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The Difference of Composite Resin Compressive Strength with Sidikalang Coffee Soaking

Mangatas H.P. Hutagalung[1*], Benarivo T Ginting[1], Sucy Erawati[1], Sri Yasa Hasibuan[1], Cindy Amalia P[1]

[1]Dentistry Education Faculty of Dentistry, Universitas Prima Indonesia, Medan, Indonesia

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***Corresponding author:**
Mangatas H.P.Hutagalung

E-mail address:

mangatashutagalung@yahoo.com

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ABSTRACT

Composite resin is a caries filling material. Generally, dentists choose this type of resin as a restoration material because this material has a high compressive strength. There are several factors that influence the compressive strength of composite resins, including beverages consumed such as coffee. This study aims to determine the difference in the compressive strength of the composite resin with Sidikalang coffee immersion in 9 hours, 27 hours and 54 hours immersion time. This type of research is experimental laboratories with posttest only control group design. The research sample was composite resin measuring 8 mm in diameter and 4 mm in height. The sample size is determined by the Federer formula and a total sample of 24 was obtained for the four treatment groups. Measurement of compressive strength using a three-point bending tool on a universal testing machine. Data were analyzed by using the oneway Anova test. Based on the results of the study, the average compressive strength of composite resin in the group without immersion, 9 hours, 27 hours and 54 hours of immersion was 20.69 ± 0.84, 18.94 ± 0.41, 14.36 ± 0.66 and 6.70 ± 0.48. From the results of the study it can be concluded that the ads are a significant difference in the average compressive strength of composite resin after immersion in Sidikalang coffee for 9 hours, 27 hours and 54 hours.

1. Introduction

Dental caries is the most common chronic disease worldwide. The etiology involves the interaction between tooth structure and microbes[1,2] Handling of carious teeth by restoring the tooth by providing fillings.[3,4] Materials used for caries fillings include amalgams, composite resins, glass ionomer cements and compomers all of which perform well on one or two restoration surfaces.[5]

In the late 1950s and early 1960s Bowen began introducing composite resins as dental restoration materials that are useful for restoring or replacing tooth structure lost due to trauma or disease, modifying tooth color and contour.[6,7]

Composite resins are a popular restorative material in the field of dentistry.[8] The distinctive advantages of this composite resin are in their physical properties in the form of aesthetic properties and a clinical appearance that is the same color as teeth so that they provide satisfactory and satisfactory results. superior mechanical properties such as high compressive strength, strong resistance, and lower coefficient of thermal expansion than other restorative materials.[9,10,11,12]

Compressive strength is one of the mechanical properties required in all types of composite resin, because composite resin which has a large compressive strength can allow it to be used as a filling for posterior teeth that require large daily compressive strength or chewing load, as well as fittings for anterior teeth that require fracture-resistant strength in terms of restoration at the incisal angle of the tooth.[7]

In general, composite resin has properties that are able to absorb water so that it can affect the mechanical

properties of the material. This water absorption in composite resins can occur because it is influenced by the monomers TEGMA (tri-ethylene glycol dimethacrylate), UDMA (urethane dimethacrylate), and Bis-EMA (bisphenol-A-ethoxylated dimethacrylate) used.[10,6]

In addition to compressive strength, another important condition that determines the clinical success of a restoring material is that it is able to withstand various exposures to fluids in the oral cavity.[13] The fluid contained in the mouth can come from saliva or food and drinks that are consumed daily.[14]

The degradation process of the composite resin matrix can change the microstructure of the composite by forming pores in the composite resin, so that a number of residual monomers come out of the pore.

The results of the initial survey conducted by the researchers to 20 dentists in the city of Medan showed that nanofiller composite resin was the most widely used composite resin, followed by hybrid composite resin and microfiller.

North Sumatra Province is one of the coffee-producing areas in Indonesia, one of which is Sidikalang coffee.[15] Sidikalang coffee includes Robusta coffee.[16] Drinking coffee has various benefits on the body such as antioxidants and can stimulate performance brain and cancer.[17,18] Besides having benefits, coffee also has disadvantages, namely that it contains high caffeine and organic acids.[17]

The caffeine content in coffee varies depending on the type of coffee. Meanwhile, the acid content contributes to the flavor given to the coffee. A good coffee has a caffeine content that is not too high and the degree of acid is too low.[19,18] The acidity of coffee comes from the chlorogenic acid content of 3.3-3.8 g / 100 g coffee grounds. The chlorogenic acid content contained in robusta coffee is higher than arabica coffee which is only 1.9-2.5 g / 100 g powder.[20]

Previous research on the effect of immersion of nano hybrid composite resin in isotonic drinks on compressive strength showed that there was a decrease in the compressive strength of nano-hybrid composite resin after immersion in isotonic drinks for 9 hours, 27 hours and 54 hours.[21] Based on this description , the researcher became interested in conducting a research entitled "The Difference of Composite Resin Compressive Strength with Sidikalang Coffee Immersion".

