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STUDY OF COMPOSITE HARDNESS WITH GANODERMA BONINENSE MUSHROOM AS FILLER

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Abstract

This study describes the hardness testing of two composite materials with the same fillers, namely ganoderma boninense mushroom particles (with variations in volume and particle size). This mushroom can cause rot at the base of oil palm tree so that it can damage the oil palm tree. Matrix used as adhesive are polyester resin and epoxy resin. Mushrooms soaked with alkali (NaOH) for 1 hour to remove dirt and sap which will reduce the bond between the matrix and particles, after that heat it in oven at temperature of 60 degrees Celsius for 12 hours to remove the water content. Then the mushrooms are made into particles using a blender at rotation of 28000 rpm and sieved with mesh of 20, 30, 40, and 50. A mixture of mushroom particles and matrix stirred and poured into a glass mold. After 24 hours the mold can be opened and the specimen has been formed. The test results showed composites with variations of mushroom volume and epoxy resin matrix is harder than polyester resin matrix with a percentage between 23.25% to 64.51%. Whereas with variations in particle size, composites with epoxy resin matrix are also still harder with a percentage between 9.2% and 22.85%. Even so the difference in hardness is not too significant because the unit of hardness is microvickers. The test results were also found that addition more than 5% of ganoderma mushrooms will decrease composite hardness. While the variation of mesh filler composites is almost not shows differences in the value of hardness.

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1. Introduction

As so far, industrial world still uses synthetic fibers as reinforcement of composite materials. Synthetic fibers are used for manufacture of various products such as aircraft, ship hulls, wind turbine blades, cars, and others. Of various types of fiber, fiber glass is the most widely used synthetic fiber.

But this synthesis fiber has several disadvantages such as expensive, cannot decompose naturally, limited in the number, and dangerous for health such as increase the risk of lung cancer. The size of glass fibers varies and the smaller and unseen can inhale and enter into the body, while larger particles can cause irritation to skin, eyes, nose and throat.

Many researchers have sought to find substitute for synthetic fibers from natural sources which have several advantages such as easy to obtain, can biodegrade naturally, not harmful to health, available in large quantities and cheap.

Green-based polymer products such as agricultural crops are the basis for forming products that are economical, efficient, sustainable, and compete with synthetic materials (Mawardi, Suryanto, & Sudewi, 2019).

Natural fibers can be grouped based on the source that is derived from plants, animals or minerals. Plant fiber consists of cellulose, while animal fibers (hair, silk, and wool) consist of proteins. Plant fibers include tree bark fibers (or fine sclerenkima or stem), leaves or hard fibers, seeds, fruit, wood, wheat, and other grass fibers. Many of these natural fibers have been developed as reinforcement in composite materials. Natural fiber composite materials have increased use because the price is relatively cheap, able to be recycled and can compete well based on the strength per weight of the material.

Fiber derived from plants, generally grouped into 2, namely non-wood fiber and wood fiber. Non-wood fibers are divided into (Mawardi et al., 2019):

1. Straw, for example: corn, wheat, and rice.
2. Bark, for example: kenaf (*Hibiscus cannabicus*), flax (*Linum usitatissimum*), jute (*Corchorus*), flax (*Boehmerianivea*), and hemp (*Cannabis sativa*)
3. Leaves, for example: sisal (*Agave sisalana*), pineapple leaves (*Ananas comosus*), and henequen fiber (*Agave fourcroydes*)
4. Fiber grass / grass, for example: bamboo fiber, grass, rattan, switch grass (*Panicum virgatum*), and elephant grass (*Eriarthuselephantinus*).

In this study, the natural fiber used was derived from ganoderma boninense mushroom. This type was chosen because this mushroom can cause Base Stem Rot disease which is a serious disease that attacks oil palm plantations. Please refer to Figure 01 for Ganoderma Boninense mushroom.



