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THE EFFECT OF PINEAPPLE TUBER EXTRACT GEL (*Ananas Comosus (L.) Merr*) ON COMPOSITE SURFACE ROUGHNESS

(PENGARUH EKSTRAK GEL NANAS (Ananas Comosus (L.) Merr) PADA KEKASARAN PERMUKAAN KOMPOSIT)

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ABSTRACT

Teeth whitening using chemicals such as carbamide peroxide can increase the surface roughness of composite resin, which risks causing plaque buildup and secondary caries. Pineapple tubers contain the enzyme bromelain and organic acids known as bleaching alternatif from natural resources whitening effect on the composite with minimal impact on the roughness of the composite. To determine the effect of pineapple tuber extract gel with pH 2.5 and 6.5 on the surface roughness of nanohybrid composites compared to 16% carbamide peroxide. This experimental research used a pre-post test-only controlled group design. A total of 45 nanohybrid composite plate samples were divided into three groups: the treatment group with pineapple tuber extract gel at pH 2.5 and 6.5, and the control group with 16% carbamide peroxide. The surface roughness of the composite was measured before and after treatment for 14 days using a surface roughness tester. Data analysis was carried out using the Kruskal-Wallis statistical test and the Mann-Whitney post hoc test. The results showed no statistically significant

differences in surface roughness between the treatment and control groups ($p > 0.05$). Although a slight increase in surface roughness was observed following application of pineapple tuber extract gel, the changes were not significant when compared with 16% carbamide peroxide. Pineapple tuber extract gel, as a teeth whitening agent, has no significant effect on the surface roughness of the composite. Therefore, it can be concluded that additional experimental studies are needed before this material can be considered a whitening agent.

Keywords: pineapple tuber extract gel; teeth whitening; composite surface roughness; nanohybrid composite resin

ABSTRAK

Pemutihan gigi menggunakan bahan kimia seperti karbamid peroksida dapat meningkatkan kekasaran permukaan resin komposit, yang berisiko menyebabkan penumpukan plak dan karies sekunder. Bonggol nanas mengandung enzim bromelin serta asam-asam organik yang diduga memiliki efek pemutih gigi dengan dampak minimal terhadap kekasaran komposit. Mengetahui pengaruh gel ekstrak bonggol nanas dengan pH 2,5 dan 6,5 terhadap kekasaran permukaan komposit nanohybrid dibandingkan dengan karbamid peroksida 16%. Penelitian eksperimental ini menggunakan desain pre-post test only controlled group design. Sebanyak 45 sampel lempeng komposit nanohybrid dibagi menjadi tiga kelompok: kelompok perlakuan dengan gel ekstrak bonggol nanas pH 2,5 dan 6,5, serta kelompok kontrol dengan karbamid peroksida 16%. Kekasaran permukaan komposit diukur sebelum dan sesudah perlakuan selama 14 hari menggunakan surface roughness tester. Analisis data dilakukan dengan uji statistik Kruskal-Wallis dan uji post hoc Mann-Whitney. Tidak terdapat perbedaan signifikan dalam kekasaran permukaan komposit antara kelompok perlakuan dan kelompok kontrol ($p \geq 0,05$). Meskipun terdapat sedikit peningkatan kekasaran setelah aplikasi gel ekstrak bonggol nanas, nilainya tidak berbeda secara signifikan dibandingkan dengan karbamid peroksida. Gel ekstrak

bonggol nanas sebagai bahan pemutih gigi tidak berpengaruh signifikan terhadap kekasaran permukaan komposit. Sehingga gel ekstrak bonggol nanas dapat direkomendasikan sebagai bahan pemutihan gigi.

***Kata kunci**: gel ekstrak bonggol nanas; pemutih gigi; kekasaran permukaan komposit; resin komposit nanohybrid*

INTRODUCTION

Composite resin restorations are often applied to teeth that will undergo whitening treatment, both anterior and posterior teeth. Currently, one of the newest types of composite resin that is widely used is nanohybrid composite resin. This material has a number of advantages, including good physical, mechanical and aesthetic properties. However, despite having many advantages, the polymers in composite resins have unstable bonds, so they are susceptible to degradation, especially when exposed to materials with a low pH or acid. This can affect the surface roughness of the composite resin. [1,2]

Tooth discoloration can be caused by internal, external factors, or both. One common complaint is tooth discoloration which can reduce the patient's self-confidence. External factors that influence tooth discoloration come from outside, for example, due to the consumption of tea, coffee, certain foods, or colored chemicals. Meanwhile, internal factors are caused by pathological and physiological conditions experienced by the patient. [1,2]

