Effect of Mesh Size on Ganoderma Boninense Composite against Tensile Strength, Modulus of Elasticity, and Fractography

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Abstract: This study aims to determine the effect of mesh size of ganoderma boninense mushroom filler on tensile strength and modulus of elasticity. The composite reinforcement particle mesh varies 20, 30, 40, and 50. The mushroom is soaked with NaOH solution for 1 hour to remove dirt and sap that can reduce the bonds between matrix and particles. Subsequently, the mushrooms are made into mesh 50-sized particles using a grinder with a rotation of 28,000 rpm. From the test results, it can be seen that the highest tensile strength of 31.48 MPa is in the composite with 40 mesh. While in 20 mesh and 30 mesh, the tensile strength slightly decreases to 21.16 MPa and 30.22 MPa. From the test results, it can be seen that the lowest modulus of elasticity is in the composite with 20 mesh. Increasing to 30 and 40 mesh makes the modulus of elasticity rise to 193.6 MPa and 252 MPa. This shows that the more presence of ganoderma fungi in the composite causes the composite to become more elastic, thereby it increases the modulus of elasticity, and decreases tensile strength.

1 INTRODUCTION

The growth of palm oil is often constrained due to ineffective management and other problems that can affect palm oil production. One of the obstacles oil palm plantations is stem rot caused by Ganoderma boninense. Ganoderma boninense is known to attack oil palm plants not only at the production stage but also during the nursery stage. Typical symptoms before the formation of the mushroom fruit body marked by decay at the base of the stem causes dry rot in the deep tissue.

Oil palm plantations on peatlands are even more susceptible to ganoderma boninense attacks because the oil palm stumps that are left in the soil are the strongest source of infection in the rejuvenation garden (former oil palm).

The results showed that the oil palm plantations which experienced more often rejuvenation or in the oil palm plantation area previously planted with coffee, rubber or other crops, would cause a high incidence of BPB disease. BPB disease can cause direct loss of yield to palm oil and a decrease in the weight of fresh fruit bunches. Damage caused can reach 80% to 100%, or even it can cause death in attacked plants.

In this study, ganoderma boninense mushroom will be used as a composite filler to determine the tensile strength, modulus of elasticity, and the spread of the filler.

Other studies that use natural fibers as composite materials include: teki grass (Yanhar, 2018), banana peel (Pereira, 2013), wood (Gallagher, 2012), (Atuanya, 2011), (Ndlovu, 2013), (Nourbakhsh, 2008), leaf pandan alas (Taufik, 2014), pineapple leaves (Sreenivasulu, 2014), bamboo fiber (Nwanonenyi, 2014), and rice husk (Fathanah, 2011) showed significant influences on composite generated.

2 RESEARCH METHOD

Tensile test specimens are made with ASTM D 638-02a type I standard. This type is chosen because it has a middle width of 13 mm so that it is not easily broken when removed from the mold. It is different from type IV which only has a middle width of 6 mm that many specimens are broken or cracked when removed from the mold (Yanhar, 2018). The matrix used in this research is BQTN 157 EX Polyester Resin, while the filler is taken from ganoderma boninense mushroom powder, which is a fungus that can damage and even

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kill the oil palm trees. The method for making composite specimens can be seen below:

1. Ganoderma boninense mushroom is washed thoroughly with water, then soaked in 5% NaOH solution for 1 hour to remove sap and dirt that can reduce the bond between matrix and filler.

Figure 1: 5% NaOH immersion.

2. After that the mushroom is dried by putting it in the oven for 12 hours to remove the water content.

Figure 2: Oven.

3. After the mushroom is dried, then it is made into particles with a grinder of 28.000 rpm, and the volume is measured according to the desired for use in making the specimen. While the matrix that acts as an adhesive is BQTN 157 EX polyester resin. This composite is made using mesh variations from the particles such as 20, 30, 40, and 50.

Figure 3: Grinder.

4. Mold made of metal is smeared with wax so that after the specimen gets hard, it will be easily removed from the mold, while the bottom of the mold is coated with waxed wax.

5. Filler and polyester BQTN 157 EX Resin which has been mixed with a hardener with a ratio of 100: 1, stirred evenly and then poured into the mold.

Figure 4: Polyester resin and hardener.

6. After the resin and filler mixture begins to thick, the glass is placed on the top of the mold and pressed with a ballast to remove trapped void (air bubbles) as well as to level the specimen surface.
7. Let the specimen harden for 12 hours, after which the mold is opened and the specimen has formed.

