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EFFECT OF DIAMETRAL TENSILE STRENGTH OF BULK FILL COMPOSITE RESIN WITH THE ADDITION OF SUGARCANE WASTE FIBER

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ABSTRACT

Backgrounds: *Bulk fill composite resin is a composite resin type which can be polymerized as deep as 4 mm and is indicated for posterior tooth restoration. Most posterior tooth restorations become fractured because of the composite resins that are not able to withstand the tensile stress that happens. Efforts to increase diametral tensile strength is by adding fiber. The use of natural fibers can be an alternative because it is environmentally friendly and inexpensive. One of the natural fibers is fiber bagasse (Saccharum Officinarum L.).* ***Purpose:*** *To know the influence of composite resin diametral tensile strength value in bulk fill with the addition of bagasse fiber.* ***Methods:*** *Experimental laboratory studies with post-test designs only with control group designs. The experiment of consist 36 samples which divided into 3 groups. Group I non-fiber bulk fill resin composite, group II filling composite with bagasse fibers and group III filling composite resins with glass fibers as a control group. The sample are immersed in saline solution and incubated for 24 hours at 37° C. Then sample tested its diametrically tensile strength using a Universal Testing Machine. Data analysis used One Way Anova test with significance value of 0,001 (p<0,05), followed by Post Hoc Bonferroni.* ***Results:*** *Post Hoc Bonfferoni test obtained p value= 0.001 (p<0.05), which means there are significant differences between the three groups where the group with the addition of glass fiber obtained the highest diametral tensile strength value.* ***Conclusion:*** *the addition of bagasse fiber affects the diametral tensile strength and can increase the diametral tensile strength of the bulk fill composite resin.*

Key words: *Bulk Fill composite resin, Diametral Tensile Strenght, Bagasse Fiber (Saccharum Officinarum L.)*

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INTRODUCTION

Composite resin bulk fill type is a composite resin that can be applied in one application or simultaneously to the cavity, so restoration can be done more quickly and easily than incremental technique.[1,2] Composite bulk fill resin has advantages such as low polymerization that can reduce microleakage and can be roughened to a depth of approximately 4 mm.[2] Composite resin bulk fill type is indicated for posterior tooth restorations.

Fracture is one of the causes of failure of composite resin restorations in posterior teeth. Fracture occurs because most composite resins do not have the strength to withstand the tensile pressure of mastication.[3] An attempt to increase the diametric tensile strength is by adding fiber. The fibers that bind to the polymer matrix on the composite resin can effectively channel the load on the restoration. Merging these two materials serves as a stress absorber because it has a low elastic modulus.[4]

Fiber's types are classified into two, natural and artificial fibers.[5] The fibers often used in the field of dentistry are artificial fibers, namely polyethylene fiber and glass fiber.[6] The price is expensive, difficult to obtain and can be toxic to the lack of this material.[7] Use Natural fibers can be an alternative material used in increasing the mechanical strength of the composite resin one of which is the fiber of sugarcane waste *(Saccharum officinarum L.*).

Sugarcane waste or bagasse is a waste from sugarcane cultivation that has been done milling for the sugar-making process.[8] The abundance of sugar cane in Indonesia causes the by-product of sugarcane to become sugar is also very large. The production of sugar cane to sugar is only 65% and the rest of it becomes the waste.[8] In Indonesia, the utilization of waste from sugar production is very limited, such as the basic raw materials of car body, body aircraft, and fuel resulting in pollution.[8,9]

The content in bagasse fibers consists of cellulose (52.42%), hemicellulose (25.8%), and lignin (21.69%), ash (2.73%), and ethanol (1.66%). Cellulose is a compound of wood. Hemicellulose is a matrix that binds cellulose and binds to lignin. The function of lignin is to surround and wrap cellulose and hemicellulose by forming tissue that has properties against enzyme and degradation and is not soluble in water.[10] Bagasse fiber is rigid, rough, low compatibility, high moisture and insoluble in water.[11] By those reasons above, the purpose of this research is to find out whether there is an influence of diametral tensile strength of composite resin bulk fill type with the addition of bagasse fiber (*Saccharum officinarum L.*).