Hydrogen peroxide, which is often used in teeth whitening, has reactive properties that can damage the organic matrix of composite resin, which in turn results in surface roughness of the resin. The quality of the organic matrix of the composite resin is a determinant in increasing surface roughness. When the composite resin surface becomes rough to exceed the critical limit of 0.2 μm, the risk of plaque, secondary caries, discoloration, damage to the surface, and irritation of the surrounding tissue becomes higher. The more matrix present, the more susceptible it is to degradation processes. This process causes the release of monomers from the resin matrix and inorganic filler, which triggers the formation of filler protrusions, thereby increasing the surface roughness of the composite resin.[3]

Composite itself is a dental material that consists of two or more components with different material properties. These components include matrix resin or monomer, inorganic filler,

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coupling agent, initiator, and other materials. Activation of polymerization can be achieved through various means, including the use of chemical agents, heat, or light. [2,4]

Nanohybrid composite resin has succeeded in attracting attention as a frequently used dental restoration material because it has good strength and a smooth surface, providing satisfactory results in terms of health and aesthetics, both for anterior and posterior tooth restoration. With very small particle sizes (0.1-2 μm) as well as nanoparticles measuring 100 nm, this resin offers significant advantages.[2,5,6]

The three main types of materials in composite resin are matrix, filler, and coupling agent. The resin matrix consists of aromatic or aliphatic diacrylate monomers. Dimectacrylate commonly used in composite resins is Bisphenol-A-Glycidyl Methacrylate (Bis GMA), Urethane dimectacrylate (UDMA), and triethylene glycol dimectacrylate (TEGMA). The resin matrix plays an important role in forming strong polymer cross-links and in regulating the consistency of the composite resin. Fillers added to reduce shrinkage during polymerization, minimize water absorption, improve the thermal expansion coefficient, and increase mechanical properties, such as strength, stiffness, hardness, and abrasion resistance. The coupling agent's job is to connect the inorganic filler material particles with the resin matrix, while providing hydrolytic stability so that water does not easily penetrate the surface of the filler material and resin.[7,8]

Some effects of dental bleaching, caused by the high concentration of materials used and excessive application duration, can cause tooth sensitivity, irritation of the oral mucosa, and morphological changes to the tooth structure. Apart from that, this condition also has the potential to reduce resistance to fracture or reduce the compressive strength of the tooth.[9,10]

For a safer, cheaper and easier to obtain alternative, there are natural ingredients that can be used to whiten teeth, one of which is pineapple tubers (*Ananas comosus* (L.) Merr). The tuber part of the pineapple is often overlooked and not consumed, even though it contains the enzyme bromelain, which is useful in the teeth whitening industry. Apart from pineapple tubers, many studies have also explored other natural ingredients for teeth whitening, such as strawberries (Fragaria x ananassa), lemons (*Citrus limon L.*), and apples (Malus sylvestris).[11–13]

Pineapple plants (*Ananas comosus L. Merr*) grow abundantly in Indonesia, with a total harvest reaching 144,896 tonnes in 2014. Pineapples are known to be rich in

fiber and water; in 100 grams The pulp contains 1.4 grams of fiber and 86.37 grams of water. This fruit has complex nutritional content and various properties, including the enzyme bromelain, which can inhibit bacterial growth.[14,15]

Pineapple tubers are not only rich in the enzyme bromelain, but also contain organic acids such as citric acid, malic acid and oxalic acid. Bromelain enzyme in pineapple can help whiten the surface of teeth that experience discoloration due to extrinsic factors. Malic acid, which belongs to the dicarboxylic acid group, can also whiten teeth by oxidizing the enamel surface. On the other hand, the citric acid found in pineapple has equivalent potential to ellagic acid in the teeth whitening process, functioning as an effective oxidizer like ellagic acid and hydrogen peroxide.[13,14]

METHOD

This research is a type of quasi-experimental research with a pre-post test only controlled group design to determine the effect of pineapple tuber extract gel (Ananas comosus (L.) Merr) on the surface roughness of the composite. The research object that will be used is a disc-shaped composite plate with a size of 5 mm and a thickness of 2 mm. The composite used is 3M Filtek Z250XT A3, a 3M Filtek Z250XT universal restoration composite nanohybrid composite. The samples that will be used are 45 composite plates taken as needed, divided into 3 groups consisting of 15 resin plates per group.[16]

