Shear Strength Cacao Pulp Extract as Etching Material in Composite Resin Fillings

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Abstract

Background: *Bonding principle of composite restoration is mechanical-interlocking that resin tags on microporosity etched enamel surface. Acid etching material commonly used is 37% phosphoric acid. Cacao pulp is white slimy membrane that surrounds the cacao bean. Cacao pulp contains various weak acid compounds. Shear strength is maximum resistance of material to withstand loads that cause shear movement on material before released.* ***Purpose:*** *This research is doing on purpose to analysis about shear strength composite resin restoration using etching material of cacao pulp extract.* ***Methods:*** *This research is an experimental laboratory research with Post Test Only Group Design research. 4 groups sampel is EA group with phosphoric acid etching 37%, EPK group 100% with cacao pulp extract 100%, EPK group 50% with cacao pulp extract 50%, and EPK group 25% with 25% cacao pulp extract. After etching, sample was bonded then filled with composite resin. After filling, sample was cutten, then planted in acrylic resin with labial side facing up, then shear strength test carried out.* ***Results:*** *Mean of shear strength EA is 15,4MPa, EPK 100% is 5,86MPa, EPK 50% is 6,76MPa and EPK 25% is 5,13MPa. Data were analyzed using Anova parametric statistical test, which obtained significance value ($p<0.05$), means all treatment groups had significant differences. Furthermore, LSD follow-up test carried out to find which groups had significant differences.* ***Conclusions:*** *Cacao pulp extract can increase shear strength of composite resin even though mean of shear strength EPK 50% group is lower than 37% phosphoric acid etching group.*

Keywords*: Acid etching, Cacao pulp, Shear strength, Composite resin*

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INTRODUCTION

Composite restorations are adhesive restorations whose basic principle of bonding with teeth is micromechanically (mechanical-interlocking), namely from resin tags on the microporosity of the etched enamel surface.[1] Etching is an acidic chemical that removes the mineral surface of the tooth and forms micropores that make the

enamel surface rough so that the composite resin can bond to the tooth surface and form a resin tag. The acid etching material often used is phosphoric acid with a concentration of 37%. [2,3]

Phosphoric acid is a strong acid.[4] Strong acids can release more H+ ions than weak acids because they can completely ionize.[5,6] The more H+ ions, the more dissolved tooth minerals.[7] The more dissolved minerals because the lower the hardness (microhardness) of the enamel.[8] Reduction microhardness can also lead to impaired adhesion to the filling material.[9]

The use of medicinal plants as alternative materials is currently growing.[10] Cacao is one of the medicinal plants that is widely used as an alternative material today. Cacao pulp is a white, slimy membrane that covers the cacao bean, making up about 25-30% of the weight of the cacao bean.[11] The pulp is a white or pale yellow mucus layer covering the cacao bean's surface. The pulp is a thick layer of endosperm consisting of turbulent cells with large intercellular spaces.[12] The degree of acidity (pH) of cacao pulp is 3.5.[13] The cacao pulp contains 12-15% sugar compounds, organic acids, and amino acids such as citric acid, acetic acid, lactic acid, malic acid, malic acid, oxalic acid, fumaric acid, and 80-85% water.[14] In dentistry, dentin conditioner citric acid glass ionomer to dental substrates to increase the bond between the resin and the tooth substrate. Although not a strong acid, citric acid can be very erosive because of its ability to bind metal ions. The enamel surface treated with citric acid will be very erosive.[15]

Shear strength is the maximum resistance of a material to withstand loads that cause shear movement in the material before it is finally released. Shear strength is influenced by several factors, including the shape of the research subject, surface texture, composition and preparation, and measurement procedures using test equipment.[16] The shear strength test of dental restorations is one way to measure the adhesion strength of restorative materials to the structure of the restored tooth. This study was conducted to analyze the shear strength of composite resin restorations using the etching material of cacao pulp extract.

RESEARCH METHODS

This research is experimental laboratory research with a post-test-only control group design. Calculate the sample size to find the minimum replication of each

treatment in the experiment in a Completely Randomized Design (simple random sampling).[17] The number of repetitions was 5 in each group, namely Group EA (control): bovine incisors treated with 37% phosphoric acid etching material in the middle third of the labial part; 100% EPK group: bovine incisors treated with 100% cacao pulp extract in the middle third of the labial amount; EPK 50% group: bovine incisors treated with 50% cacao pulp extract in the middle third of the labial amount; EPK group 25%: bovine incisors treated with 25% cacao pulp extract in the middle third of the labial part.

The cacao pulp is separated from the cacao beans manually by as much as 1 kg, the cacao pulp is put into an icebox and then taken to the Biology Laboratory of the Faculty of Pharmacy, University of Jember to make cacao pulp extract. Cacao pulp is put in a freeze-dryer. After the cacao pulp was dry, cacao pulp was mashed with 2 liters of 96% ethanol as solvent. The finely ground cacao pulp was transferred to a 2-liter volume jar for the soaking process (maceration) for 3 days. After 3 days of immersion, the results of the maceration process were then filtered with a filter cloth to separate the dregs from the filtrate. the filtrate was then evaporated using a Rotatory Evaporator to separate the solvent (ethanol) at a temperature of 60° and an ethanol pressure of 175 mbar. Obtained 100% cacao pulp extract as much as 142.49 grams in the form of a thick brown liquid with a pH of 3.5. Then dilute the cacao pulp extract to concentrations of 100%, 50%, and 25%.