Figure 5: Tensile test specimen.

8. In this study, tensile testing was carried out with the machine servopulser in the laboratory of the USU Mechanical Engineering Department, with a pull force of 5000 kg and a speed of 1 mm/min.

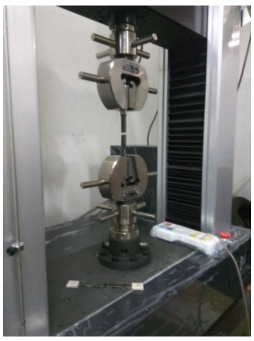

Figure 6: Tensile Test Machine.

3 RESULT AND DISCUSSION

Tensile test results can be seen as follows:

Table 1: Tensile strength.

Mesh Size	Specimen (n)	Tensile Strength (MPa)	Average Tensile Strength (MPa)
20	Specimen 1 Specimen 2 Specimen 3	23.48 18.85 20.17	21.16
30	Specimen 1 Specimen 2 Specimen 3	31.16 29.28 30.46	30.22
40	Specimen 1 Specimen 2 Specimen 3	33.29 29.65 30.74	31.48
50	Specimen 1 Specimen 2 Specimen 3	22.99 18.8 21.34	21.04

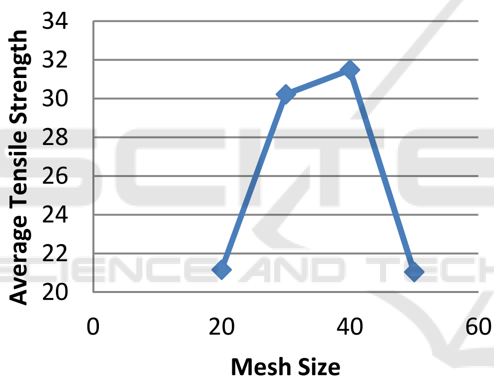

Figure 7: Tensile strength graph.

From the test results, it can be seen that the highest tensile strength of 23.21 MPa is in the composite with a filler volume of 5%. The addition of particle volume to 10% makes the tensile strength slightly decrease to 21.04 MPa. The addition of filler volume to 15% and 20% causes the tensile strength to decrease to 20.55 MPa and 19.68 MPa.

This shows that the increasing presence of ganoderma fungi in the composite causes an improvement in the stiffness properties of the composite that reduces its tensile strength. When observed, the percentage decrease in composite tensile strength from the filler volume is relatively small. From the filler 5% (23.21 MPa) to 10% (21.04 MPa), the decrease in tensile strength was 10.31%. From 10% (21.04 MPa) to 15% (20.55 MPa), it is 2.38%, and from 15% (20.55 MPa) to 20% (19.68 MPa), it is 4.42%. But if we observe the filler volume from 5% - 20%, the tensile strength is down from 23.21 MPa to 19.68 MPa or 17.93%. This number is quite significant and interesting to investigate further, especially in terms of how much is the decrease in tensile strength, if the filler volume continues to increase, for example up to 50%.

Table 2: Elasticity Modulus.

Mesh Size	Specimen (n)	Elasticity Modulus (MPa)	Average Elasticity Modulus (MPa)
20	Specimen 1 Specimen 2 Specimen 3	81.62 150.89 120.43	116.25
30	Specimen 1 Specimen 2 Specimen 3	209.06 178.26 194.90	193.6
40	Specimen 1 Specimen 2 Specimen 3	275.9 228.13 255.67	252
50	Specimen 1 Specimen 2 Specimen 3	72.86 92.07 85.89	82.47

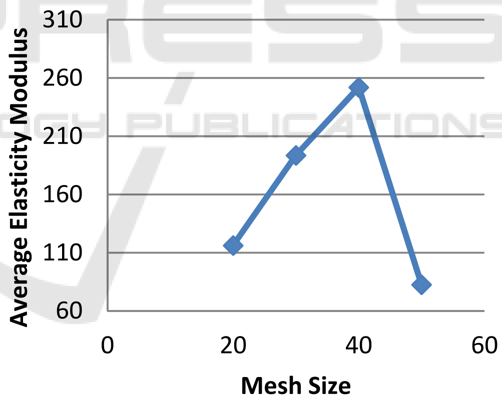

Figure 8: Elasticity modulus graph.

