESIN COLOR ON
IMMERSION IN ALCOHOL AND NON-ALCOHOL MOUTHWASH**

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ABSTRACT

Background: Composite resin is the most used material for caries restoration and highly chosen by dental patients regarding its high aesthetic value. People often use mouthwash to maintain dental and oral hygiene, both those containing alcohol and non-alcohol. According to several studies, the alcohol in mouthwash will cause a decrease in the physical properties of the composite resin, such as surface roughness, compressive strength, hardness, and also the aesthetic value of the composite resin. **Objective:** To determine the difference of bioactive composite resin color on immersion in alcohol and non-alcohol mouthwash. **Methods:** Experimental laboratory with a pre-test and post-test with control group design using 27 samples of composite resin with a diameter of 15 mm and 1 mm. The samples were divided into 3 groups, namely the immersion group in alcoholic mouthwash, non-alcohol, and aquades. Each group consisted of 9 samples to be measured the value of color change before and after immersion for 12 hours. **Results:** The results of the One Way ANOVA statistical test showed that there was an effect of soaking mouthwash on the color of the bioactive composite resin. The Post Hoc LSD test showed between the alcohol and non-alcohol mouthwash group, as well as alcohol and distilled water group had a significant difference, but not in the non-alcohol mouthwash and distilled water group. **Conclusion:** The immersion in both alcohol and non-alcohol mouthwash are significantly affecting the color changing in bioactive composite resin. The value of color changing between mouthwash groups are significantly different.

Keywords: Bioactive composite resin, discoloration, liquid absorption, mouthwash.

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INTRODUCTION

Dental caries is the most common oral disease, which becomes evidence of the poor condition of Indonesians oral cavity.¹ Based on the data of Basic Health Research in 2018, dental caries in Indonesia were very high, at 88.8%. The treatment for dental caries is restoration. Restoration aims to prevent further caries and maintain the structure and shape of the remaining teeth.²

With the development of science and technology, restorative materials in dentistry are also growing.³ Restorative materials that are now widely used in dentistry and have great demand by patients are composite resins because they have advantages with high aesthetic value and are able to provide restoration results in accordance with natural teeth.^{4,5} Composite resins provide

satisfactory results because of their high aesthetic value; however, they also have weaknesses, one of which is that they can easily change color.³ The latest composite resin introduced in 2013 is a bioactive composite resin that has modified the matrix and filler.⁵ Bioactive composite resin at an oral pH of 5.5 can easily release fluoride.⁶ Intrinsic and extrinsic factors are the factors that can cause color changes in composite resins. Intrinsic factors are caused by the resin material, while extrinsic factors are from liquids or color carriers such as nicotine, coffee, tea, wine, and mouthwash.^{7,8}

People often use mouthwash to maintain dental and oral hygiene, both those containing alcohol and non-alcohol. The use of mouthwash is to clean the oral cavity and esophagus.¹ However, people are still not aware of how to use mouthwash well and correctly, especially when

using mouthwash containing alcohol.⁸ According to several studies, the alcohol in mouthwash will cause a decrease in the physical properties of the composite resin, such as surface roughness, compressive strength, hardness, and also the aesthetic value of the composite resin.⁹ There is no study discussing the effect of alcohol on the color of bioactive composite resins. Therefore, the writer is interested in conducting further research to observe and find out the differences of using mouthwash containing alcohol and non-alcohol on the color change of bioactive composite resins.

RESEARCH METHODS

The research was conducted after obtaining a research permit and ethical feasibility No.026/KEPKG-FKULM/EC/II/2021 from the ethical committee of the Faculty of Dentistry, Universitas Lambung Mangkurat.

This research was carried out at the Biochemistry Laboratory, Faculty of Medicine, Universitas Lambung Mangkurat using a true experimental method with the pre-test and post-test with control group design, by observing the value of color changes in the bioactive composite resin before and after treatment. The number of samples were 27 samples. The samples were divided into 3 treatment groups, which immersed in mouthwash containing alcohol, non-alcohol, and distilled water.

The research materials used were ActivaTM BioActive Restorative composite resin, alcohol mouthwash, non-alcohol mouthwash, distilled water, and artificial saliva. The tools used were a mold with a diameter of 15 mm and a thickness of 1 mm, a mylar strip, slide glass LED 800 mW/cm², Activa dispenser gun, digital analysis, diagnostic sets, glass specimen or place for immersing composite resin, mask, and rubber gloves.

Sampling

Samples were made by inserting a composite resin into a mold using an Activa dispenser gun, covering the mold surface with a mylar strip and glass slide with a thickness of 1 mm. The bioactive composite resins were irradiated with Light Cure LED 800 mW/cm² for 20 seconds. The samples that have been removed from the mold were soaked first in artificial saliva for 24 hours and incubated at 37°C to condition as in the oral cavity. After that, the samples were re-immersed in each treatment group for 12 hours at 37°C.

Making Artificial Saliva

Artificial saliva was made by mixing all ingredients, that were NaCl 0.47 grams, NaHCO₃ 9.8 grams, KCl 0.57 grams, Na₂HPO₄ 12H₂O 10 grams, and MgSO₄ 7 H₂O 0.12 gram, then added with 500 ml sterile distilled water into beaker glass, and stirred until homogeneous.