Figure 01. Ganoderma Boninense mushroom

More research has been done on natural fiber composites, such describes hereunder. Astuti (2013) examined the effect of kapok banana fiber thickness on the mechanical properties of natural fiberpolyester composite materials. She found that maximum composite compressive strength is 12.92 N/mm² on fiber addition with a fiber thickness of 0.70 mm while the composite tensile strength reaches a maximum point of 2.53 N/mm² in fibers addition with a thickness of 0.82 mm.

Al Mosawi (2012) has been examined the incorporation of pelem tree synthetic fiber and kevlar synthetic fiber with a percentage of fiber weight of 0, 20, 40, and 60% and tested for impact, hardness, tensile, and flexural strength.

Diharjo and Nuri (2006) examined the effect of alkali treatment on composite tensile properties reinforced by continuous hemp fiber with a polistermatrix. The results showed that composite tensile strength and strain had optimum values for 2-hour fiber treatment, namely 190.27 Mpa and 0.44%. Fiber-reinforced composites subjected to 6-hour treatment have the lowest strength. Cross section of composite fiber reinforced treatment subjected to 0.2 and 4 hour treatment was classified as slitingin multiple area fracture type. In contrast, cross section of 6-hours fiber-reinforced composite fracture was classified as single fracture type.

Agus and Sri Mulyo (2018) examined the banana tree midrib fiber. As a result of fiber boiling, changes occur in the microstructure, and the longer it is boiled, the higher the fiber diameter. In the treatment of polyester resin, the longer the boiling, value of fiber density to resin is lower, so that the fiber is not compatible with polyester resin.

2. Problem Statement

The problems statement is researchers want to study comparison of hardness of natural fiber composites using ganoderma boninense mushroom as a filler with a matrix of polyester resin and epoxy resin.

3. Research Questions

The research questions is as follow:

1. Which hardness value is higher between the composite of ganoderma boninense mushroom and epoxy resin or polyester resin matrix and how much the percentage?
2. What is the effect of adding composite fillers to hardness.

4. Purpose of the Study

The purpose of this study is to compare hardness of ganoderma boninense mushroom composite with polyester resin and epoxy resin matrix, and study the effect of adding composite fillers to hardness.

5. Research Methods

The method for making specimens can be seen as below:

1. Ganoderma mushrooms are cut and washed with water, then soaked in NaOH 5% (alkali) solution for 1 hour to remove sap and dirt which can reduce the bond between matrix and filler

2. After soaking in alkali then the mushrooms are put in the oven for 12 hours to remove the water content.
3. After the mushrooms are dried, then blend and sieve with mesh 20,30,40,50, and the volume is measured as desired to be used to make specimens. Volume comparison can be seen as follows:
 - a. Filler 5% and matrix 95%.
 - b. Filler 10% and matrix 90%.
 - c. Filler 15% and matrix 85%.
 - d. Filler 20% and matrix 80%.

The matrix used is polyester resin and epoxy resin

4. Filler and polyester resin BQTN 157 EX which has been mixed with hardener are stirred evenly then poured into the mold. Please refer to Figure 02 for specimen of hardness test.

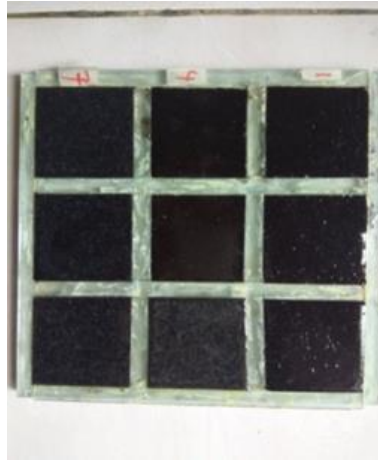


Figure 02. Specimen of hardness test

5. Allow the specimen to harden for 24 hours, after which the mold is opened and the specimen has been formed.
6. After that, the hardness was tested with a Micro Vickers FM 800 device. Please refer to Figure 03 for Microvikers FM 800 for hardness test.