Treatment group 1 will be given pineapple tuber ethanol extract with a pH of 2.5, treatment group 2 will be given pineapple tuber ethanol extract with a pH of 6.5 and the control group with 16% carbamide peroxide. The research sample consisted of 45 composite plates. Making composite slabs according to predetermined criteria. After that, the appropriate composite slab is then applied with pineapple tuber extract gel to see whether there is any roughness on the composite surface.[15]

This study was conducted at the Biochemistry Laboratory of the Faculty of Medicine, the Dental Materials Laboratory, and the Pharmacy Laboratory of Universitas Jenderal Achmad Yani (Unjani). A total of 45 composite resin plate specimens were used and allocated into three groups: two treatment groups receiving pineapple tuber extract gel at pH 2.5 and 6.5, and one control group treated with 16% carbamide peroxide (home bleaching).

Pineapple Weevil Extract Gel

This research used Subang pineapple fruit obtained from Jalangcagak

District, Subang Regency, West Java. First of all, the pineapple is peeled, and only the tuber part is taken, then cut into small pieces. Then the small pieces of pineapple tuber are put into a simplicia oven at a temperature of 40-600 °C. After the pineapple tuber pieces are dried, blend them until smooth. Making pineapple tuber extract is done by maceration, namely by soaking the blended pineapple tubers in 96% ethanol. Then maceration and filtering are carried out twice, and the dregs are discarded. The results of the soaking are put into a rotary evaporator for 5 days until it becomes a thick extract. 38

Treatment Procedures

The research sample used consisted of 45 composite plates. The research began with making a printing tool made of acrylic, and in the center there was a hole with a diameter of 5 mm and a thickness of 2 mm. The resin is put into the mold, then the mold is covered with a glass preparation with a thickness of 1 mm, and a load of 500 g is placed evenly on top of the glass preparation, after which it is illuminated using light curing for 20 seconds. Irradiation is carried out perpendicular to the surface of the composite resin (Figure 1: Making Composite Resin Samples). The specimens were then placed in a closed box with 100% humidity and stored in an incubator at 37°C for 24 hours. Before applying the pineapple tuber extract gel, the composite plates were first divided into 3 groups, with each group containing 15 composite plates and labeled according to the order of each group. [17]

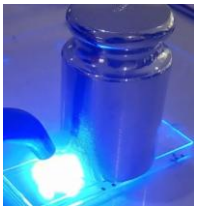

Figure 1. Making Composite Resin Samples.

The whitening process was carried out every day for 14 days by administering pineapple weevil extract gel, pH 2.5 and pH 6.5 and 16% carbamide peroxide to each group consisting of 15 plates. The application is carried out using a microbrush on the entire surface of the composite plate base. Then leave it to dry for 60 minutes. Then rinse under running water until clean, then dry and put into a container containing 5 cc of Aquabides solution. After that, put it in an incubator at 37°C for 24 hours. 39

The roughness test is carried out by keeping the sample on the profilometer table in a position in the direction of the axis of symmetry. Composite surface roughness is measured using a surface roughness tester by placing a stylus on all parts of the

composite surface. After the measuring instrument is run and finally stops, the roughness measurement data can be seen on the monitor screen in the form of numerical data. The roughness test was carried out twice, before applying the pineapple weevil extract gel (day 0) and after applying the pineapple weevil extract gel (day 14). 40

RESULT

This research was carried out at the Biochemistry Laboratory of the Unjani Faculty of Medicine, the Unjani Dental Materials Laboratory and the Unjani Pharmacy Laboratory. The samples used in this research were 45 composite plates. The samples were divided into three groups, namely two treatment groups (pH 2.5 and 6.5 pineapple weevil extract gel) and one control group, namely 16% carbamide peroxide "home bleaching".

Nanohybrid composite samples were stored in the Biochemistry Laboratory, Faculty of Medicine, Jenderal Achmad Yani University, for treatment for 14 days. The composite samples were then divided into 3 treatment groups, namely 2 treatment groups (pineapple weevil extract gel, pH 2.5 and pH 6.5) and a control group (16% carbamide peroxide). Of the three groups, there are 15 composite resins to be tested according to research.