Immersion and Measurement of Color Change

The initial color value was measured (pre-test) before treatment, and then the samples were divided into 3 groups and re-immersed in alcohol mouthwash, non-alcohol mouthwash, and distilled water for 12 hours in an incubator at 37°C. After that, the value of the color change (post-test) was measured again with digital tool analysis.

RESULTS

The results of measurements carried out by digital tool analysis were presented in Table 1.

Table 1. Table of Mean and Standard Deviation of Color Change Value of Bioactive Composite Resin

Treatment Group	Mean ± Standard Deviation
Alcohol	10.62 ± 3.08
Non-alcohol	4.93 ± 2.55
Distilled Water	4.40 ± 1.71

Table 1 shows that the highest value of color change was in the group of immersion in alcoholic mouthwash and the lowest value was in the distilled water. The data obtained were then inserted into the SPSS system. The normality test with Shapiro-Wilk Test was conducted, and the results were obtained in the alcoholic group with p=0.559, the non-alcoholic group with p=0.638, and the distilled water group with p=0.625. The data showed a p value > 0.05, which meant that the data was normally distributed. Then, it was continued with Levene's test to see the homogeneity of the data, and the results were obtained with p value=0.406 (p>0.05), which indicated a homogeneous data variance. From the test results, the data obtained were normally distributed and homogeneous, so it can be continued with a parametric analysis of One way ANOVA.

One way ANOVA test results showed a value of p = 0.000 (p<0.05), which meant that there was a significant difference in the treatment group. To see which groups were significantly different, a follow-up LSD test was carried out. The significance value of the color change test for bioactive composite resins can be seen in table 2.

Table 2. Table of Significance Value of LSD Test on Color Change of Bioactive Composite Resin.

	Alcohol	Non-alcohol	Distilled Water
Alcohol		0.00*	0.00*
Non-alcohol			0.66
Distilled Water			

Note:

* = there was a significant difference

The results of the LSD test showed that there was a significant difference ($p < 0.05$) between immersion in alcoholic mouthwash and non-alcoholic mouthwash, as well as immersion in alcoholic mouthwash and in distilled water. There was also a group that was different but not significantly ($p > 0.05$), namely the group that was immersed in non-alcoholic mouthwash and the one immersed in distilled water.

DISCUSSION

The color change in each treatment group was caused by the physical properties of the composite resin which can absorb liquid followed by the absorption of dyes or other substances that will cause color changes.⁶ The liquid that enters the composite resin will seep into the composite resin material, resulting in a hydrolysis reaction that will degrade the matrix and siloxane bonds, and weaken the filler bond at the matrix interface, causing color changes. The discoloration can also be attributed to the strength of the composite resin that can absorb the color pigments found in mouthwash.^{6,10}

The highest color change value was found in the mouthwash group containing alcohol. This can occur because of the ethanol solvent used in alcoholic mouthwash. Ethanol (C_2H_6O) can cause degradation of the matrix surface and filler, resulting in a rough surface of the restoration.⁸ Ethanol also has very soluble properties. Its solubility is $22.0 \text{ (J/cm}^3\text{)}$, close to the composite resin which is $26.1 \text{ (J/cm}^3\text{)}$.⁹ Alcoholic mouthwash also contains benzoic acid, which is a derivative of carboxyl acid.⁶ During the absorption process, ethanol and benzoate will enter the resin matrix, and absorption of ethanol and benzoate occurs into the polymer structure, and then the polymer chain will expand, causing the composite resin to be soft and porous.³ The solubility value of ethanol, which is close to the solubility value of composite resin, causes the hydrolysis process so that the absorption of dye will be faster and the color change will also increase.^{4,11} This is in line

with previous research, which stated that when the composite resins are immersed in ethanol, a large loss of monomer occurs in a short period of time compared to when the composite resin is only immersed in water. Therefore, it is very clear that the ethanol content in alcoholic mouthwash will affect the discoloration of the composite resin.⁹

The composite resin immersed in non-alcoholic mouthwash and distilled water also experienced a color change but not significant. This occurs because the use of solvent in non-alcoholic mouthwash and distilled water is only pure water without any ion content.⁸ The solubility value of pure water is also different with the solubility of ethanol, which is 30.1 J/cm^3 .⁹ The process of H_2O in degrading composite resin is not as fast as ethanol, so the color change that occurs is also not significant.⁸ Color change occurs when H^+ and OH^- diffuses into the polymer resin matrix. This causes an attractive force between the polymer and H_2O , resulting in swelling of the polymer matrix, and the distance between the resin polymer chains increases.⁹ This hydrolysis process will occur continuously and causes the loss of residual monomer. This process also breaks the bond between the restoration and the tooth surface which then becomes a pathway for pigment penetration into the composite resin.^{10,12,13} Based on this study, it is concluded that the alcohol and non-alcohol mouthwash group, as well as alcohol and distilled water group had a significant difference, but not in the non-alcohol mouthwash and distilled water group.

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