The Effect of Robusta Coffee Immersion on the Surface Roughness of Hybrid Composite Resin

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Abstract. *Hybrid composite resin is a restorative material that has a filler size ranging from 0.4 to 1.0 μm which is resistant to fracture, has a colour similar to the tooth structure, and resistant to abrasion. Hybrid composite resin has the property of absorbing liquid like robusta coffee. Robusta coffee contains acids that can cause surface roughness in hybrid composite resins. The purpose of this study was to determine the effect of Robusta coffee immersion on the surface roughness of the hybrid composite resin. The research sample amounted to 27 which were printed in the form of a cylinder measuring 10 mm and a thickness of 4 mm. Each sample was immersed in distilled water for 24 h and then tested for surface roughness. Group A was immersed in robusta coffee solution for 3 days. Group B was immersed in robusta coffee solution for 5 days. Group C was immersed in robusta coffee solution for 7 days. Then, the surface roughness of the sample was measured using the Surfcorder SE 1700 brand surface roughness tool and the results were paired t-test and One Way Anova. The results of the paired t-test showed p-value = 0.000 which means that there is a significant difference between the pre-test and post-test scores. The results of the One Way Anova test showed p-value = 0.039, which means that there was a significant difference between the sample groups. There is an effect of robusta coffee immersion on the surface roughness of the composite resin.*

Keywords: Hybrid composite resins · Surface roughness · Robusta coffee

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1 Introduction

Composite resins are the most common restorative materials in dentistry because they can bind enamel and dentin well, have similarities with tooth structure in terms of color and mechanical properties, are easy to apply, and are relatively inexpensive [1]. Composite resin contains the main ingredients is the matrix, inorganic filler, and coupling agent (silane) which functions to bind the matrix and filler [2].

There are several classifications of composite resin types are macrophile composite resin, microfil composite resin, hybrid composite resin and nanofil composite resin [3]. Hybrid composite resins have an average particle size of about 0.4 to 1.0 μm. The characteristics of the hybrid composite resin are having good aesthetics, lower curing shrinkage, and low water absorption [4].

In modern society, diet includes foods and drinks of various colors. The surface coloring of the composite resin is related to the absorption or absorption of the dye. In addition to color changes, several substances can affect various surface properties of composite resins, namely surface roughness [5]. In addition, the effect of the drink on the restorative material also depends on how often a person consumes the drink [6].

Robusta coffee is a type of coffee that is widely produced, reaching 87.1% of the total coffee production in Indonesia [7]. The content of chlorogenic acid in Robusta coffee beans is 9.0 g/100 g. The level of acidity in coffee can cause damage to the resin surface. The H + ions in the acid from the coffee solution will cause degradation of the polymer bonds, so that some monomers will be released from the resin and will release filler particle ions, such as calcium, aluminum, strontium, barium, phosphorus, and silicon. The release of the filler will cause pores to form between the polymer matrix, thereby encouraging the diffusion of liquid from the outside into the composite resin which can cause roughness [8]. Based on research conducted by Nurmalasari (2015), stated that the surface roughness of nanofil composite resin soaked in coffee solution showed a higher number than soaking using tea.

Surface roughness in hybrid composite resins can lead to bacterial accumulation and plaque buildup, which increases the risk of developing periodontal disease, inflammation of the gingiva, caries, surface discoloration, and user discomfort [9].

This study aims to determine the effect of soaking Robusta coffee solution on the surface roughness of the hybrid composite resin.

2 Materials and Methods

This research uses Experimental Laboratories research with the research design used is Pre-Post Test design. This research was conducted at the Pharmacy Laboratory of UMY and the Mechanical Engineering Laboratory of the UGM Vocational School. The sample of this study used FILTEK Z250 hybrid composite resin with a cylinder shape measuring 10 mm x 4 mm with a total sample of 9 samples per group with a total of 27 samples.

All samples were printed using a mold and irradiated using a Light Curing Unit at a distance of 1 mm for 40 s. Soak the sample in distilled water at 37 °C and then store it for 24 h in an incubator.

Table 1. Paired t-test

No.	Speciment	Surface Roughness Value	p
	Pre-test	1,6357	0,000
	Post-test	2,1540	

Table 2. One Way ANOVA hypothesis test results of denture cleaning

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.287	2	0.644	3.717	0.039
Within Groups	4.155	24	0.173		
Total	5.442	26			

Making soaking media using 30 g of robusta coffee powder brewed in 300 ml of water at 100 °C. The coffee solution is filtered to remove the pulp and put into a clear plastic bowl and put into an incubator after being allowed to stand until a temperature of 55 °C.

All samples were divided into 3 groups. Group A was given the treatment soaked in a solution of robusta coffee for 3 days. Group B was given the treatment soaked in a solution of robusta coffee for 5 days. Group C was given the treatment soaked in a solution of robusta coffee for 7 days. Robusta coffee solution is changed every day. Measurement of the surface roughness of the hybrid composite resin before and after immersion in robusta coffee using a surface roughness measurement with the Surfcorder SE 1700 brand.