2. Methods

This research is a laboratory experimental research with pre test and post test only control group design. This research was conducted at the Dental Laboratory Test Unit of USU's FKG

This research was conducted in the Dental Laboratory Test Unit of USU's FKG. This study consisted of 4 groups: group 1 (without immersion), group 2 (9 hours immersion), group 3 (27 hours immersion), and group 4 (54 hours immersion). The number of replications carried out was 6 times for each treatment group. Thus, the total sample was 24 composite resins.

Research tools include sample prints with a diameter of 8 mm and a height of 4 mm, rubber bowls, spatulas, sand paper (abrasive paper) numbers 300 and 600, universal testing machines, autographs, hydraulic presses, large cuvettes, digital balances, vibrators, oven, and waterbath.

Sampling: A master cast with a diameter of 8 mm and a height of 4 mm was smeared with silicon oil, then placed on a glass slide and cellophane strip. The nanofiller composite resin was inserted into the mold with a plastic instrument. The top is covered with a cellophane strip. Emphasis is carried out on the two glass objects to obtain an even thickness of the sample. Irradiate the object glass for 20 seconds on the top and bottom surfaces of the sample using a light curing unit. Radiation is carried out in a direction perpendicular to the sample surface. 1mm apart. The hardened composite resin is removed from the mold, then stored in an incubator with a temperature of 27 °C for 24 hours.[21]

Preparation of Coffee Solution: The coffee solution used in this study was obtained by mixing 6 grams of pure Sidikalang coffee powder with 150 ml hot water.

Immersion: Soaking the samples in coffee solution was carried out for 9 hours (group 2), 27 hours (group 3) and 54 hours (group 4).[21] Eighteen composite resins were immersed in 6gr coffee solution. Meanwhile, group 1 was not immersed.

Compressive Strength Testing: The measurement of compressive strength uses a three-point bending tool on a universal testing machine by placing the sample in a vertical position and pressing it by attaching a pressure to the surface of the sample. The pressure starts at zero pressure and continues to increase with a 200 kgf load until the nanofiller composite reson sample breaks. Load data for each group is obtained in kilograms (N), then converted into units of MPa. Size 1 MPa = 1 N / mm^2. The data is entered into the formula to get the value of the sample strength.

3. Results

The results showed that the average strength of the composite resin in the group without immersion, 9 hours, 27 hours and 54 hours were 20.69 ± 0.84, 18.94 ± 0.41, 14.36 ± 0.66 and 6.70 ± 0.48. This result shows a decrease in the compressive strength of the composite resin after soaking in Sidikalang coffee for 9 hours, 27 hours and 54 hours.

The results showed that there was a difference in the average compressive strength of the composite resin after immersion in Sidikalang coffee for 9 hours, 27 hours and 54 hours with a value of p = 0.001 (p <0.05).

Table 1 Average compressive strength of composite resin after soaking Sidikalang coffee without immersion, 9 hours, 27 hours and 54 hours

Sample	Treatment group			
	No immersion	**Immersion 9 hours**	**Immersion 27 hours**	**Immersion 54 hours**
1	19.79	18.46	13.71	6.30
2	20.01	18.56	13.76	6.43
3	20.42	18.80	13.91	6.44
4	20.81	19.00	14.64	6.62
5	20.93	19.33	14.80	6.79
6	22.15	19.46	15.31	7.61
$\bar{x} \pm SD$	20.69 ± 0.84	18.94 ± 0.41	14.36 ± 0.66	6.70 ± 0.48

Table 2 Differences in the compressive strength of composite resin after soaking Sidikalang coffee without immersion, 9 hours, 27 hours and 54 hours

Treatment group	$\bar{x} \pm SD$	**P value**
No immersion	20.69 ± 0.84	0.001
Immersion 9 hours	18.94 ± 0.41	
Immersion 27 hours	14.36 ± 0.66	
Immersion 54 hours	6.70 ± 0.48	

4. Discussion

The composition of the restoration material, the hardening process of the material, and the oral environment can affect the compressive strength of the restoration material. Restorative materials in the oral cavity are continuously exposed to chemicals contained in acidic saliva, food, and drinks which can cause degradation.[22,23] In this study, Researchers used

Sidikalang coffee immersion to test the compressive strength of the composite resin after immersion for 9 hours, 27 hours and 54 hours. Based on the results of the study, it was found that the average strength of the composite resin after immersing in Sidikalang coffee for 9 hours, 27 hours and 54 hours was 18.94 ± 0.41 MPA, 14.36 ± 0.66 MPA and 6.70 ± 0.48. MPA, it appears that there is a decrease in the compressive strength of the composite resin after soaking in Sidikalang coffee for 9 hours, 27 hours and 54 hours. The longer the sample is immersed in Sidikalang coffee, the lower the compressive strength of the Composite Resin.

