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Effect of Rias Banana Fiber Percentage as Reinforcement of Polyester Matric Composite to Increase Waste Materials Become a High Value Functional Material

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A B S T R A C T

Along with the reduced use of metal in various materials, many new materials that have characteristics close to the metal have been developed for example in terms of tensile strength or other mechanical strength and have other advantages such as ease of manufacturing and low production costs. Composite is a material that formed from a minimum of two materials and usually has different mechanical properties to get new properties that are better than the ingredients. Each composite produces different properties depending on the matrix filler, type of filler and reinforcing material used. Rias banana fiber and wood sawdust available in large quantities need to be utilized better, for example for composite materials. This research can facilitate development in other fields because it has criteria to reduce metal imports, increase local product content, and increase foreign exchange if the product is exported. This study also supports government programs to increase independence in making independent products. The results of this study indicate that variations in the composition of composites made from rias banana fiber and teak sawdust with an epoxy matrix affect the mechanical properties of the composite. Hardness value increases with an increasing percentage of resin given. While the highest value of max strength is produced by composites with basic ingredients of 40% rias banana fiber, 20% teak sawdust and 40% epoxy. In this study it was concluded that the more resin given, the higher the composite hardness.

Keywords: Composite, Material, Epoxy, Natural Fiber, Rias Banana Fiber

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1. Introduction

Nowadays material needs are increasing and availability is decreasing. Along with the reduced use of metal materials in various products due to component weight, relatively difficult manufacturing processes, corrosive materials, and expensive production costs [1], many new materials have been developed that have characteristics close to the desired metal material for example in terms of tensile strength or other mechanical strength [2] and will have several advantages in other respects such as in terms of manufacturing ease and low production costs.

In this case, one of the superior materials is composite based material. Composite is a new material that is formed from a minimum of two materials and usually has different mechanical properties in order to obtain new properties that are better than the composite constituent material [3]. Composite consists of two main parts, namely the matrix as a composite binder or protector and the filler as a composite filler. Each composite will produce different properties depending on the matrix filler, filler type and reinforcement material used [4].

Natural fiber is an alternative filler for polymer matrix composites because it has several advantages over synthetic fibers. Natural fiber is easily obtained at a relatively cheaper price, easy to process, low density, environmentally friendly, and can be described biologically [5]. One of the abundant wastes of natural fiber is waste produced from the banana tree truncation which is usually only taken by the fruit, then the trunks are left alone. Banana makeup (the heart of a banana stem) is a part of a banana trunk located in the deepest part of a pile of pseudo-layered trees (*gedebog*), where the stem extends from the root to the end of the banana stem.

According to data from the Horticultural Production Center (2014) [6], the amount of banana production ranks highest, this is in line with the waste produced. Banana fruit with a production of 6,862,558 tons or around 34.65 percent of the total fruit production in Indonesia, contributes the largest to the national fruit production. The biggest banana production center is in Java, with production of 3,375,423 tons or around 49.19 percent of the total national banana production.

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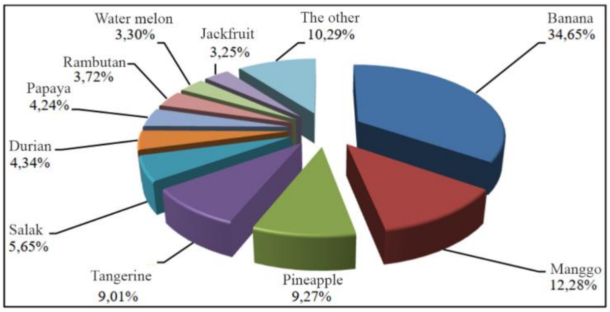

Figure 1. Percentage of Fruit Production in Indonesia in 2014
Resource*: Sentra Produksi Holtikultura (SPH) 2014*

In addition to rias banana fiber waste, the availability of wood sawdust waste is also abundant in nature. Along with the increasing demand for wood for furniture, building materials, plywood, and various other needs, leaving a lot of wood waste. One of them is sawdust waste. The sawdust has not been used to the maximum and is usually only used as firewood or left alone into waste that is useless and pollutes the environment.

Sawdust is a type of natural fiber in the form of particles. The density of natural fibers is around 1.3 - 1.4 gr / cm3. Thus, the density of sawdust is almost the same as the density of fibers [7]. These natural materials have the potential to be engineered into more environmentally friendly technology products. Before it is used as a filler / reinforcement, wood sawdust needs to be charred first, because charcoal cannot be decomposed and is safe from wood-eating animals.