Figure 03. Microvikers FM 800 for hardness test

6. Findings

6.1. Variation of Filler Volume

Table 01 shows the Polyester Resin Matrix.

Table 01. Polyester Resin Matrix

Filler Volume (%)	Specimen (n)	Hardness (MV)	Hardness average(MV)
5	1	0.9	0.93
	2	0.9	
	3	1	
10	1	0.8	0.8
	2	0.8	
	3	0.8	
15	1	0.5	0.6
	2	0.7	
	3	0.6	
20	1	0.4	0.43
	2	0.5	
	3	0.4	

Hardness test showed that with polyester resin matrix, the highest hardness is 0.93 MV for composites with a filler volume of 5%. Addition of composite filler volume to 10% and 15% reduce hardness to 0.8 MV and 0.6 MV respectively. The lowest hardness value was found in volume 20% which is 0.43 MV. This shows that the more addition of filler in the composite causes a decrease in hardness. Table 02 shows Epoxy Resin Matrix.

Table 02. Epoxy Resin Matrix

Filler Volume (%)	Specimen (n)	Hardness (MV)	Hardness average(MV)
5	1	1.4	1.53
	2	1.6	
	3	1.6	
10	1	1	1.2
	2	1.2	
	3	1.4	
15	1	0.5	0.6
	2	0.7	
	3	0.6	
20	1	0.5	0.53
	2	0.5	
	3	0.6	

The result of hardness test with epoxy resin matrix shows that the highest hardness is 1.53 MV for composites with particle volume of 5%. Addition of composite filler volume to 10% and 15% reduce hardness to 1.2 MV and 0.6 MV, respectively. The lowest hardness value was found in the volume of 20% which is 0.53 MV. This shows that the more addition of ganoderma mushrooms in composites causes a

decrease in hardness. The test results also showed composites with epoxy resin matrix is harder than polyester resin with a percentage of 23.25% to 64.51%.

6.2. Variation of Particle Mesh

Table 03 shows Polyester Resin Matrix.

Table 03. Polyester Resin Matrix

Filler Mesh	Specimen (n)	Hardness (MV)	Hardness average (MV)
20	1	0.8	0.7
	2	0.6	
	3	0.7	
30	1	0.8	0.76
	2	0.7	
	3	0.8	
40	1	0.8	0.76
	2	0.8	
	3	0.7	
50	1	0.7	0.76
	2	0.8	
	3	0.8	

The test show that variation of composites mesh filler almost not indicate differences in the value of hardness. The hardness value is between 0.7 MV and 0.76 M. Table 04 shows Matriks Epoxy Resin.

Table 04. Matriks Epoxy Resin

Filler Mesh	Specimen (n)	Hardness (MV)	Hardness average (MV)
20	1	0.9	0.86
	2	0.8	
	3	0.9	
30	1	0.8	0.83
	2	0.8	
	3	0.9	
40	1	0.9	0.83
	2	0.8	
	3	0.8	
50	1	0.9	0.83
	2	0.9	
	3	0.7	

The test results show that variation of composites mesh filler does not show a significant difference for the hardness value. The hardness value is between 0.83 MV and 0.86 MV. While for mesh variation, composite with epoxy resin was still harder than polyester resin with a percentage of 9.2% to 22.85%. Figure 04 shows the example of hardness test value.



Figure 04. Example of Hardness Test Value

7. Conclusion

1. Hardness test showed that addition of ganoderma mushrooms above 5% caused a decrease in composite hardness.
2. The test results also showed composite hardness with volume filler variation using epoxy resin matrix is harder than polyester resin with a percentage of 23.25% to 64.51%. While the mesh variation showed that composite with epoxy resin was still harder than polyester resin with a percentage of 9.2% to 22.85%.
3. The test results showed that variation of mesh composite particles does not show a significant difference in the value of hardness.

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