This decrease may be due to the compressive strength of the composite resin being affected by the degradation process. The resin matrix has hydrophilic properties or is able to absorb water. The adsorbed water molecules will induce degradation in the composite resin through two mechanisms. First, the absorbed water molecules will diffuse into the polymer chain and fill the empty space between the polymer chains, then the polymer bonds will soften and expand causing the release of monomers. Second, water molecules also cause degradation of the siloxane bonds (the bond between the silanol groups on the silica surface and the silane coupling agent) through the hydrolysis reaction. This causes the bond between the filler and the resin matrix to be unstable.[23]

The difference in the compressive strength of the composite resin after soaking Sidikalang coffee for 9 hours, 27 hours and 54 hours was also seen from the results of the oneway Anova test which showed a significant difference $p = 0.001$ ($p < 0.05$). The results of this study are in line with several previous studies which proved that immersion in acidic solutions can reduce compressive strength. One of them is research conducted which states that immersion in a robusta coffee solution can reduce the compressive strength of the nanofiller composite resin.[24]

These researchers used nanofiller composite resins as samples. According to Sakaguchi and Powers (2012), the large number of monomers, filler particles and ions released may cause the compressive strength value of the nanofiller composite resin in the treatment group to decrease over time. Degradation of the filler components caused by acid particles which will result in a decrease in the physical properties and strength of the nanofiller composite resin[25], from the results of this study it has been shown that immersion in coffee affects the compressive strength of the composite resin.

The decrease in the compressive strength of the composite resin after immersion in acid laruyan was also seen from the results of the research which stated that there was a difference in the compressive strength of the nanofiller composite resin after soaking in alcoholic mouthwash and non-alcoholic mouthwash, with the lowest value owned by group II, namely immersion in alcoholic mouthwash. [8]

Compressive strength is one of the factors that affect the hardness and abrasion of a material which will increase if the material is in dry conditions.[26] Other researchers have defined compressive strength as a mechanical property of restoration materials which is very important in the chewing process, especially in the posterior region where this can be determined by a compressive strength test.[24] The amount of compressive strength in this compressive strength test can be determined by applying a compressive charge to a cylindrical or square cross-sectional area. Compressive strength is considered an important indicator of the success of a material because high compressive strength is required to withstand the chewing force.[8,10]

Acid compounds in coffee can affect the roughness, hardness, and strength of the resin.[27] The acidity of the robusta coffee solution can increase the solubility of the composite resin and the absorption of water into the resin matrix. The solubility causes erosion on the surface of the composite resin and the breaking of the polymer bonds in the resin matrix and siloxane bonds as well as the release of filler particle ions such as calcium, aluminum, strontium, barium, phosphorus, and silicon. This can reduce the compressive strength of the composite resin.[23]

The acidic Sidikalang coffee solution contains more H^+ ions than OH^- ions. The absorption of water into the resin matrix causes H^+ ions from the robusta coffee

solution to be absorbed into the matrix and react with the ester groups of the dimethacrylate monomer, then form carboxylic acids and alcohol molecules. The dimethacrylate monomer that binds to the H^+ ion is broken from the polymer chain, causing expansion in the material, and inducing the hydrolysis of the resin matrix component. This reaction causes the polymer chain to split into oligomers and monomers, resulting in a softening and enlargement process of the matrix, and porous formation in the material. Degradation of the composite resin component causes the resin monomer to be released, thereby reducing the mechanical properties of the composite resin.[23]

5. Conclusion

The conclusions of this study were as follows: The average compressive strength of composite resin without Sidikalang coffee immersion was 20.69 ± 0.84. The average compressive strength of the composite resin after soaking Sidikalang coffee for 9 hours was 18.94 ± 0.41. Then, the average compressive strength of composite resin after soaking Sidikalang coffee for 27 hours was 14.36 ± 0.66. The average compressive strength of composite resin after soaking Sidikalang coffee for 54 hours was 6.70 ± 0.48. And there was a significant difference in the compressive strength of composite resin after immersion in Sidikalang coffee for 9 hours, 27 hours and 54 hours p = 0.001 (p <0.05).