This shows that the rias banana fiber waste and wood sawdust available in large quantities need to be utilized better than just to be used as firewood. In addition, this research can facilitate development in other fields because it has criteria to reduce imports of finished metals, save foreign exchange, increase local product content, and increase foreign exchange if the product is exported. This study also supports government programs to increase independence in making independent products.

The element of science in this study is quite high, because it will be applied to a variety of tests of physical-mechanical properties. In the use of rias banana fibers, several treatments are carried out such as mixing with alkali (NaOH) in the hope that it can affect the resulting composite, because the alkaline function can eliminate existing lignin [8]. Furthermore, the carbonization process is also carried out on wood sawdust so that it cannot be broken down again.

The application of this knowledge is done to answer the needs of new materials that are environmentally friendly, have positive properties that are relevant to previous materials, in accordance with the needs of existing communities, and in accordance with applicable standards. New material produced from this research is expected to produce materials that are suitable to the needs of the community.

This research activity will also be able to strengthen the national innovation system, where one focus in the field of advanced materials is about supporting the transformation of waste materials and waste treatment as well as supporting structural materials. This research answers that focus where raw materials from composites as the core of this research are derived from natural waste which then transforms into new materials that can be applied in the industrial world.

Based on the description above, the research on a comprehensive study of functional materials based on cellulose fiber-based composite waste banana fiber - wood sawdust with epoxy matrix for functional material products is very interesting for further study.

Figure 2. Rias of Banana

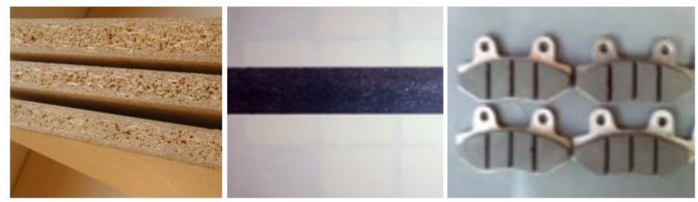

Figure 3. Examples of Composite Applications

2. Related work

Related to this research, previously Diharjo et al [9] had utilized kenaf fiber and sea sengon wood as engineering materials for making composite sandwich panels and acoustic panels. Furthermore Mamur LO, et al (2016) [10] have also conducted research on the mechanical properties of sago stem fiber composite material combined with teak sawdust with a polyester matrix in which from the results of this study it can be seen that the highest bending strength is found in the composite composite 40:30 : 30 that is 278,1268 N / mm2, and the lowest is in the 50:30:10 mixture composition of 118,87844 N / mm. While the highest tensile strength is in the 30:30 mixture composition of 31,059 N / mm2, the lowest is in the 40:10 mixture composition of 18,136 N / mm2. Researchers suggest that further research be carried out between teak sawdust and polyester resin.

Nopriantina and Astuti (2013) [11] concluded that the compressive strength value of pure polyester was 12.12 N / mm2 and the maximum compressive strength value of polyester composites after the addition of banana fiber fibers with an optimum thickness of 0.70 mm had a compressive strength of 12.92 N / mm2. The thicker the fiber is used, the compressive strength value will be better until it reaches the maximum point. The tensile strength value of pure polyester is 2.93 N / mm2 while the tensile strength of polyester composites is maximum value after the addition of banana frond fiber with an optimum thickness of 0.82 mm.

In the manufacture of PVC-CaCO3 composites with banana stem fiber powder as a filler can meet the requirements of SNI 15-0233-1989 Quality and Test Method for Cement Fiber Sheets. The effect of banana stem fiber powder as a PVC-CaCO3 composite filler, has been proven to increase tensile strength, hardness, water absorption, and flash point. Another effect is to reduce some mechanical properties, namely weight per unit area, weight content, flexural strength, water density, ability to be nailed and sawed. PVC-CaCO3 composite with banana stem fiber powder filler has various characteristics such as: unity weight area of 4.55-5.90 kg / m2, content weight 1.50-1.99 g / cm3, tensile strength 67.56–79 , 03 kg / cm2, hardness55,00-66,66 shore D, water absorption 0,96-3,32%, flexural strength 118,99–165,09 kg / cm2, flash point 0,03-0,07 inc / second, good water density (no droplets) and ability to be sawed and nailed well (not deformed / cracked) [12].

