

Lemon Extract as an Alternative Etching Materials on Composite Resin Restoration Against Shear Strength

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Abstract

Background: Composite restoration is an adhesive (mechanical interlocking) restoration, which is from resin tags on micro porosity on the etched surface of the enamel. Etching is to clean the smear layer and forming porous on the enamel surface as to provide mechanical retention in the restoration. The acidic etching material that is often used is phosphoric acid with a concentration of 37%, but 37% phosphoric acid can cause inflammatory cell infiltration. Lemon contains citric acid, a weak acid that has the potential to be an alternative to acid etching.

Purpose: To find out the effect of lemon extract as an alternative etching material on the shear strength of composite resin.

Method: 14 samples of bovine teeth incisors were divided into two groups. Each group consisted of 7 samples, then cavity preparation. Group 1 with 37% phosphoric acid etching, group 2 with lemon extract. The samples were bonded, filled with composite resin and carried out shear strength tests.

Results: There was no significant difference in shear strength from the composite resin group with 37% phosphoric acid etching and composite resin group with lemon extract.

Conclusion: Lemon extract can be used as an alternative material for acid etching in composite resin.

Keywords: Shear strength, lemon extract, 37% phosphoric acid etching and composite resin.

Introduction

Recently, the field of dental medicine, composite resins have begun to be widely used as anterior and posterior restorative materials, due to the demand of patients who want tooth-colored restoration¹. Composite resins are increasingly popular because they have good aesthetics and good mechanical strength, among others are not easily separated from the tooth surface, not easily

cracked and broken, has a high visual opacity and low polymerization shrinkage.²

Composite resins are restorations whose basic principle of bonding with teeth is micromechanical (mechanical-interlocking)², i.e. from resin tags on micro porosity on the enamel surface that has been etched³. Etching is performed to clean the smear layer and produce small pores on the enamel surface, so can provide mechanical retention in restoration⁴.

Acid etching material that is often used is phosphoric acid with concentrations ranging from 30-40%, but the most widely used concentration is 37%⁵. Phosphoric acid is a strong acid, 6 is able to release more hydrogen ions than weak acids, because it is able to completely mineralize⁶.

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The strong acid can cause hydroxyapatite to dissolve so that the demineralization process occurs on the enamel surface⁷. When the composite resin is applied to the enamel surface that has been etched⁸, the resin will flow on the irregular surface and form a resin tag⁹, resulting in mechanical interlocking of the resin on the resin enamel³.

The use of phosphoric acid can be dangerous to the dental pulp¹⁰. Phosphoric acid can cause excessive demineralization so that it will increase the permeability of the dentin. Penetration of etching material will be more through the dentinal tubules into the pulp. The etching material of phosphoric acid with low pH causes the environment outside the cell to be hypertonic, so that the fluid inside the cytoplasm will be pulled out and the cell will contract. This can trigger permanent damage to odontoblast cells and cause an inflammatory reaction¹¹. The effects of using potentially harmful chemicals can be minimized by using alternative medicinal plants.

To overcome the shortcomings of etching that can irritate the dental pulp, natural materials that can replace etching, one of them with lemons. Lemon contains organic acids which are citric acid. Citric acid is a chelating solution that is able to remove the smear layer on the cavity so as to increase contact between the cavity surface and the restoration material¹².

The shear strength test for tooth restoration is one way to measure the adhesion strength of the material¹³ to the restored tooth structure besides the tensile strength test^{14,15}. In this research the magnitude of force acceptable for composite resin restorations was measured when the restorations were detached from the tooth surface. Shear strength can indicate how the adhesion occurs *in vitro*¹⁶.

The value obtained from the shear strength test is not absolute, but the value of the test results can be used to help compare an adhesive material. This research was conducted to find out more about the effect of lemon extract as an alternative etching material to the composite resin shear strength.

Materials and Method

The ingredients used were bovine teeth, 37% phosphoric acid, lemon extract, sterile aquadest, 96% ethanol, 0.9% PZ/NaCl solution, cotton pellet, composite resin bonding and composite resin.

The sample making of bovine teeth is as follows, each bovine teeth separated by the crown and roots, then planted on top of acrylic with the labial surface facing up. The sample was prepared in the labial section of a cylinder with a diameter of 4 mm and into 2 mm with contra angle low speed. Tooth cavity is checked using a sonde, to see the surface is smooth and then rinsed using distilled water and dried.

