Effect of Guava Extract on Shear Bond Strength of Direct Composite Veneer Post Bleaching

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Abstract. Direct composite veneer is often done to increase the aesthetics of teeth after bleaching. In direct composite veneer treatment, the presence of free radicals residual after bleaching can inhibit the polymerization of the bonding agent and decrease composite shear bond strength. Increasing shear bond strength of composite resin after bleaching can be done with the application of antioxidant agent. Guava is a fruit rich in antioxidant such as ascorbic acids, carotenoids and fenols. This study aims to evaluate the difference between the effectiveness of 10%, 20%, and 40% guava extract solution as natural antioxidants to improve the shear bond strength of direct composite veneer to bleached enamel. This cross-sectional study design divided 20 permanent premolar teeth into four groups: control group, 10%, 20%, and 40% guava extract solution group. Composite shear bond strength was measured with Universal Testing Machine. Data were analyzed using ANOVA followed by a Post Hoc test. The result showed shear bond strength of the four groups' scores was 1.33 ± 0.42 MPa, 3.0 ± 1.06 MPa, 2.11 ± 0.61 MPa, and 1.94 ± 0.65 MPa, respectively. Significant highest shear bond strength values were observed in the 10% guava extract solution group ($p < 0.05$). 10% guava extract solution was the most effective natural antioxidant to improve the shear bond strength of direct composite veneer to bleached enamel.In conclusion, 10% guava extract solution was the most effective natural antioxidant to improve shear bond strength of direct composite veneer to bleached enamel. The significance of this study was to find alternative natural antioxidants applications after tooth bleaching.

Keywords: Bleaching · Composite veneers · Guava extract

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1 Introduction

Tooth discoloration is the main reason patients seek dental care [1], one of which is bleaching [2]. The most commonly used bleaching material is hydrogen peroxide [3]. Hydrogen peroxide has a very light molecular weight making it easier to penetrate the deeper tooth structure [4]. Hydrogen peroxide works by oxidizing organic pigments in teeth to produce whiter teeth [5].

Veneer coating is often used to add aesthetics to the teeth after bleaching [6]. Direct composite veneers have several advantages, such as simple techniques, minimal preparation, the natural look of the tooth, and affordable cost [7]. The composite resin is bonded to the teeth by a micromechanical interlocking bond formed by applying etching and bonding [8].

Hydrogen peroxide produces residues in the form of highly reactive free radicals in the form of oxygen and hydroxyl or perhydroxyl ions [9]. These free radicals can inhibit bonding polymerization and prevent the formation of resin tags on the etched enamel surface [5]. Bleaching residue can reduce the bond strength of the composite resin to the teeth and increase the risk of fracture [10].

Increasing the bond strength of composite resins on post- bleaching can be done by applying antioxidant agents [10]. 10% ascorbic acid is a commonly used antioxidant [6]. Ascorbic acid has a weakness in the form of the potential to form a porous tooth surface and can trap pathogenic bacteria such as Streptococcus mutans [11].

Guava (Psidium guajava, L.) is a fruit rich in antioxidants such as ascorbic acid, carotenoids, and phenols. 100 g of fresh guava contains 228.3 mg of vitamin C [12]. Guava extraction is carried out to separate the parts of the guava plant that function as medicinal ingredients [13]. The extraction results in the solution preparation have the lowest viscosity compared to other preparation forms. Viscosity affects the rate of diffusion; the lower the viscosity is, the higher the diffusion rate will be, so its effectiveness also increases [13].

The antioxidants' ability to increase the composites' shear bond strength at post-bleaching is tested using UTM (Universal Testing Machine) to determine the shear strength [10]. This study aims to determine the difference in the effectiveness of 10%, 20%, and 40% guava (Psidium guajava, L.) extract as a natural antioxidant in increasing the shear bond strength of direct composite resin veneers to teeth after bleaching using hydrogen peroxide 40%.

2 Material and Method

This research is an experimental laboratory study with a cross-sectional study design. This research was conducted at PSKG UMY Yogyakarta in October - December 2018. The research sample consisted of 20 permanent premolars that had been extracted and collected from several Puskesmas and dental clinics in the Magelang - Yogyakarta area. Inclusion criteria for sample selection included extracted permanent premolars with intact crowns. Meanwhile, the exclusion criteria for the sample included teeth with or have been filled with teeth and teeth with structural abnormalities such as dentinogenesis imperfecta or amelogenesis imperfecta.

