Research article

Differences in surface roughness of nanohybrid and nanofilled composite resins after polishing after soaking with lemon (Citrus Limon) juice

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Abstract: Resin composite is the material that currently used very widely in dentistry. Resin composite is commonly used by dentist to replace lost tooth structure it can be restore its function. Nanohybrid composite is formulated that consist of two mixed fillers namely microfine (0,01 to 0,1 μm) and small (fine) particle filler (0,1 to 10 μm). Nanofilled composite have filler particle size 1-100 nm (0,001 to 0,1 μm). Lemon (citrus limon) has many benefits, it can be processed into kinds of drinks and foods because it provides a fress effect. However, lemon also contains a low pH means it can increase erosion in polymer resin composite and surface roughness occurs. The research aimed to know the differences in the surface roughness of nanohybrid and nanofilled resin composite that were polished on the immersion of lemon juice. Methods of research were used experimental laboratory with a post test only control group design using 24 samples nanohybrid and nanofilled resin composites which are grouped into 4 groups. Each group contained 6 sample of resin composites. Surface roughness is measured using a surface roughness tester. The result of the analysis by LSD (Least Significant Difference) test showed that there were differences in the surface roughness of nanohybrid and nanofilled resin composites on the immersion of lemon juice with value $p < 0,05$. The conclusion of this research is that there is an effect of lemon immersion on the surface roughness of nanohybrid and nanofilled resin composites where more roughness occurs in nanohybrid composite.

Keywords: resin composite, nanohybrid composite, nanofilled composite, polishing, lemon (citrus limon), surface roughness.

INTRODUCTION

Composite resin was introduced as a tooth-colored restoration material about 40 years ago. Composite resins that are often used today are nanohybrid and nanofilled composite resins. Nanohybrid composite resins have heterogeneous

particles that are a combination of microparticles measuring 0.1-2 µm and particles with nano sizes ≤ 100 nm [1,2]. This composite resin has a fairly good level of strength and smoothness so that it can be indicated for anterior and posterior dental restorations[1,3]. Nanofilled composite resins developed with nanotechnology are usually used to form products with component dimensions of about 0.1 to 100 nm. The filler component in nanofilled composite resins contains individual nanoparticles and nanoclusters. The combination of nanoparticles with nanoclusters will reduce the amount of interstitial space between particles, thereby improving physical properties and better polishing results compared to composite resins[4,5]

Polishing of composite resin restorations is an important procedure to be carried out properly in order to obtain a successful restoration because it can obtain a smooth restoration surface that minimizes plaque accumulation that can cause secondary caries, gingival irritation, and discoloration that can affect the aesthetics of the restoration. In addition, a rough restoration surface on the occlusal surface can cause excessive attrition on the enamel surface of the antagonist teeth, therefore, polishing is necessary to reduce the surface roughness of the composite resin[4,6,7].

Lemon fruit (citrus limon) is a fruit that is widely grown and developed in Indonesia. Lemon fruit has many benefits so it is often processed into various drinks and foods because it gives a fresh effect. However, lemon fruit also contains a low pH so that it can increase erosion on polymers and surface roughness occurs. Roughness on the surface increases the surface area and absorption area, so that the absorption of water increases[8,9].

METHODS

The research design used was laboratory experimental with a post test only control group design approach. There are 4 treatment groups, namely: (1) nanofilled composite resin soaked in lemon juice (citrus limon), (2) nanohybrid composite resin soaked in lemon juice (citrus limon), (3) nanofilled composite resin soaked in distilled water and (4) nanohybrid composite resin soaked in distilled water. The number of samples used for each treatment group was 6 samples so that for 4 groups 24 samples were required.

This research was conducted with the following working procedure. Sample making procedure (1). Preparing tools and materials to be used, (2). Acrylic molds are smeared with vaseline to prevent sticking and placed on a glass lab covered with celluloid strips, then composite resin is applied to the plastic ring using plastic filling, after which compaction is carried out using a cement stopper. (3) The composite resin was irradiated for 20 seconds using light curing. (4) The composite resin was removed from the mold. (5) Next, the samples were polished using 3M Soflex disc, then soaked each group of samples, namely group I and group II in lemon juice, group III and IV in distilled water for 1 hour and then measured the roughness of the composite resin using a surface roughness tester (Mitutoyo SJ 201).

RESULTS

The results of data analysis on the average surface roughness of nanohybrid and nanofilled composite resins in each group of 3M discs, then soaked each sample group, namely group I and group II into lemon juice, groups III and IV into distilled water for 1 hour and then measured the roughness of the composite resin using a surface roughness tester (Mitutoyo SJ 201).

Table 1. Descriptive Research

Group	Mean	Value Minimum	Value Maximum
Lemon Immersion Nanofilled	$1,66 \pm 0,38$	0,95	1,95
Lemon Immersion Nanohybrid	$3,00 \pm 0,30$	3,53	3,33
Aquades Immersion Nanofilled	$1,16 \pm 0,46$	0,43	1,69
Aquades Immersion Nanohybrid	$2,48 \pm 0,64$	1,45	2,48

The results of the Shapiro Wilk normality test in each group were normally distributed because the $p>0.05$ value was obtained for all treatments.

