Nurah Tajjalia - Effect of Lactic Acid and Artificial Saliva on Bioactive Resin's Calcium Release

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EFFECT OF LACTIC ACID AND ARTIFICIAL SALIVA ON BIOACTIVE RESIN'S CALCIUM RELEASE

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INTRODUCTION

Caries is a disease hard tissue of the teeth that damages the structure of the email, dentine and sementum.[1] Dental caries can occur due to four factors: host, microorganism, substrate and time.[2] Once caries lesions are formed, restoration material applications must be made.[3] One of the most common causes of restoration failure is secondary caries.[4] Secondary caries are caries lesions that are on the edge of restoration or caries tied to restoration or sealant.[5] Secondary caries can form due to the influx of bacteria into the gap edge of restoration.[6]

As the times progress, the use of conventional restoration materials such as metals has been replaced because this material does not have good adhesive and aesthetic properties.[7] One of the aesthetic restoration materials and has mechanical properties that are strong and not infrequently used in the field of dentistry, is composite resin.[8] In 2013 has introduced the latest composite resin that is bioactive composite resin.

Bioactive composite resins can release phosphate, fluoride and calcium ions if in contact with saliva.[9] This material releases more phosphate, fluorine and calcium ions than glass ionomers.[10] Restoration materials that can release ions such as calcium can act as a protective of hard tissue of teeth from the influence of acidic food or beverages consumed and can also help the remineralization process on the edge of restoration.[6]

In acidic pH, bioactive composite resins release calcium, fluoride and phosphate ions.[9] One of the causes pH oral cavity has decreased to acid due to the metabolic results of *Streptococcus mutants*. These bacteria metabolize carbohydrates into organic acids that cause demineralization of tooth structure and the edge of restoration.[11] Organic acids resulting from the metabolism of *Streptococcus mutans* are lactic acid with 70% of the resulting acid from the metabolism in addition to acetic acid.[12] The acid production caused the pH of the liquid around the teeth to be low due to the increase in the concentration of hydrogen ions. These hydrogen ions are able to diffuse all the pores of enamel and dentin, triggering demineralization. The demineralization process will occur when the pH is less than 5.5 and the pH of the oral cavity after eating ranges from 5.2-5.5. The pH of the oral cavity will return to normal after 20-30 minutes and the demineralization process in this normal cycle is followed by the remineralization process.[13] Remineralization is the process of returning calcium and phosphate mineral ions to hydroxysiapatite crystals in enamel.[14]

METHODS

The research has passed the ethical clearence test published by the Faculty of Dentistry ULM No.010/KEPKG-FKGULM/EC/II/2021.This study is a pure experimental study (true experimental) with a post-test only and control group design. The research samples were 42 samples of bioactive composite resins with inclusion criteria that are cylindrical with a diameter of 15 mm and a thickness of 1 mm, flat surface, no porous, no fractures, no cracks and intact. Exclusion criteria are samples contaminated with other materials, defects or deformation of the form so that it does not match the actual sample size.

Samples are made by applying bioactive composite resin into the mold that is in accordance with the desired sample size using Activa Spenser Gun. Then cover the surface of the composite resin mold so that the resin surface is flat and smooth. Bioactive composite resin is illuminated with LED light curing unit with a distance of 1 mm for 20 seconds, then remove the sample from the mold.

The sample was then divided into 6 immersion groups to be soaked in a solution of lactic acid (pH 5.2), artificial saliva (pH 6.7) and aquades (pH 7) for 1 and 7 days. Then the sample is inserted into beaker glass to be soaked with each volume of 30 ml solution and stored in an incubator with a temperature of 37^{o} and the solution is replaced every 24 hours.

The sample is then crushed until smooth and homogeneous using mortar. Calculation of the amount of calcium ion release is using titration method. Ca Weight calculation is done with the following formula:

0,7056 x vol. KMnO4 x 2,8 mg CaO

Data analysis was conducted by *Two Way ANOVA* test with a confidence level of 95%, then conducted *Post Hoc Bonferroni Test*.

RESULTS

The results of the study influenced the solution of lactic acid and artificial saliva on the number of calcium ion releases of bioactive composite resins obtained the average value presented in table 1.

Table 1. Mean and standard deviation of the number of release calcium ions of bioactive composite resins

No.	Media and Immersion Time	*Mean* ± SD
1.	Asam Laktat 1 hari	4,02 ± 0,360
2.	Asam Laktat 7 hari	5,40 ± 0,318
3.	Saliva Buatan 1 hari	0,64 ± 0,338
4.	Saliva Buatan 1 hari	1,61 ± 0,215
5.	Aquades 1 hari	1,04 ± 0,504
6.	Aquades 7 hari	1,93 ± 0,184

Based on the table above it can be known that the average number of calcium ion releases is highest in the sample group of bioactive composite resins soaked in a lactic acid solution with a pH of 5.2 for 7 days, while for the group with the lowest number of releases is the group with immersion of artificial saliva with a pH of 6.7 for 1 day.