Table 1. Guava Extract Solution Preparation Formula

Composition	**10%**	**20%**	**40%**
Guava Extract (mg)	1	2	4
Aquadest (ml)	10	10	10

Independent variables in this study were guava extract solution 10%, 20%, and 40%. The dependent variable is the value of the composite sticking to the teeth at post-bleaching. Controlled variables were tooth type, fruit type, composite resin type, bleaching technique, composite resin application technique, time, and temperature. The uncontrollable variable was tooth age.

The tools used in this research included blender, oven, vacuum rotary evaporator, water bath, porcelain dish, micromotor, bur wheel, light-curing unit Litex 682 Dentamerica brand, acrylic mold, and UTM Pearson Panke Equipment Ltd, UK brand. The materials included premolar teeth, red guava, 96% ethanol, resin, catalyst, 40% hydrogen peroxide, composite resin i-Light shade A2 brand, acid etching T-Etchant brand, bonding iDent brand, distilled water, vaseline and plasticine.

2.1 Guava Extract

Guava was extracted using the maceration method. The extraction procedure was carried out at the UGM Pharmacy Laboratory, Yogyakarta. The guava used was selected according to inclusion criteria: the flesh variety with red seeds, almost ripe, and still fresh. The exclusion criteria for guava were rotten fruit and animal bite marks.

Two kg of guava were washed, cut into small pieces randomly, and then baked in an oven at 50 ˚C for five days. The dried guava was then blended until it became a powder. The guava powder was then dissolved in 96% ethanol in a ratio of 1:3. The maceration process lasted for five days and was filtered every 24 h. The filtrate was evaporated using a rotary evaporator at 70˚ and then concentrated using a water bath. The extract was then formulated into a guava extract solution with concentrations of 10%, 20%, and 40% using distilled water based on the formula Table 1.

2.2 Specimen Preparation

The labial of all tooth samples was prepared using a bur wheel until the surface was flat. The prepared teeth were then fixed with acrylic resin leaving the labial crown. All samples were soaked in 40% hydrogen peroxide solution for 20 min and then rinsed with running water for 60 s. The bleaching procedure was repeated once. The teeth were then stored in a plastic container filled with distilled water for 24 h at room temperature.

The samples were randomly divided into four groups, where one group contained five dental samples:

Control group: Etching was applied to the labial surface of the teeth for 15 s and rinsed with water for 20 s. Bonding was applied for 20 s, aerated, then irradiated with

a light cure for 20 s. Composite resin was applied with a size of 6x6x1 mm using an acrylic mold on the labial surface of the teeth and irradiated using a light cure for 40 s.

Group 2 (10% guava extract): the sample was soaked in a 10% guava extract solution for 10 min. The etching was applied to the labial surface of the tooth for 15 s, then rinsed with water for 20 s. Bonding was applied for 20 s, aerated, then irradiated with a light cure for 20 s. Composite resin was applied with a size of 6x6x1 mm using an acrylic mold on the labial surface and irradiated using a light cure for 40 s.

Group 3 (20% guava extract): The sample was soaked in a 20% guava extract solution for 10 min. The etching was then applied to the labial surface of the tooth for 15 s, then rinsed with water for 20 s. Bonding was applied for 20 s, aerated, then irradiated with a light cure for 20 s. Composite resin was applied with a size of 6x6x1 mm using an acrylic mold on the labial surface and irradiated using a light cure for 40 s.

Group 4 (40% guava extract): The sample was soaked in a 40% guava extract solution for 10 min. The etching was then applied to the labial surface of the tooth for 15 s, then rinsed with water for 20 s. Bonding was applied for 20 s, aerated, then irradiated with a light cure for 20 s. Composite resin was applied with a size of 6x6x1 mm using an acrylic mold on the labial surface and irradiated using a light cure for 40 s.

2.3 Shear Strength Measurement

The shear strength test was carried out with the UTM tool. Sample testing was conducted in the Mechanical Engineering D3 laboratory, UGM, Yogyakarta. The shear strength test results were indicated as the shear stress value in megapascals (MPa). The composite shear stress data obtained were then analyzed using One Way ANOVA followed by the Post Hoc LSD test.

3 Result

The shear stress value of all samples in each group is presented in a graphic diagram, as shown in Fig. 1. The 10% guava extract solution group had the highest shear stress value, while the lowest shear stress value was in the control group, which did not receive any intervention of guava extract solution as a natural antioxidant agent. Table 2 shows the comparison of the shear stresses between the test groups. The shear stress value in the 10% guava extract solution group was significantly different compared to the shear stress in the control group with a significance value of 0.002 ($p < 0.05$), and the 40% guava extract solution group with a significance value of 0.035 ($p < 0.05$).). A comparison of shear stress values in other groups did not show a significant difference.