Data analysis was performed by statistical analysis of paired t-test and One Way ANOVA followed by Post Hoc Bonferroni.

3 Result

Table 1 shows the results of the paired t-test with a significance value of 0.000 (sig: $p < 0.05$), which means that there is a significant difference between the pre-test and post-test values in Robusta coffee solution immersion on the surface roughness of the hybrid composite resin. To find out the difference in the average of the groups that have been immersed, the One Way Anova hypothesis test is carried out.

Table 2 shows the results of the One Way Anova hypothesis test, a significance value of 0.039 (sig $p < 0.05$), which means that there are significant differences between the immersion groups. Furthermore, a follow-up test, namely Post Hoc Bonferroni, was carried out to find out which groups had significant differences.

Table 3 shows the results of the Post Hoc Bonferroni test, all the significance values between the treatment groups showed $p > 0.05$ which means that the surface roughness values between the immersion groups were not significantly different.

Table 3. Post Hoc Multiple Comparison Dependent variable: difference Bonferroni

Group (J) Group	Mean Difference (I – J)	Std. Error	Sig.	95% Confidence Interval	
				Lower Bond	Upper Bond
Group A Group B	−0.08411	0.19614	1.000	−0.5889	0.4207
Group C	−0.49944	0.19614	0.053	−1.0042	0.0053
Group B Group A	0.08411	0.19614	1.000	−0.4207	.5889
Group C	−0.41533	0.19614	0.134	−0.9201	0.0895
Group C Group A	0.49944	0.19614	0.053	−0.0053	1.0042
Group B	0.41533	0.19614	0.134	−0.0895	0.9201

4 Discussion

This research was conducted to see how the results of the hybrid composite resin roughness test after soaking in robusta coffee solution for 3, 5, and 7 days. The immersion period in this study was determined with the assumption that if you consume coffee every 15 min, soaking 3 days is equivalent to 1 year, 5 days is equivalent to 1.5 years, and 7 days is equivalent to 2 years of using composite resin restoration materials in the oral cavity [10].

Based on the paired t-test analysis test, it was stated that there were differences in the surface roughness of the hybrid composite resin before and after soaking in robusta coffee solution. In accordance with research conducted by Diansari et al. [11] that based on the results of the paired t test, there was a significant difference ($p < 0.05$) in the surface roughness test results of composite resin before and after soaking in coffee.

The results of the One Way Anova hypothesis test showed that there were significant differences between the three groups of immersing the hybrid composite resin for 3, 5, and 7 days. In accordance with research from (Gouvea et al. 2011) that based on the One Way Anova test, there was a significant difference between the groups that were soaked in coffee and soft drinks for 15 days with a significance ($p < 0.05$). Meanwhile, for the Post Hoc Bonferroni test in Table 3, the results $p > 0.05$, which indicates that there is no significant difference between the immersion groups.

Hybrid composite resin soaked in robusta coffee solution can cause surface roughness. Chlorogenic acid contained in coffee is a polyphenolic compound with a chemical molecular structure with many H + ions. The H + ions can make the double chemical bonds of the polymer resin composite matrix unstable. The instability of the compound is caused by cross-linking with H + ions and the breaking of double bonds in the polymer matrix. When the double bonds in the polymer matrix are broken, it can erode the matrix material and leave filler protrusions so that roughness occurs on the surface of the composite resin [11].

Factors that can affect the composite resin include resin monomer, filler, and coupling agent. Filler content is related to polymerization depth, color stability, hardness, compressive strength and stiffness. Matrix damage caused by water absorption and hydrolytic degradation is known to change the mechanical properties of composites

[12]. Under acidic conditions, the water absorption properties of the composite resin can cause the filler particles to be released and the matrix to be damaged. Bisphenol A diglycidyl methacrylate (BisGMA) and triethyleneglycodimethacrylate (TEGDMA) underwent hydrolysis. BisGMA and TEGDMA are more hydrophilic than UDMA (urethane dimethacrylate) because they have a hydroxyl group in their chemical structure so they can absorb more water from food or drinks. The more water absorbed by the composite resin, the greater the possibility of a decrease in the quality of the composite resin [13].

In this study, there are still many shortcomings, including in this study no phytochemical test was carried out to determine the content of the robusta coffee used. Another tool that can be used in further research is Atomic Force Microscopy (AFM) because it can show a more accurate three-dimensional profile.

5 Conclusion

There is an effect of soaking Robusta coffee on the surface roughness of the hybrid composite resin. Soaking in robusta coffee solution for 7 days caused the surface roughness of the hybrid composite resin to be higher than that of soaking for 3 and 5 days.

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