From the results of previous studies, the use of composites with banana stem fibers and sawdust have a good opportunity to be developed into composite materials for industrial needs such as car interiors. In this study, the banana stem part is more focused on cellulose fibers taken from banana stem dressing (banana stem hearts) which have a higher fiber content.

3. Methodology

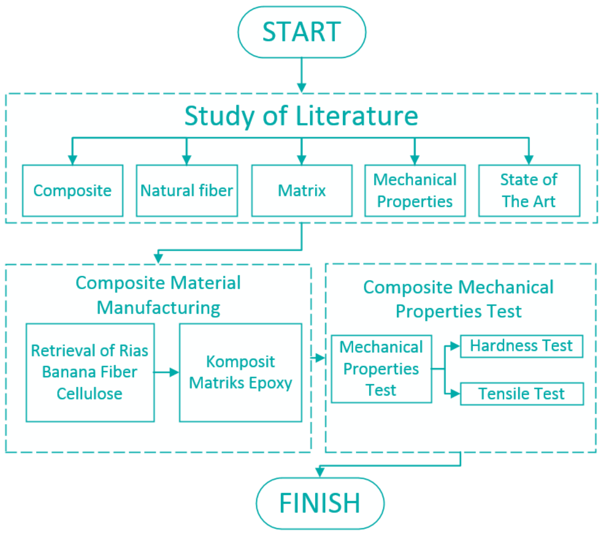

Figure 4. Flow Chart

In this study, it is divided into four steps as the foundation of the research, as follows.

3.1 Study of literature

Literature studies are used to deepen concepts and scientific studies of previous research. This literature study will focus on deepening the problem of composites, rias banana fiber waste, matrices and mechanical properties.

3.1 Study of literature

The next stage is making composite materials. Composite material is made using banana vanity fiber cellulose filler and sawdust which has been fabricated with epoxy matrix. The first step in making this specimen is to collect rias banana fibers and then dried in the sun to dry. Furthermore, the rias banana fibers were treated with alkali mixed with sawdust which has been made, mixed with epoxy matrix with a comparison according to the following table.

Table 1. Material Composition

Composite Composition			Sample Label			
Rias Banana Fiber (%)	Teak Sawdust (%)	Epoxy (%)	1	2	3	Average
50	20	30	A1	A2	A3	A
45	20	35	B1	B2	B3	B
40	20	40	C1	C2	C3	C
35	20	45	D1	D2	D3	D

Note:

1. Material A is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 50:20:30%.
2. Material B is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 45:20: 35%.
3. Material C is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 40:20:40%.
4. Material D is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 35:20:45%.

3.3 Test the Mechanical Properties of Composite Materials

Tests carried out to determine the mechanical properties of the sample. Tests to be carried out are tensile tests and hardness tests. Composite manufacturing is done by the hydraulic press printing method. The shape and geometry of the tensile test object refers to the ASTM D 3039 standard. Formation of the tensile test and hardness test is done manually by cutting composites using a hand grinder. Tensile testing uses the WDW-20 E. tensile testing machine. While the hardness test is carried out using the Rockwell hardness testing machine with the TH550 model.

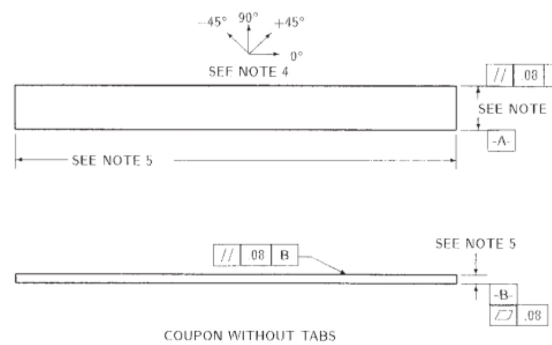

Figure 5. Image of Tensile Test Specimen without Notch

A B

Figure 6. **(a)** WDW-20 E Tensile Test Equipment; **(b)** Rockwell Hardness Test Tool TH550

3.4 Tools and Materials

Tools

The tools used in this study are:

1. Furnace
2. Hardness test equipment
3. Impact test equipment

4. Machine Press

5. Scales

6. Sandpaper

7. Chainsaws

8. Drill Machine

9. Milling Machine

10. Stingy

11. Clamp Pliers

12. Composite dough container

13. Sifter

14. Water spray

Material

1. Rias Banana fiber

2. Epoxy matrix

3. Catalyst

4. Non-sticky wax matrix

5. ST 37 steel plate for mold

3.4 Research Variable

Independent variables: persentase serat dan resin

Dependent variable: hardness value dan max strength

4. Result and Discussion

In this study the sample used was four samples with three types of replication in each sample according to the explanation in Table 1. The purpose of replicating and repeating the test at different points for hardness testing is to obtain results that are close to the truth. In the hardness test, each replication is tested three times and taken on average so that the average final results of each test will be obtained as described in Figure 7 and Figure 8, while for tensile tests only one test is performed on each replication, because the specimen will break immediately at each test.