4 Discussion

Direct resin composite veneers are often used to add aesthetics to teeth after bleaching [6]. The bleaching residue can cause a decrease in the composite sticking after bleaching. The application of antioxidant agents is required to remove bleaching residue so that the composite sticking to the post-bleaching teeth can be increased [10].

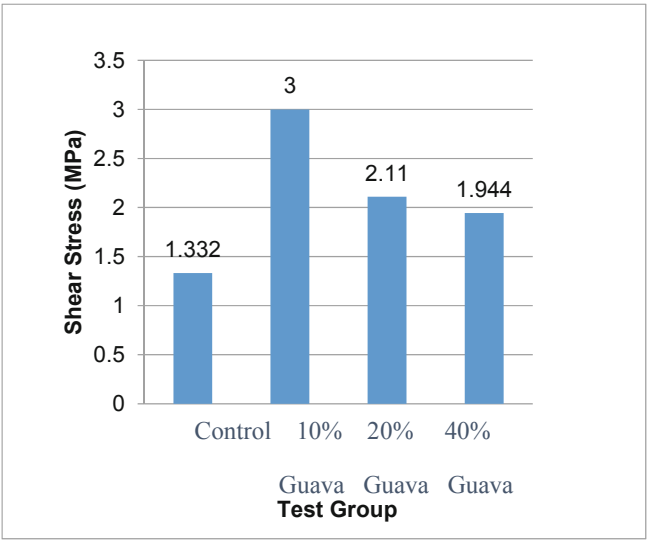

Fig. 1. The Graphic of the Comparison of Shear Stress Values between the Test Groups

Table 2. Comparison of Shear Stress Values between Test Groups

Group	Mean ± SD (MPa)	*p*-value	Significance Group
Control	1.33 ± 0.42 MPa	P < 0.018 (Sig.)	Control vs 10%
10% Guava Extract	3.0 ± 1.06 MPa		
20% Guava Extract	2.11 ± 0.61 MPa		10% vs 40%
40% Guava Extract	1.94 ± 0.65 MPa		

The results of the analysis test showed that there was a significant difference in the shear stress of the post- bleaching direct resin composite veneers due to the application of natural antioxidants in guava extract solutions of 10%, 20%, and 40%. The 10% guava extract solution group had the highest shear stress value, followed by 20% and 40% guava extract while the lowest shear stress value was in the control group, which did not receive any intervention of guava extract solution as a natural antioxidant agent. The difference in shear stress was influenced by the difference in concentration in the three solutions used. The difference in concentration affects the viscosity; the higher the concentration of a solution is, the more the substances are dissolved, so the viscosity increases. The viscosity of a solution is influenced by molecular weight; a high molecular weight causes a high viscosity solution. Based on that theory, it can be concluded that the 10% guava extract solution has the lowest molecular weight, while the 40% guava extract solution has the highest molecular weight.

Differences in molecular weight affect a solution's penetration ability; the lower the molecular weight of the solution is, the better the penetration ability will be, so the

performance will also be more effective [10]. Guava extract solution with low molecular weight will facilitate the penetration of the solution into the deeper tooth tissue. The deeper the penetration of the guava extract solution is, the more the bleaching residue will be eliminated, so the composite sticking to the post- bleaching teeth increases.

In the case of this study, the result showed that the 10% guava extract solution group was proven to be the most effective in increasing the direct resin composite veneers to post- bleaching teeth compared to other groups. The 10% guava extract solution had the lowest molecular weight, indicating that the solution also had the best penetration ability compared to the 20% and 40% guava extract solutions. Furthermore, 10% guava extract solution is the most effective natural antioxidant in eliminating free radicals from bleaching residue so that the shear bond strength of direct resin composite veneers to post-bleaching teeth can be significantly increased. The result aligns with the research by Arumugam et al. [9], showing that the application of antioxidant agents with low molecular weight to the post- bleaching tooth surface will increase its effectiveness in eliminating free radicals from bleaching residues [10].

5 Conclusion

Based on the result of this study, there were difference between the effectiveness of 10%, 20%, and 40% guava extract solution as natural antioxidants to improve the shear bond strength of direct composite veneer to bleached enamel. It can be concluded that applying 10% guava extract solution could be most significantly increase the shear stress value and have the potential as a natural antioxidant in increasing the shear bond strength of direct resin composite veneers after bleaching.

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