Table 2. Normality Test

Group	Stat.	df	*P*	Description
Lemon Immersion Nanofilled	0,817	6	0,084	Normal
Lemon Immersion Nanohybrid	0,930	6	0,583	Normal
Aquades Immersion Nanofilled	0,956	6	0,787	Normal
Aquades Immersion Nanohybrid	0,924	6	0,538	Normal

The results of the study of lemon juice (*citrus limon*) immersion on the surface roughness of polished nanohybrid and nanofilled composite resins were carried out by One Way Anova testing at the LSD post hoc significance level of 5% shown in the following table.

Table 3. Statistical test results using One Way Anova

Group	Average Amount of Roughness	F	*P*
Lemon Immersion Nanofilled	$1,66 \pm 0,38$		
Lemon Immersion Nanohybrid	$3,00 \pm 0,30$	28,798	0,000
Aquades Immersion Nanofilled	$1,16 \pm 0,46$		
Aquades Immersion Nanohybrid	$2,48 \pm 0,64$		

There is an effect of lemon juice (*citrus limon*) immersion on the surface roughness of polished nanohybrid and nanofilled composite resins. LSD test results of surface roughness of polished nanohybrid and nanofilled composite resins on lemon (*citrus limon*) juice immersion

Table 4. Test for differences between treatments with LSD test

Group	1	2	3	4
Lemon Immersion Nanofilled	-	-1,34767*	0,49033*	-0,48150*
Lemon Immersion Nanohybrid	1,34767*	-	1,83800*	0,86617*
Aquades Immersion Nanofilled	-0,49033	-1,83800*	-	-0,97183*
Aquades	0,48150*	-0,86617*	0,97183*	-

The LSD (Least Significant Difference) test aims to determine the extent of the difference in roughness that exists in each group compared to the sig value obtained. From the results of the analysis with LSD, it shows that there is a difference in the surface roughness of nanofilled and nanohybrid composite resins in lemon juice immersion with a p value <0.05.

DISCUSSION

In this study, the composite resins used were Filtek Z250 XT with A2 color for nanohybrid composites and Filtek Z350 XT with A2 color for nanofilled composites produced by 3M ESPE. The selection of these materials as research materials is based on the consideration of products that are well known to the public. In the study there were 4 treatment groups with the number of samples used for each treatment group was 6 samples so that 24 samples were needed

The results of the LSD (Least Significant Deference) test show that there are differences in the surface roughness of nanofilled and nanohybrid composite resins in lemon juice (citrus limon) immersion. The filler particles of nanohybrid composites ($\leq$ 5 μm) are larger than those of nanofilled composites ($\leq$ 100 nm). This is consistent with the theory that the surface roughness of composite resins can be influenced by the size and volume of the filler. Composites with larger filler particles have a rougher surface than those with smaller fillers[10,11] . This statement can also be seen in the control group of nanohybrid composites which have a slightly larger surface roughness than the nanofilled composites.

Composite resins have several physical, mechanical and chemical properties. Its physical properties consist of polymerization shrinkage, water absorption and solubility. Its mechanical properties consist of flexural strength, elastic modulus, surface roughness and hardness[4,12]. The chemical properties consist of material polymerization, composite resin thickness, irradiation distance and irradiation duration[5,14]. The factors that cause roughness of composite resins are the food and beverages consumed. If acid-containing foods and beverages are consumed continuously for a long time, it can cause matrix degradation in the composite resin[13,14].

Research conducted by Ningsih et al (2012) states that the surface roughness of unpolished composite resins shows a higher roughness value than polished ones. The high surface roughness value of the unpolished composite resin is thought to occur due to the protrusion of the composite resin filler material still on the surface. The protrusion of this filler material causes the surface of the composite resin to be uneven and causes roughness. Therefore, in this study, polishing was carried out on each nanohybrid and nanofilled composite resin sample using 3M sof lex disc[15,16].

Water absorption is also one of the factors causing surface roughness of composite resins. The results of statistical tests using the One Way Anova test show that there is an effect of lemon juice (*citrus limon*) immersion on the surface roughness of polished nanohybrid and nanofilled composite resins. The results of this study are in accordance with research conducted by Tandrayuana et al (2017) which states that citric acid contained in lemon (*citrus aurantifolia swingle*) causes roughness on the surface of composite resins[16].

Lemons contain about 5% citric acid which gives lemons their sour taste and has a pH range of 2-38.9. Citric acid is a weak acid but has a high acid titration rate, so it contains a lot of hydrogen ions (H^+) in it. These hydrogen ions will bind to oxygen in the siloxane bond (Si-O-Si-) so that the siloxane bond is broken and returns to silanol (-Si-OH). The breakage of the soloxane bond causes the filler particles and resin matrix to be released1,16. This detachment of matrix and filler particles causes many small gaps in the composite so that the surface roughness increases[13,15]

The second mechanism that can occur is that hydrogen ions hydrolyze the ester bonds in the composite resin matrix. H^+ ions will bind to methacrylate groups at the ends of the matrix causing the breakage of intermolecular bonds in the matrix polymer. This results in the release of monomers in the form of methacrylic acid groups into the soaking medium and changes in the microstructure of the composite surface. The two mechanisms above are what cause the surface roughness of the composite resin in lemon (citrus limon) juice immersion [8,16].

CONCLUSION

The conclution of this study that there is a significant difference in the roughness of nanohybrid and nanofilled composite resins polished in lemon juice (citrus limon) immersion.

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