Making liquid lemon extract is as follows, as much as 1000 grams of lemon is prepared, washed clean, cut into small pieces and mashed with 96% ethanol as much as 2 liters using a blender. Lemon that has been smooth is transferred into a 2 liter volume jar for soaking (maceration) for 3 days. After 3 days soaking, then filtered with filter cloth separated the pulp with the filtrate. The ethanol filtrate was evaporated with a rotary evaporator with a temperature of 60 ° and ethanol pressure of 175 mbar until the solvent completely evaporated. The liquid yield of lemon extract was 165 ml, then the pH of the lemon extract is measured using litmus paper, around 2.5.

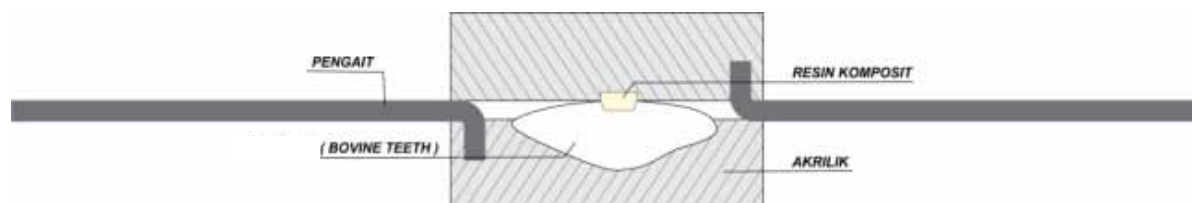


Figure 1. Sample tested

The next treatment procedure, bovine teeth were etched for 20 seconds, the samples were divided into 2 groups, namely group I: bovine teeth etched with 37% phosphoric acid, group II: bovine teeth) which was

etched with liquid lemon extract. The etching material was rinsed with distilled water \pm 1 cc until clean, then dry using blow dry for 10 seconds. Resin bonding was dropped on a microbrush as much as 1 drop (0.01 ml) and

applied to the surface of the cavity, irradiated with light curing for 10 seconds (visible light with a wavelength of 400-800nm). Composite resin was applied using a plastic filling instrument on the cavity layer by layer as many as 3 layers to meet the cavity, each layer was condensed and shined by using light cure. Samples were stored in a room temperature tool box for 24 hours. Shear strength testing uses a Universal Testing Machine (Autograph).

Result

Average and standard deviation of composite resin with phosphate and lemon extract can be seen on Table 1.

Table 1. Average and stand deviation of composite resin with phosphate and lemon extract

Group	n	Average	Standard Deviation
Group I	7	12.5054	0.59058
Group II	7	12.9943	0.73885

Information:

- Group I: Bovine teeth etched with 37% phosphoric acid
- Group II: Bovine teeth etched with liquid lemon extract

Normality test with the Kolmogorov-Smirnov Z test in both groups obtained p value for composite resin group with phosphoric acid etching p value = 0.200 ($p > 0.05$) and for composite resin group with lemon extract obtained p value = 0.200 ($p > 0, 05$). This shows that the data from the two groups are normally distributed. After knowing the data the two groups were normally distributed then Independent T-Test was conducted.

Levene test results obtained a significant level of 0.629 which indicates that the variance of homogeneity of data is normal. The statistical test was continued with the Independent T-Test by using the results in the normal variant sequence. The results of the Independent T-Test in the sample group A and sample B obtained a significant level of $p = 0.197$ ($p > 0.05$). This shows that there is no significant difference between the shear strength of composite resins with acid etching and composite resins with lemon extract.

Discussion

This research uses incisive cow's lower teeth. Lower mandibular incisors are used because they are easier to obtain and are easily standardized. The chemical and

micromorphological composition between bovine teeth and human teeth also has similarities. The results showed that the amount of inorganic pyrophosphate in enamel and dentin bovine teeth and human teeth was almost the same¹⁷. The research was conducted to determine the difference in shear strength of composite resins using 37% phosphoric acid etching with composite resins using lemon extract. The magnitude of the shear strength (MPa) is assessed based on the shear force (kgf) acceptable to composite resin restorations.

The results showed no significant difference in shear strength between composite resin with 37% phosphoric acid etching and composite resin with lemon extract etching. Lemon extract contains weak acids namely, citric acid. Citric acid in lemon extract plays a role in the process of dissolution of tooth enamel, because at acidic pH causes an increase in hydrogen ions, which will damage hydroxyapatite. Lemon extract shows a pH of 2.5. The degree of acidity affects the coefficient of the reaction rate, that the lower the pH or the more acidic, the higher the rate of reaction to release Ca-P ions in tooth enamel. High concentrations of H⁺ ions can dissolve Ca-P bonds in hydroxyapatite so that enamel loses the inorganic minerals that make up hydroxyapatite. This condition is known as the demineralization process.

