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Differences Of Saliva pH Towards The Compressive Strength Of Bulkfill Composite Resin

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ABSTRACT

Bulkfill composite resin has special qualities such as can be polymerized to 4 mm depth. One of the mechanical characteristics of bulkfill composite resins is high compressive strength. The compressive strength of restoration material is an indicator of successful restoration in the long-term. One factor that can affect the compressive strength in composite resins is the condition of the oral cavity. The oral cavity condition can be affected by the liquid in the oral cavity such as salivary pH. The compressive strength in composite resins is affected by the degradation process that is caused by changes in salivary pH. The purpose of this study was to find differences in artificial salivary pH toward the compressive strength in bulkfill composite resins. This study was divided into three groups, each group has 9 samples of bulk-filled composite resin in a disk shaped with 4 mm for diameter and 6 mm for the thickness based on ADA specification No.27/1993. All groups were soaked in artificial saliva at pH 4, 7, and 10 for 24 hours, and then the compressive strength was measured using UTM with a load of 250 kgf and speed of 0.5 mm/minute. The results of the tests were analyzed using Anova. Based on it, there is no difference between compressive strength in bulkfill composite resin on the immersion pH of artificial saliva 4, 7, and 10 with p-value of 0.546 ($p>0.05$). Moreover, there is no difference between the three-action maybe because of filler in bulkfill composite resin has more filler and UDMA rather than conventional composite resin. Therefore,.

1. INTRODUCTION

The most widely used restorative material today is composite resin. Composite resins are widely used because of their good esthetics, ease of clinical manipulation, durability, and low heat conductivity. However, composite resins are less resistant to wear and tear, so they are less durable when used for posterior teeth. Along with the development of composite resins from both matrix components and techniques for making posterior dental restorations that are more efficient, in 2010 a bulkfill type composite resin was introduced to restore posterior teeth. Bulkfill composite resins have better physical and mechanical properties than conventional composite resins. One of the mechanical properties of bulkfill composite resin is compressive strength.1-5

Compressive strength is the ability of a material to withstand the forces of mastication. The compressive strength of a restorative material is considered the most important property as an indicator of the success of a restoration in the long term because most of the forces that occur during the masticatory process are compressive forces. Several factors that can affect the compressive strength of composite resins include the composition of the restorative material, the polymerization process, and

the condition of the oral cavity. Conditions of the oral cavity can come from fluids in the oral cavity such as salivary pH and food or drinks consumed daily.

The compressive strength of the composite resin is affected by a degradation process, one of which is caused by changes in salivary pH. The resin matrix has the property of being able to absorb water, then a hydrolysis event occurs which can damage the bond between the silane and the filler, and damage the filler and matrix bond, even hydrolysis can also cause degradation between the fillers so that water can enter the bond between the two and can reduce the strength of the mechanical properties. of composite resin.8-9

Saliva with an acidic pH can increase the solubility of the composite resin and water absorption into the resin matrix. The solubility can cause release on the surface of the composite resin and break the polymer bonds in the resin matrix and release ions of filler particles. At normal and alkaline salivary pH, degradation can still occur

According to personal research, changes in salivary pH can affect the mechanical properties of hybrid composite resins. Acidic pH can increase the surface roughness of the hybrid composite resin, while at alkaline pH it has no effect on the surface roughness of the hybrid composite resin. Sun G's research stated that bulkfill composite resin immersed in mouthwash containing 9% alcohol experienced a decrease in compressive strength compared to immersion in mouthwash that did not contain alcohol. press bulkfill composite resin.

2. METHOD

This research is a type of pure experimental research conducted in a laboratory. The object of this research is a flowable bulkfill composite resin (Dentsply) which was prepared according to the specifications of the American Dental Association (ADA) No. 27/1993 in the form of a plate with a thickness of 6 mm and a diameter of 4 mm which was irradiated using a DemiPlus LED with a light intensity of 1,100 mW/cm2 for 20 minutes. seconds and then soaked in artificial saliva for 24 hours then measured the compressive strength using UTM (Universal Testing Machine). The criteria in this study were bulkfill composite resin that had not expired, a disk-shaped bulkfill composite resin sample measured in diameter 4 mm with a thickness of 6 mm, a bulkfill composite resin sample that had no cracks or fractures before the compressive strength test was carried out, nonporous bulkfill composite resin samples. The research was conducted at the PSKG Unjani Skills Laboratory, the Unjani FK Biochemistry Laboratory, and the Unpad FKG Integrated Research Laboratory.