The results of the *Two Way Anova* statistical test showed the significance of the immersion media group p=0.000 (p<0.05) which means there is a difference in the number of calcium ion releases of bioactive composite resins immersed in lactic acid, artificial saliva and aquades. The significance value of the immersion time group p=0<0.05) means that there is a difference in the number of calcium ion releases of bioactive composite resins immersed for 1 and 7 days. Because the *Two Way Annova* test is meaningful and the variants are the same, it can be continued with a follow-up test of *Post Hoc Bonferroni* to find out which groups have meaningful differences.

DISCUSSION

Based on the results of the study, the entire group of bioactive composite resins soaked in a solution of lactic acid, artificial saliva and aquades experienced the release of calcium ions. The immersion group in lactic acid solution had a higher average amount of calcium ion release than the artificial saliva immersion group and aquades. In addition, the immersion group for 7 days had a higher value of calcium ion release compared to the immersion group for 1 day.

One of the factors that play a role in the release of ions is the degree of acidity or pH.[16] Composite resin will release ions on the acidic pH, in addition to bioactive composite resins are able to release calcium, fluorine and phosphate ions when in contact with saliva.[9] Based on research that has been conducted lactic acid solution with pH 5.2 classified as more acidic than artificial saliva (pH 6.7) and aquades (pH 7). This led to the amount of calcium ion release in the lactic acid immersion group having higher amounts than the artificial saliva soaking group and aquades. This is in accordance with research conducted by Irpansyah et al (2020) which states that the lower the pH, the greater the number of ions released.

The group with the lowest amount of calcium ion release was the group that was immersed in artificial saliva with a pH of 6.7 even though the immersion group had a more acidic pH than the pH of aquadest solution (pH 7). Artificial saliva is made from a mixture of mineral salts made using the McDougall method with a mixed composition of NaHCO3 (58.80g), Na2HPO4.7H2O (48 g), KCl (3.42 g), NaCl (2.82 g), MgSO4.7H2O (0.72 g) and CaCl2 (0.24 g) in 6 liters of distilled water. Artificial saliva with a normal pH does not produce H+ and OH- ions. This is because the ionization process is not perfect to produce these ions, so that fewer calcium ions are released than when the acid state has a lot of H+ ions, so that in a neutral pH state, the bioactive glass state becomes more stable than other conditions.[17] Solutions with high viscosity are difficult to penetrate the bioactive glass particles in the bioactive composite resin.[16]

The bioactive composite resin contains bioactive glass which is composed of silica (SiO_2),

phosphorus pentoxide (P_2O_5) and boron trioxide (B_2O_3). The silica network in bioactive glass is more open, so that water molecules can enter the composite resin more easily. Water molecules that enter the composite resin will come into contact with the silica glass, then an ion exchange process occurs between hydronium ions (H^+) with modifier ions Na^+ and Ca^{2+} to form silanol or $Si(OH)_4$ caused by hydrolyzed silica. Furthermore, silanol undergoes a condensation process to form a gel layer on the silica surface. The gel layer formed does not function as a protector due to the open silica network allowing deeper water penetration, causing degradation of the composite resin which causes the release of calcium ions in the bioactive glass.[17]

The immersion time also has a role in the ion release process. The longer the immersion is carried out, the greater the ion that will be released.15 Therefore, in this study the number of ions released during the 1-day immersion time was less than the 7-day immersion time.

The limitation of this study is that it is not absolute because the circumstances when the research was conducted were not in accordance with the actual state of the oral cavity. This study attempted to approach the actual situation, which was put in an incubator with a temperature of 37o to adjust to the actual state of the oral cavity. This research has obstacles such as research materials, namely bioactive resins with the brand Activa Bioactive-Restorative which are difficult to obtain, so they have to wait quite a long time. The conclusion of this study is that there is an effect of lactic acid solution and artificial saliva on the amount of calcium ion release in bioactive composite resins.

CONCLUSION

Based on the research that has been done, it can be concluded that there is an effect of lactic acid solution and artificial saliva on the amount of calcium ion release in bioactive composite resins.

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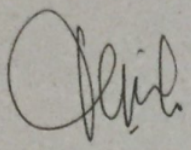

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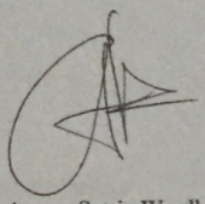

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