The bovine teeth that met the criteria for the research sample were cleaned of remaining soft tissue, then washed, dried, and implanted in a red wax block and labeled according to the name of the group. Dripped 1 drop of etching material and cacao pulp extract on a micro brush and applied (1 sample using 1 micro brush) on the middle 1/3 of the labial part of the bovine teeth according to each treatment group. Then let stand for 15 seconds, then irrigated using sterile distilled water (3 ml), then dried using sterile cotton pellets and aerated using air spray with light pressure. Then, bonding was applied using a micro brush on the etched tooth surface (same procedure as when applying to etch), then left for 15 seconds, and dried with air spray with light pressure. Then curing for 20 seconds. Furthermore, applying composite resin using a plastic filling instrument formed a beam with a length of 6

mm, a width of 4 mm, and a height of 2 mm (bulk fill), then cured for 20 seconds. Then finishing and polishing (Figure 1).

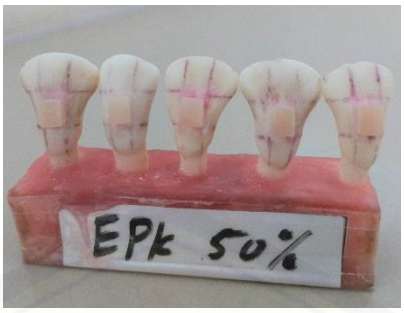

Figure 1 Sample of finished and polished bovine teeth

The filled sample is removed from the red wax block. teeth were cut using a carborundum disc in the form of a beam with a distance of 2 mm from the filling on each side, this was done in all treatment groups. Then the bovine incisor teeth were implanted on acrylic with the labial surface facing up, then a shear strength test is carried out. The data were tabulated and statistically analyzed using ANOVA. The method used in this study has been approved by the Health Research Ethics Commission, Faculty of Dentistry, University of Jember with the number 1386/UN25.8/KEPK/DL/2021.

RESULT

The shear strength of cacao pulp extract as an etching material on composite resin fillings in removing tooth mineral surfaces and forming micropores that make the enamel surface rough, so that the composite resin can bind to the tooth surface and form resin tags can be seen from the value of the shear strength of etched composite resin using cacao pulp extract. The shear strength of the composite resin with etched teeth using phosphoric acid and cacao pulp extract can be seen in table 1.

Table 1 Mean Shear Strength and Standard Deviation in Mega Pascal (MPa)

	Composite Resin Shear Strength			
	EA Group	**EPK Group 100%**	**EPK Group 50%**	**EPK Group 25%**
n	5	5	5	5
SD	1,04	0,43	0,56	0,57
$\bar{x}$	15,41	5,85	6,75	5,12

Parametric statistical test ANOVA had a significance value of $p<0.05$, indicating that there were significant differences in all treatment groups. The results of the Post Hoc LSD test showed that there was a significant difference between the EA group and the 100% EPK, 50% EPK, and 25% EPK groups. And there was an

insignificant difference between the 100% EPK group and the 50% EPK group, and between the 100% EPK group and the 25% EPK group.

DISCUSSION

The results of this study indicate that cacao pulp extract as an etching material can increase the shear strength of the composite resin and cause demineralization of the enamel surface. This is because the extra cacao pulp has the ability as a chelating agent that can remove metal ions or increase the excretion of metal ions on the tooth enamel surface. This statement is supported by a theory that explains that cacao pulp extract contains various acidic compounds such as citric acid, malic acid, acetic acid, oxalic acid, lactic acid, malic acid, and fumaric acid.[18,19,20] The acidic compound contained in this cacao pulp extract acts as a chelating agent by chemically binding metal ions and causing demineralization of the enamel to occur. Based on the above, cacao pulp extract as an etching material can increase the shear strength of composite resin although the shear strength value is descriptively lower than 37% phosphoric acid etching and there is a significant difference in analysis with 37% phosphoric acid shear strength. This is assumed because the 37% phosphoric acid etching has a lower pH=1 than the pH=3.5 cacao pulp extract. This degree of acidity affects the demineralization process because low pH will increase the concentration of hydrogen ions and these ions will change the Ca/P hydroxyapatite ratio in the enamel.[21] And the content of 37% phosphoric acid etching is 37% phosphoric acid which is a strong acid. In contrast, the acid content of cacao pulp extract is citric acid, malic acid, acetic acid, oxalic acid, lactic acid, malic acid, and fumaric acid. which is a collection of weak acid compounds. This difference in acid strength also affects the results of why 37% phosphoric acid has a higher shear strength. This is due to the nature of solid acids which can release more hydrogen ions than weak acids because they can completely ionize.[5]

The shear strength of 50% cacao pulp extract can be stronger than that of 100% cacao pulp extract because it is assumed there are too many dissolved minerals in 100% cacao pulp extract so tooth enamel experiences excessive microporosity and causes a decreasing hardness. This reduced enamel hardness causes the enamel to become weaker and more vulnerable when exposed to physical impact.[8] This is also in line with the research conducted by Maulidiyah (2021), that the most effective

concentration of cacao pulp extract to clean the smear layer of root canal walls is 50% cacao pulp extract.[22]

Cacao pulp extract was more beneficial in terms of tissue health, but when viewed from the shear strength of the composite resin etched using cacao pulp extract, the composite resin etched using phosphoric acid etching 37% had a significantly greater shear strength than the composite resin etched using phosphoric acid etching. cacao pulp extract. This less than optimal result could be caused by several factors, namely because the cleaning time of the bovine tooth sample was not clean and the time lag between the completion of filling the sample to the long shear strength test, causing the retention of the composite resin filling to be weaker.

Cacao pulp extract (EPK) can be used as an alternative etching material even though the average shear strength is lower than the shear strength of 37% phosphoric acid etching.

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