The sample is 27 which has been calculated using the Federer formula

then divided into 3 groups, namely 1) soaked in artificial saliva pH 4 for 24 hours, 2) control group immersed in artificial saliva pH 7 for 24 hours, 3) soaked in artificial saliva pH 10 for 24 hours. The procedure of this research was started by preparing tools and materials, then making artificial saliva with Mc. Dougall with the composition of artificial saliva in table 1 Table 1 Composition of artificial saliva (Mc. Dougall)

Ingredient	g/L
$NaHCO_3Na_2HP$	0.98
$O_4.12H_2O$	0.93
NaCl	0.047
KCl	0.057
$CaCl_2$or $CaCl_2.2H_2O$	0.004
MgCl or MgCl. $2H_2O$	0.006

After making artificial saliva, then making a bulkfill composite resin sample in the form of a plate using a shellac mold and placing the Celluloid strip just above the surface of the bulkfill composite resin sample then the sample is irradiated using an LED for 20 seconds with the tip of the LED tip placed perpendicular to the sample surface, then each sample was immersed in artificial saliva according to the group for 24 hours, after 24 hours all bulkfill composite resin samples were measured using UTM with a load of 250 kgf and a speed of 0.5 mm/minute, by placing the sample in UTM and then applying

compression pressure until cracks appear, then numerical results will be obtained in MPa units. Data analysis carried out was the normality test of the compressive strength value of bulkfill composite resin with Shapiro-wilk and then continued with the Anova test.

3. RESULTS AND DISCUSSION

Compressive Strength of Bulkfill Composite Resin

The compressive strength value of bulkfill composite resin immersed in artificial saliva with variations in pH is written in table 1

Sample	Artificial Saliva pH Variations (MPa)		
	pH 4	pH 7	pH 10
1	134.82	164.17	177.83
2	159.95	152.11	145.49
3	167.09	145.05	162.13
4	122.97	150.23	175,90
5	178.01	164.02	145.72
6	158.18	166.14	155.85
7	164.28	164.79	166.94
8	151.81	161.29	164.88
9	173.75	190.93	186.50
Average□SD	156.76□17.90	162.08□13.20	164.58□14,10

Table 1 shows that the compressive strength value of bulkfill composite resin at pH 4 artificial saliva immersion has the lowest compressive strength value, which is 156.76□17.90 MPa among the other two treatment groups, namely pH 7 and pH 10. This statement is reinforced by the results of the study. conducted by Pribadi N et al, that the low pH used to soak the composite resin can increase the release of the polymer and cause a decrease in the compressive strength of the composite resin.

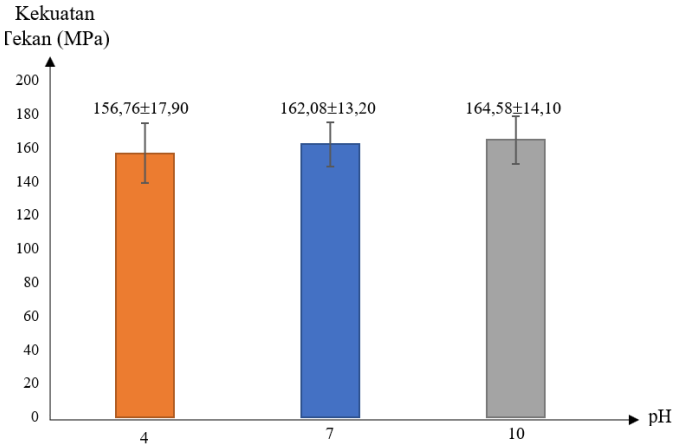

Figure 1. Diagram of Compressive Strength of Bulkfill Composite Resin with Variation of Artificial Saliva pH

In table 1 and figure 1, samples with artificial saliva immersion pH 4 have the lowest compressive strength values. This happens because artificial saliva with a pH of 4 has a high H+ ion content, causing the polymer bonds to break in the resin matrix and the release of filler particle ions, thereby reducing the compressive strength of the bulkfill composite resin. The decrease in the compressive strength of bulkfill composite resins can be influenced by several factors, including the composition of the restorative material, the polymerization process, and the condition of the oral cavity.