Measurements of the surface roughness of the composites for each group were carried out at the beginning and at the end of the treatment, which was carried out for 14 days. Each sample had its roughness value measured using a Roughness Tester by placing a felt needle on the composite surface three times to collect data and take the average value. Measurements were carried out before and after treatment. The research results were then analyzed using statistical applications, which were previously tested for normality first with the Shapiro-Wilk test. Differences in composite surface roughness after treatment on the 14th day in all groups were carried out using the Kruskal-Wallis test because the distribution was not normal.

Table 1. Results of the composite surface roughness test

Group	Variable				
	Before Treatment			After Treatment	
Pineapple Tuber extract gel 2.5					
Mean ± SD	0.354 0.23	±		0.347 0.23	±
Min - Maks	0.108 0.740	–		0.423 0.515	–
Pineapple Tuber extract gel 6.5					
Mean ± SD	0.313 0.27	±		0.267 0.24	±
Min - Maks	0.101 0.830	–		0.791 0.854	–
16% carbamide peroxide (control group)					
Mean ± SD	0.341	±		0.290	±

	0.29		0.32	
Min - Maks	0.104	–	0.481	–
	0.970		0.567	

Ket: *nilai uji *mann whitney* tidak signifikan p≥00,05

Table 1 shows the results of the composite roughness test before and after treatment. The 2.5 pineapple tuber extract gel group had an average roughness value before treatment of 0.354 and decreased after treatment to 0.347. The 6.5 pineapple weevil extract gel group had a roughness value before treatment of 0.313 and decreased after treatment to 0.267. The 16% carbamide peroxide control group had a roughness value of 0.341 and decreased after treatment to 0.290.

Table 2. Normality test of surface roughness values of each group after treatment

Group	Mean ± SD	Nilai P	Homogenity
Pineapple Tuber extract 2.5	0.347 ± 0.23	0.007	0.350
Pineapple Tuber extract 6.5	0.267 ± 0.24	0.000	
16% carbamide peroxide (control group)	0.290 ± 0.32	0.000	

*nilai p≥00,05 data berdistribusi normal

Table 2 shows the results of the normality test for numerical data which was carried out using the Shapiro Wilk test because the data was <50 with the normality test results for the pineapple weevil extract group being 2.5, the pineapple weevil extract group being 6.5, and the control group obtaining information on the roughness P value (P≤0,05) which means the data is not normally distributed. It is also known that the homogeneity test result on this numerical data is 0.350 (P 0,05), which means the data is homogeneous.

Table 3. Comparison of composite surface roughness among all groups after 14 days of treatment

Group	Mean ± SD	Min - Maks
Pineapple Tuber extract 2,5	0.347 ± 0.23	0.423 – 0.515
Gel ekstrak bonggol nanas 6,5	0.267 ± 0.24	0.791 – 0.854
Pineapple Tuber extract 6,5	0.290 ± 0.32	0.481 – 0.567

Based on Table 3 of the composite roughness test results after treatment, it is known that the highest average composite roughness value was obtained by the 2.5 pineapple tuber extract gel group of 0.347, with a minimum value of 0.423 and a maximum value of 0.515. The lowest average composite roughness test result was

in the pineapple tuber extract gel group, 6.5, valued at 0.267 with a minimum value of 0.791 and a maximum value of 0.854.

Table 4. Effect of ethanol extract gel of pineapple Tuber (*Ananas comosus (L.) Merr.*) on composite surface roughness

Group	Variable		P Value
	Before Treatment	After Treatment	
Pineapple Tuber extract 2,5			0.983
Mean ± SD	0.354 ± 0.23	0.347 ± 0.23	
Min - Maks	0.108 – 0.740	0.423 – 0.515	
Pineapple Tuber extrac6,5			0.868
Mean ± SD	0.313 ± 0.27	0.267 ± 0.24	
Min - Maks	0.101 – 0.830	0,791 – 0,854	
16% carbamide peroxide (control group)			0.431
Mean ± SD	0.341 ± 0.29	0.290 ± 0.32	
Min - Maks	0.104 – 0.970	0.481 – 0.567	

Note: *Mann–Whitney test results were not statistically significant (p ≥ 0.05).*

Table 4, after carrying out paired tests on the 2.5 pineapple weevil extract gel group, the 6.5 pineapple weevil extract gel group, and the 16% carbamide peroxide control group using the Mann Whitney test, it was found that all of these groups did not have a significant difference in the surface roughness of the composite before and after treatment with a value of P≥0,05.