Demineralization of tooth enamel occurs through a diffusion process which is the process of transferring molecules from the enamel to saliva due to acid. Demineralization occurs when hydroxyapatite (Ca₁₀(PO₄)₆(OH)₂) crystals in tooth enamel dissolve in acidic conditions into Ca²⁺, (PO₄)³⁻ and OH⁻. This reaction can be explained as follows: Ca₁₀(PO₄)₆(OH)₂ + 8H⁺ ↔ 10Ca²⁺ + 6(HPO₄)₂₋ + 2H₂O. The CaHPO₄ molecule is a neutral molecule that will diffuse out of the enamel thus the email will lose the inorganic minerals that make up hydroxyapatite, while the two OH ions bind to the H⁺ ion to form 2H₂O in the email¹⁸.

Demineralization that occurs in a long time will cause the loss of hydroxyapatite crystals so that enamel is more porous and increases the microporosity of tooth enamel. The formed microporosity will be activated by the bonding material and composite resin, resulting in a shear strength that is not much different from the yield of 37% phosphoric acid.

The results of the SEM (Scanning Electron Microscope) test after the application of lemon extract on bovine teeth also showed the formation of microporosity.

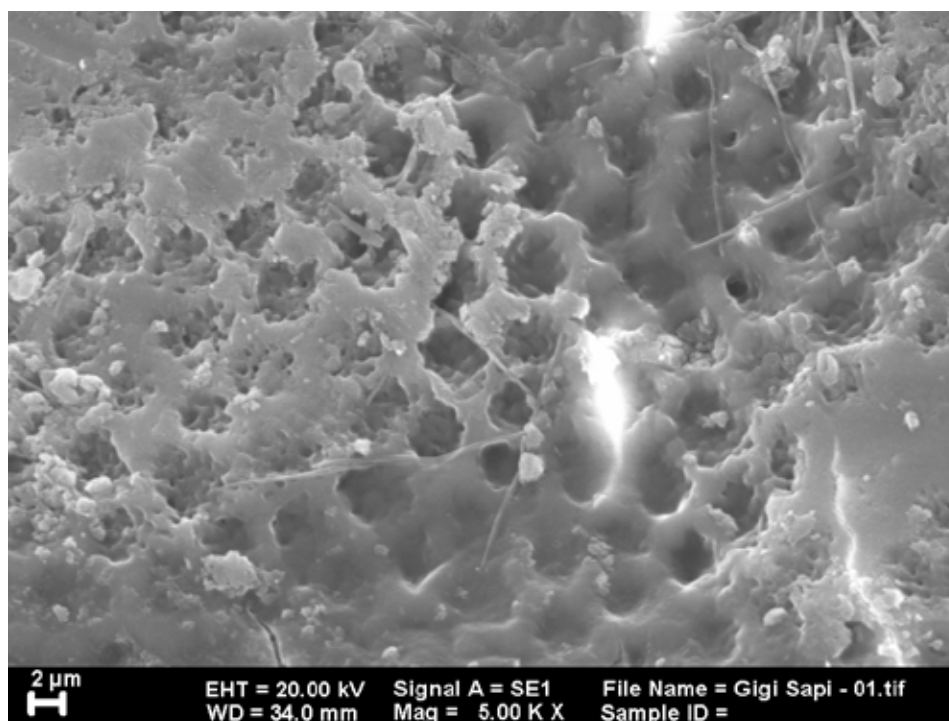


Figure 1: Depth of microporosity of tooth enamel after application of lemon extract for 20 seconds.

Lemon extract is more beneficial in terms of tissue health, because the pH is not too low when compared to the pH of 37% phosphoric acid. Lemon extract also has the ability to remove the smear layer and form microporosity like 37% phosphoric acid etching. The results showed no significant difference, but taking into account the advantages of lemon extract, the lemon extract can still be used as an alternative to 37% phosphoric acid etching.

Conclusions

The conclusion of the research is that lemon extract can be used as an alternative etching material on composite resin spills with shear strength.

Conflict of Interest: None

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Ethical Clearance: This research has obtained research ethics that have been approved by the research team with number 208/HRECCFODM/VIII/2018.

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