From the test results, it can be seen that the lowest modulus of elasticity is in the composite with 50 mesh. The addition of particle mesh to 20 makes the modulus of elasticity rise to 116.25 MPa. The addition of filler volume to 30 and 40 causes the modulus of elasticity to increase to 193.6 MPa and 252 MPa. This shows that the more presence of ganoderma fungi in the composite causes the composite to become more elastic, thus increasing the modulus of elasticity.

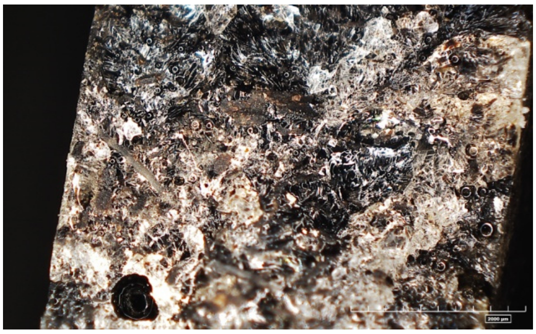

Figure 9: SEM photo of mesh 20.

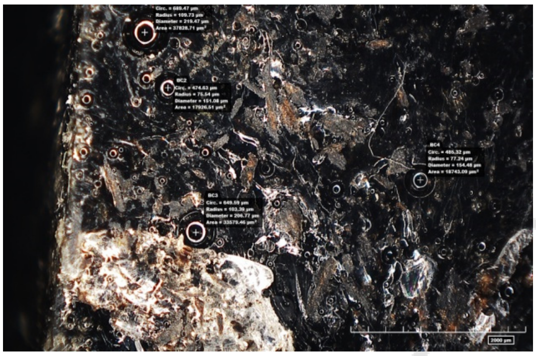

Figure 10: SEM photo of mesh 30.

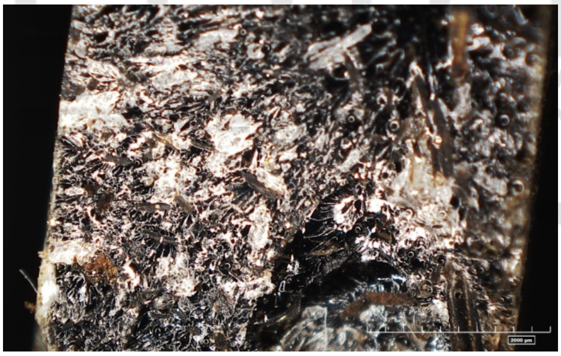

Figure 11: SEM photo of mesh 40.

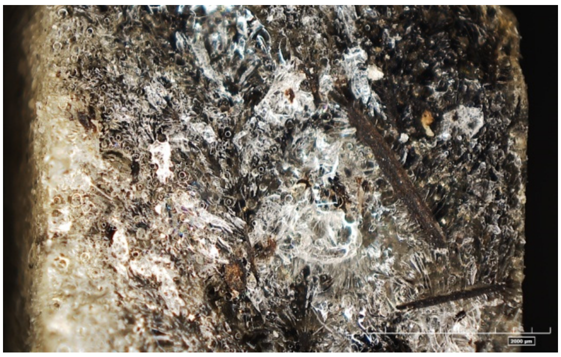

Figure 12: SEM photo of mesh 50.

Fractography test through SEM shows that bond between matrix and filler is quite good because there is no cavity between matrix and filler. However, in some specimens, bubbles are found quite many, even though they are small with a radius less than 100 µm. This bubbles can slightly reduce the composite tensile strength.

4 CONCLUSION

1. The highest tensile strength of 23.21 MPa is in the composite with a filler volume of 5%. The addition of particle volume to 10% makes the tensile strength slightly decrease to 21.04 MPa. The addition of filler volume to 15% and 20% causes the tensile strength to decrease to 20.55 MPa and 19.68 MPa.
2. The lowest modulus of elasticity is in the composite with a filler volume of 5%. The addition of particle volume to 10% makes the modulus of elasticity rise to 83.15 MPa. The addition of filler volume to 15% and 20% causes the modulus of elasticity to increase to 126.77 MPa and 159.10 MPa.
3. The increasing presence of ganoderma fungi in the composite causes the composite to become more elastic, thus increasing the modulus of elasticity and decreasing tensile strength.
4. The results of SEM photos shows the spread of mushroom powder at a volume of 5%, 10%, and 15% less evenly distributed, while in the filler 20%, it shows the spread of powder quite evenly.
5. Fractography test through SEM shows there is no cavity between matrix and filler, but bubbles are found quite many.

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