Table 5. Intergroup comparison of composite surface roughness after application of pineapple tuber extract gel (*Ananas comosus (L.) Merr.)*

Group	Mean ± SD	*p*	Interpretation
Pineapple Tuber extract 2.5	0.347 ± 0.23		
Pineapple Tuber extract 6.5	0.267 ± 0.24	0.330	Not significant
16% carbamide peroxide (control group)	0.290 ± 0.32		

Ket: *nilai uji *Kruskal-Wallis* tidak signifikan p≥0,05

In Table 5, the results of calculations using the Kruskal-Wallis test can be explained that there is no significant difference in the results of the composite roughness test after administering pineapple tuber extract gel (Ananas Comosus (L.) Merr) because the P value is 0.05 (0.000 0.05). It is known that the highest roughness value was produced by the pH 2.5 pineapple weevil extract gel group, with an average of 0.347 and the lowest roughness value was produced by the pH 6.5 pineapple weevil extract gel group, with an average of 0.267.

Table 6. Paired comparison test results among treatment groups

Group	Pineapple Tuber extract 2,5	Pineapple Tuber extract 2,5	Pineapple Tuber extract 2,5
Pineapple Tuber extract 2.5	-	0.407	0.184
Pineapple Tuber extract 6.5	0.407	-	0.340
Pineapple Tuber extract 6.5	0.184	0.340	-

In Table 6, the results of pairwise test calculations between treatment groups using the non-parametric post hoc Mann-Whitney test can be explained that all treatment groups did not have a significant difference in roughness values compared to the control group, namely the 16% carbamide peroxide group (P 0,05).

DISCUSSION

The results of Table 1 show that there is no significant difference in the average surface roughness of the composite before and after being treated with pineapple weevil extract gel 2.5 and 6.5, as well as administering carbamide peroxide, with a P value for each group of P 0,05. The results of group research I before being treated using pineapple tuber extract gel showed a result of 0.345 μm, and after being treated, it was 0.347 μm. Based on these results, there was an increase in the roughness of the composite surface after treatment. The results of table 2 of calculations using the Kruskal Wallis test showed that there was no significant difference in the results of the composite surface roughness test after applying pineapple weevil extract gel because the value was P≥0,05 (0,000≥0,05).

The control group that used 16% carbamide peroxide had composites that experienced increased roughness. The research results stated that the acid from the bleaching agent could increase the surface roughness of the composite. This is because the pH of carbamide peroxide used in home bleaching treatments ranges from 4 to 7.7. This low pH causes the dissolution of the composite components, thus forming pores

and increasing the surface roughness of the composite. 27

The roughness of the composite resin surface is something that must be considered because it can pose a risk of plaque and secondary caries, so it is necessary to understand the factors that cause the surface roughness of the composite resin. Surface roughness is caused by the influence of acidic pH (<7). The acidic environment causes degradation of the resin matrix, causing the release of filler particles and an increase in the surface roughness of the composite. [18,19]

Pineapple (Ananas comosus (L) Merr). contains the enzyme bromelain and organic acids, namely citric acid, malic acid and oxalic acid, which are thought to whiten teeth. The more dominant acid is citric acid, 78% of the total acid. The citric acid contained in pineapple is thought to be able to whiten teeth, and chemically, acid is a substance that, in water, can produce hydrogen ions (H+), after which the acid will ionize into hydrogen ions and remaining acid ions, which are negatively charged. The mechanism behind this increase in roughness is related to the acidic nature of pineapple, which can cause erosion of the composite resin surface. Acids can affect the surface integrity of composite resins by diffusing into the polymer matrix and separating polymer chains, thereby increasing surface roughness. In this study, Subang honey pineapple was used with a pH of 3.86, which indicates that pineapple is a fruit that has an acidic pH. This research discusses the effect of pineapple weevil extract gel, pH 2.5 and 6.5, with 16% carbamide peroxide, on the surface roughness of composites as a natural whitening agent.

The results of the study showed that there was composite surface roughness between the groups on day 1 and day 14, with significant differences between the groups after being treated with pineapple weevil (Ananas comosus (L) Merr) extract gel. So, from the results of this study, it can be concluded that pineapple weevil (Ananas comosus (L) Merr) extract gel is a natural material with a carbamide control group, where the roughness produced from the pH 2.5 and pH 6.5 gels is not significant compared to carbamide peroxide. so that the tooth whitening agent does not affect the roughness of the composite surface.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that pineapple tuber extract gel (Ananas comosus (L.) Merr), pH 2.5 and 6.5, does not affect the surface roughness of the composite.

CONFLICT OF INTEREST

There is no conflict of interest in this research.

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