MATERIALS AND METHODS

This experimental laboratory study was designed with post-test only with control group design. The research was conducted at the Integrated Research Laboratory of Dentistry Faculty of Gajah Mada University for the manufacture of samples. The test of diametral tensile strength samples was conducted at the Materials Laboratory of the Faculty of Mechanical Engineering at Gajah Mada University in September-November 2017. The materials used in this study were bulk fill composite resin (Tetric N-Ceram® Bulk Fill & Tetric N-Flow® Bulk Fill, Ivoclar Vivadent), bonding (Syntac Adhesive, Ivoclar Vivadent), bagasse fiber (*Saccharum officinarum L.*), glass fiber (everStick®NET GC), aquades, and saline solution.

This research procedure began with making cylindrical mold samples according to ADA No.27 diameter of 6 mm and height of 3 mm. The next step was the preparation of bagasse fiber. Juice of sugar cane was separated with sugarcane waste fiber using the aid of the machine and then milled as much as 5 times. The bagasse was soaked in plastic containers by using water for 1 day which aims to reduce sugar substance. The bagasse was cleaned by combed using a wire brush to remove the cork attached to the fiber. After sufficiently clean, the fibers of the pulp were dried in the sun for 1 day. The cane bag was combed back and the bagasse fiber was taken with tweezers to get the sugar cane yarns. The fiber to be used was equalized in diameter according to the sample mold, then the ready-to-use bagasse fiber was placed one by one placed on the glass plate, then spilled with the bonding material.

There were 36 samples of composite resin samples, which were divided into 3 groups. Group I non-fiber bulk fill composite resin, group II bulk fill type composite with bagasse fiber and group III bulk fill composite resin with glass fiber as the control group. Tetric N-Ceram® Bulk Fill composite resin was applied to molds as high as 1.5 mm and then shine for 10 seconds. The wetted fibers were applied over the resin with horizontal position and unidirectional fiber orientation, then the Tetric N-Flow® Bulk Fill composite resin was applied to the prepared fibers. The fibers were covered using a Tetric N-Ceram® Bulk Fill composite resin up to 3 mm high. Condensation was carried out using a condenser and irradiated for 10 seconds with the ray distance as close as possible or 1 sheet of celluloid ribbon. The finished composite resin mold was soaked in saline solution and incubated for 24 hours at 37° C. Then the samples were tested on diametric tensile strength using the universal testing machine.

RESULTS

The result of this research is the average value of tensile strength of diameter of the composite resin of bulk fill type in table 1.

Table 1 Average value table and standard deviation of tensile strength of diametric bulk-fill composite resin

Composite Resin of Bulk Fill Type	Mean ± Deviation Standard
Non- Bagasse Bulk Fill Composite Resin	43,832 ± 1,33
Bulk Fill Type Composite With Bagasse	46,614 ± 2,69
Glass Fiber	51,059 ± 2,53

Table 1 shows that the average diameter tensile strength of the bulk fill composite resin with the addition of synthetic fiber has the highest diametral tensile strength value that is 51.059 MPa. The lowest diametral tensile strength is the bulk fill composite resin without the fiber additional, 43.832 MPa. The average diameter tensile strength of the bulk fill composite resin with the addition of bagasse fibers has a higher value compared with no fiber addition of 46.832 MPa.

The result of Shapiro-Wilk normality test showed the value of p = 0,475 (p> 0,05), which means normal distributed data and continued homogeneity test obtained significance value of 0,096 (p> 0,05) meaning homogeneous data. The statistical analysis test using the One Way ANOVA parametric test with 95% confidence degree shows the significance value of 0.001 which means that there is a significant difference of tensile strength of diameter of bulk fill composite resin with the addition of bagasse fiber (*Saccharum Officinarum L.*). Further data were tested by using the Post Hoc Bonferroni test to determine the pairs of groups that had significant differences. The result of Post Hoc Bonferroni test can be seen in table 2.

Table 2 Value significance of tensile strength of diametral resin composite bulk fill type.