6. References

1. Veiga N, Aires D, Douglas F, dkk. 2016. Dental caries: a review. *Journal of Dental and Oral Health*, 2(5), 1-3.
2. Pitts NB, Zero DT, Marsh PD, dkk. 2017. Dental caries. *Nature Reviews*, 3(17030), 1-16.
3. Yengopal V, Harnekar SY, Patel N, dkk. 2016. Dental fillings for the treatment of caries in the primary dentition (review). *Cochrane Library Syst Rev* 10:CD004483.
4. Duangthip D, Jiang M, Chu CH, Lo ECM. 2016. Restorative approaches to treat dentin caries in preschool children: systematic review. *European Journal of Paediatric Dentistry,* 17(2), 113-21.
5. Qvist V, Laurberg L, Poulsen A, et al. 2010. Class II restorations in primary teeth: 7 years study on three resin-modified glass ionomer cements and a compomer. *Eur J Oral Sci*, 112(2), 188–96.
6. Bayne SC. 2013. Beginnings of the dental composite revolution. *JADA*, 144(8), 880-884.
7. Anusavice K-J. 2013. *Phillips' Science of Dental Materials*, 12th ed, Missouri: Elsevier Saunders; pp:275-306.
8. Kumala YR, Prasasti A, Saputra CS. 2020. Perbedaan kekuatan tekan resin komposit nanofiller pada perendaman obat kumur beralkohol dan non alkohol. *E-Prodenta Journal of Dentistry*, 4(1), 293-301.
9. Chan KHS, Mai Y, Kim H, dkk. 2010. Review: resin composite filling. *Materials,* 3, 1228-43.
10. Sakaguchi RL, Powers JM. 2012. *Craig's Restorative Dental Materials*. 13th ed. Philadelphia: Elsevier;pp: 91,143,162.
11. Nahsan FPS, Mondelli RFL, Franco EB, dkk. 2012. Clinical strategies for esthetic excellence in anterior tooth restorations: understanding color and composite resin selection. *J Appl Oral Sci,* 20(2), 151-6.
12. Zhou X, Huang X, Li M, dkk. 2019. Development and status of resin composite as dental restorative materials. *Journal of Applied Polymer Scince*, 48180:1-12.
13. McKenzie MA, Linden RWA, Nicholson JW. 2003. The physical of conventional and resin modified glass ionomer dental cements stored in saliva, water. *Biomaterials*, 24, 4063-69.
14. Bozorgi C, Holleufer C, Wendin K. 2020. Saliva secretion and swallowing—the impact of different types of food and drink on subsequent intake. *Nutrients*, 12, 256; doi:10.3390/nu12010256.
15. Aziz, MM, Siregar AZ, Hasanuddin. 2018. The utilization of chlorogenic acid attractant in traps to controlling pbko (hypothenemus hampei ferr.) on coffee plantation in Dairi. *Jurnal Agroteknologi*, 9(1), 7 – 22
16. Sitanggang, JTN. 2013. Development of the potential for coffee as a leading commodity in the

agropolitan area of Dairi Regency. Journal of Economics and Finance, 1 (6), 147-48.
17. Farida A, Ristanti E, Kumoro AC. 2013. Decreasing levels of caffeine and total acid in robusta coffee using facultative anaerobic fermentation technology with microbe nopkor mz-15. Journal of Chemical Technology, 2 (3), 70-5.
18. Hastuti DS. 2018. Caffeine content in coffee and its influence on the body. November Ten Institute of Technology.
19. Sunarharum WB, William DJ, and Smyth HE. 2014. Complexity of coffee flavor: a compositional and sensory perspective. *Food Research International*, 62, 315–25.
20. Farah A. 2012. Coffee Constituen. In : Chu YF (ed). *Coffee: Emerging Health Benefits and Disease Prevention*. USA: John Wiley & Sons; pp. 21-58.
21. Dianita S. 2016. The effect of immersion resin composite nano hybrid on isotonic drink against compressive strenght. *Jurnal Wiyata*, 2(2), 176-80.
22. Fan H, Gan X, Zhu Z, dkk. 2014. The nanomechanical and tribological properties of restorative dental composites after exposure in different types of media. *J of Nanomaterials*. http://dx.doi.org/10.1155/2014/759038
23. Rahim TNA, Mohamad D, Md Akil H. 2012. Water sorption characteristics of restorative dental composites immersed in acidic drink. *Dent Mater*, 28, 63-70itss
24. Andari ES, Wulandari E, Merry DC, Robin. 2014. The effect of robusta coffee solution to nanofilled composite resin compressive strength. Stomatognatic (J. K. G Unej), 11(1), 6-11
25. Basri MHC, Erlita IM, Ichrom MYN. 2017. Surface roughness of nanofiller composite resin after immersion in river water and tap water. Dentino, 2 (1), 101-106.
26. Susiani. 2015. The effect of immersion resin composite nano hybrid on isotonic drink against compressive strength. *Jurnal Wiyata*, 2(2), 176-80.
27. Agustono B, Laksono H, Astari NN. 2020. Transverse strength of Robusta-soaked (Coffea canephora L.) acrylic resin denture. *Eurasia J Biosci*, 14, 3765-68.