Each sample has a different surface texture. This is because of the difference in composition composites used. In sample A it has a more abrasive texture because there are fewer resins than other specimens, and vice versa. Sample D has a smoother texture because the portion of resin used is the most compared to other samples.

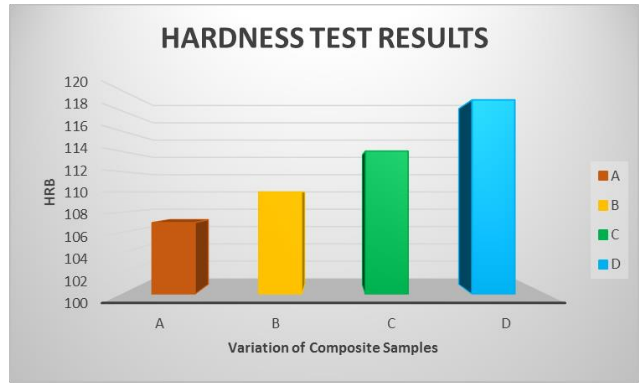

Figure 7. Rockwell hardness test results.

Based on the explanation in Figure 7, the results of Rockwell's hardness test can be described as follows.

1. Sample A has the lowest Rockwell hardness level (107 HRB)
2. Sample B has a Rockwell hardness level (110 HRB)
3. Sample C has a Rockwell hardness level (114 HRB)
4. Sample D has the highest Rockwell hardness level (119 HRB)

Based on Table. 1, sample D has the highest percentage of resins compared to samples A, B, and C. This opens the hypothesis that in this study, the higher the percentage of resin can affect the surface hardness value of the composite. This is because the particles become denser because the gaps between the particles of teak sawdust are filled with resin so that the hardness of the composite increases following the hardness of the resin. The second test carried out was a tensile test. This was done to determine the maximum tensile strength of the composite specimens made from epoxy teak sawdust. The test is carried out using the ASTM D 3039 standard. Tensile test results are described in the following Figure 8.

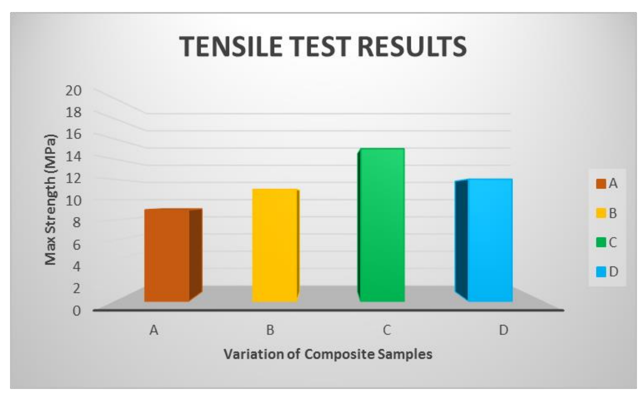

Figure 8. Tensile Test Results

Based on the explanation in Figure 8, the tensile test results show the Max Strength (MPa) value of each sample that has been tested is described as follows.

1. Sample A has the lowest Max Strength value (9 MPa) compared to the Max Strength value of samples B, C, and D.
2. Sample C has the highest Max Strength value (15 MPa) compared to the Max Strength value of samples A, B, and D.

5. Conclusion

Variation in the composition composition of composites made from rias banana fiber and teak sawdust with epoxy matrix affects the mechanical properties of the composite. The hardness value increases with increasing percentage of resin given to the composite. While the highest max strength value is produced by composites with basic ingredients of rias banana fiber 40%, teak sawdust as much as 20% and epoxy as much as 40%. In this study it was concluded that the more resin specimens were given, the higher the hardness of the composites. As for the max strength, there is no known effect of the resin given.

Further research is needed to examine the characteristics of the mechanical properties of these composites to further be applied to functional materials such as brake disks, particle boards, car interiols, and other functional materials.

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