Group	Non-Bagasse Bulk Fill Composite Resin	Non-Bagasse Bulk Fill Composite Resin	Non-Bagasse Bulk Fill Composite Resin
Non-Bagasse Bulk Fill Composite Resin	-	0,015*	0,000*
Bulk Fill Type Composite With Bagasse		-	0,000*
Glass Fiber			-

Based on table 2 it can be concluded that there is a significant difference ($p < 0.05$) between the bulk fill composite group without the addition of fiber with the addition group of bagasse fiber, the group of adding glass fiber with the addition group of bagasse fiber and the group without the addition of fiber with group of glass fiber addition.

DISCUSSION

Addition of bagasse fibers was assessed to increase the diametral tensile strength of the bulk fill composite resin. Several factors can increase the diameter tensile strength of bulk fill composite type resins such as fiber type, fiber layer, adhesion bonds between composite with fiber, fiber position, and orientation.[12]

The bagasse fiber can be used as an alternative material to increase the tensile strength of the diameter of the bulk fill composite type resin. The content in bagasse fibers consists of cellulose, hemicellulose, lignin, ash, and ethanol. Cellulose is an unbranched glucose (glucose) polymer that allows cellulose to accumulate into a very strong form of fiber. It is known to be the main factor there is an increase in tensile strength value of the diameter of composite bulk fill composite after added fiber bagasse. Other compounds are hemicellulose which is located on the cell wall together with cellulose and serves as a matrix of cellulose. Lignin is hydrophobic, thus affecting the properties of other tissues. Lignin acts as a coupling agent and increases the stiffness of cellulose-hemicellulose.[13]

The fiber layer used is known to be the cause of the increased tensile strength of the diameter of the bulk fill composite type resin. After exceeding the optimum value, the addition of fiber, mechanical strength tends to decrease, this is because the composite resin is not able to come into contact with the fiber.14 The thicker the fibers used the adhesive material is not able to wet the fiber perfectly, thus affecting the diametral tensile strength. In this study, the amount of fiber used is one layer. The addition of fibers with 1 layer fiber volume is optimal for use as posterior restorations.15 The average diametric tensile strength results in the addition of bagasse fiber of 46.614 MPa while the mean strength of diametral tensile strength of the composite resin is 30-45 MPa.[16]

Other factors that may affect the diametral tensile strength of bulk fill composite type fill with fiber addition is position and fiber orientation. The fibers placed in the 2/3 base of the specimen can withstand tugs resulting in the separation of the bonds between molecules that inhibit the occurrence of fracture. Unidirectional orientation is the arrangement of fibers in one direction so that the fibers are parallel to each other.[17] Unidirectional placement has better mechanical strength than random laying. In this study using the unidirectional fiber orientation. According to Al-Jeebory et al value of the highest tensile stress obtained in the straight array because the force is given in the form of a direct pull force with the fiber arrangement. Based on the concept of action-reaction force (Newton's Law III) fiber will provide a reaction force of greater tensile stress than a random array of fibers.[18]

The bagasse fiber bulk fill composite resin is also added with glass fiber as the comparison group. Composite type bulk fill resin added with glass fiber has the highest diametral tensile strength value. This is because the glass fiber is able to bind well with the matrix through the adhesive material, has heat resistance and has a uniform diameter. Glass fiber used in this research is E-glass fiber. E-glass fibers contain Al2O3, CaO, Na2O, K2O, and Na¬ + Glass fiber type E has a silica oxide content that makes the fiber able to bind well with the matrix. CaO content is a stabilizer that can increase strength and chemical resistance. Al2O3 content has a function to modify tissue structure and improve glass fiber ability. Na2O and K2O contents provide corrosion resistance and the addition of Na + ions provides good resistance to the restorative material.[19]

Based on the results of this study it can be concluded that the addition of bagasse fiber affects the diametral tensile strength and can increase the tensile strength of diameter of bulk fill composite resin, but still lower than glass fiber. The researchers suggest that further research should be conducted on the procedures and methods of application of bagasse fiber that can increase the maximum diametral tensile strength.

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