The decrease in the compressive strength of bulkfill composite resin immersed in artificial saliva pH 4 can occur because, acidic pH can affect the surface compressive strength of the exposed bulkfill

composite resin due to H+ ions from pH 4 artificial saliva solution being absorbed into the composite resin matrix causing H+ ions to react with methacrylate group of composite resin matrix. The methacrylate group that binds to H+ ions causes the chemical bond of the composite resin matrix polymer to become unstable and the chemical bond to the composite resin matrix polymer is broken, which is called the composite resin matrix degradation process.12,13,14

The degradation process causes the polymer chains to split into residual monomers, resulting in a matrix enlargement process and the formation of pores in the material. Water absorption into the composite resin matrix occurs because the composite resin matrix is hydrophilic so that the composite resin matrix is able to absorb water, which causes hydrolysis events that can damage the bond between the filler and the matrix, then lead to degradation between the fillers so that water can enter between the matrix and filler. which can reduce the compressive strength of the composite resin. The degradation of the composite resin occurs in the TEGDMA or Bis-GMA components which causes the polymer chain to break into monomers, thereby reducing the compressive strength of the composite resin. The degradation process can occur because the bond between the matrix and filler is not too strong so that water can enter the bond between the matrix and filler and can reduce the compressive strength of the composite resin.9,12,13,15

Research Afrianti N et al, stated that a solution with a low pH contains abundant H+ ions so that it can cause a decrease in the mechanical properties of the composite resin surface through a matrix degradation process. Based on the research of Susianni D, stated that the compressive strength of the composite resin immersed in a solution containing a pH below normal and containing excess H+ ions causes the chemical bond of the polymer matrix to become unstable due to cross-linking with H+ ions so that the chemical bond of the polymer discontinuous matrix.13,16,17

Table 1 and Figure 1 show that the compressive strength of the bulkfill composite resin immersed in artificial saliva at pH 7 and pH 10 increased. The increase in compressive strength in artificial saliva immersion pH 7 and pH 10 is related to research according to Pribadi N et al., who suggested that solutions with alkaline pH produced more OH- than normal pH saliva so as to increase the compressive strength of bulkfill composite resins.9

Handayani DP et al, in their research stated that a solution with a pH of 7 contains a small amount of H+ and has OH- which binds to the dimethacrylate monomer. OH- will undergo release and bind to the Si-O-Si siloxane bond which results in the breaking of the Si-O-Si siloxane bond to Si-OH-, but degradation occurs very slowly so that requires a long time to produce a decrease in the mechanical properties of the composite resin.18

Differences in Compressive Strength of Bulkfill Composite Resin with Variation of Artificial Saliva pH

Statistical data analysis was carried out to determine whether there was a difference in the compressive strength of bulkfill composite resin samples immersed in artificial saliva variations, namely pH 4, pH 7, and pH 10. The data was tested first with the normality test using Shapiro-Wilk because the number of samples was less than 50.

The results of the normality test using Shapiro-Wilk in the artificial saliva treatment group with pH 4, pH 7, and pH 10 obtained a p-value of 0.717, namely the data was normally distributed (p>0.05). The Anova parametric test was carried out to see the difference in the compressive strength of the bulkfill composite resin from the three treatment groups with the test results listed in table 2.

Table 2 Differences in Compressive Strength of Bulkfill Composite Resin

Treatment Group	mean	SD	*P-Value*
pH 4	156.76	17.90	
pH 7	162.08	13.20	0.546
pH 10	164.58	14.10	

Based on the test results in table 2, statistically from the three treatment groups, the pH variation of artificial saliva obtained a p-value of 0.546 which means there is no difference (p>0.05). For the

ANOVA test results are not significant, a double comparison test is not carried out. There was no difference in compressive strength between the three treatment groups, probably due to the filler in bulkfill composite resin which contained a higher amount of filler than conventional composite resin, filler in bulkfill composite resin consisted of barium and strontium alumino-fluoro-silicate glass as much as 68 % by weight and 44% by volume. The filler in the composite resin serves to maximize the strength of the composite resin. In addition to fillers, the matrix in the bulkfill composite resin contains UDMA which causes the amount of monomer released in the UDMA matrix to be lowmuch as compared to conventional composite resins containing Bis-GMA.12,15,19

4. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that there is no difference in the compressive strength of bulkfill composite resins with variations in pH of artificial saliva 4, 7, and 10. Bulkfill composite resins are stable and good for use as dental restorative materials under conditions of varying oral pH. change. Based on the results of the research that has been done, it can be suggested that dentists can use bulkfill composite resin well as a dental restoration material because there is no difference in compressive strength in conditions of the oral cavity with different pH and further research is needed with different storage temperatures.

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