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ANALYSIS OF PHYSICAL AND MECHANICAL PROPERTIES OF PARTICLEBOARDS TRENGTHENED IN COFFEE HUSK - LDPE (LOW DENSITY POLIETHYLENE)

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ABSTRACT--*The research has been carried out to make and analyze the physical and mechanical properties of particle board from coffee husk waste and Low Density Polyethylene (LDPE) with hot pressing method. The composition of coffee husk and LDPE sample composition ranged from 0: 100, 30:70, 40:60, 50:50, 60:40 and 70:30. The physical test results showed that the density values ranged from 0.48-0, 9 gr / cm 3 and the maximum value of density with the addition of coffee husk particles was at a composition of 30:70 of 0.8 gr / cm3 while the water content values ranged between 10.5 -14% and the minimum water content value with the addition of coffee husk particles of 12.45% is in the composition 30:70. In mechanical testing, the MOR strength values ranged from 70.45-100.6 kgf / cm2 and the optimum value was in the composition of 60: 40. From the MOE test results ranged from 10.00.23-13.000.07 kgf / cm2. Where the maximum MOE value is in the composition of 60:40.*

Keywords*--coffee husk, particle board, low Density Polyethylene (LDPE), physical properties, mechanical properties.*

I. INTRODUCTION

Recent developments in technology and science have pushed particle board material to be used in a variety of product applications, for example as interior panels, sound proofing, helmets, sports needs and others. Globally, composite materail was developed to replace metal materials that were widely used before the development of composite materials and particle boards. This technological trend shift is based on the nature of the composite reinforced natural fibers that are more environmentally friendly. This composite also has a strength ratio with a high density so that the resulting component is lighter. Biocomposite is one of the smart materials that has the opportunity to shift the use of synthetic metal and composite materials. The production of biocomposite reinforcement natural fibers is quite abundant. Some of the advantages of natural fibers, namely natural fiber is very easy to obtain, the harvest age is relatively short, planting can be done on marginal land, the technology for processing is very simple, and the level of sustainability is very high.

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One of the particles that can be used as composite filler material is coffee husk waste. Physical and mechanical properties of composites are influenced by the type of matrix and its filler. According to Milawarni, 2017, coffee husk waste can be used as a filler material that improves the mechanical properties of making coffee husk composite particles [1]. Diversification of coffee husk waste can be made into compost blocks [2] and animal feed [3].

Coffee (Coffea sp.) is one of the plantation commodities which plays an important role in the Indonesian economy. In 2011, the area of coffee reached 1.3 million hectares with a total production of 709 thousand tons [4]. Central Aceh and Bener Meriah districts are the main centers of Arabica coffee producers in Aceh Province. Arabica coffee from the two districts is known as Gayo Arabica coffee. Coffee productivity in this area reaches 700 to 800 kg / ha and all coffee is cultivated by smallholder plantations.

Particle board is one material that has the opportunity to shift the use of metal and synthetic composites. The production of natural fiber reinforcement particle boards or biocomposites is quite abundant. Some of the advantages of natural fibers, namely natural fibers are very easy to obtain, the harvest age is relatively short, planting is simple, and the level of sustainability is very high. In the coffee production process, it certainly produces a lot of waste in the form of post-harvest coffee fruit husk. Waste of coffee husk produced on average reaches 16.37% or each processing of coffee fruit will produce 45% coffee husk, 10% mucus, 5% epidermis and 40% coffee beans. This waste will be of use value as a filler for the manufacture of particle composites [5]. The matrix used in making this composite is the type of Low Density Polyethylene (LDPE). The type of LDPE used is transparent plastic. According to Maulana, et.al, 2013, the manufacture of ferro ferrite (FeO.Fe2O3) / strontium ferrite (SrO.6Fe2O3) and LDPE composite composites has been successfully made with coercive fields ranging from 1,011 kOe to 1,297 kOe [6]. The use of LDPE plastic has been widely made for composite matrices, such as composite camphor wood sawdust has been successfully carried out with a MOR value of 200.24 Mpa [7] [8].

Characterization of LDPE particle composites was carried out to determine the effect of variations in the composition of LDPE and variations of coffee husk on physical and mechanical properties. Characterization is carried out using tests based on SNI 03-2105-2006 which include physical properties such as density, moisture content and mechanical properties such as broken modulus (MOR) and elastic modulus (MOE). Fracture modulus is a magnitude in the field of engineering that shows the maximum load that can be held by a material (in this case a composite board) wide unity until the material is broken. While Modulus of Elasticity (MOE) is a scale in the field of engineering that shows the size of the material resistance withstand the load in the proportion limit (before breaking) [9] [10].

II. MATERIAL AND METHODS

a. Materials and tools

Materials utilized in this study include: LDPE plastic waste (transparent plastic), xylen, coffee bean horn husks, aquades and NaOH. Tools: 500 ml Beaker Glass, Sifter, Spatula, Analytical Balance Sheet, Hot Plate, Mold, Electronic System Universal Tensile Machine Type SC-2DE, Aluminum Foil, Mold (mall).

b. Procedure

- **Preparation of Material Composition:**

Coffee husk weight percent: (0%, 30%, 40%, 50%, 60%, 70%) and weight percent of LDPE: (100%, 70%, 60%, 50%, 40%, 30%).

- **Provision of coffee bean horn husk**:

Coffee bean shells are left open for one week, then soaked in 10% NaOH liquid after being washed with water until the pH is neutral. Then dried with an 80^0C oven. After that, it is ground and sieved to become coffee horn husk ready to use.

- **LDPE Provision**

Used LDPE obtained from transparent plastic waste. This plastic is cleaned and dried. Then cut the size 0.5x0.5 cm. LDP E was refluxed with acetone for 8 hours at 57^0C to remove impurities and additives present on the LDPE film. After that it is dried in an oven at 50^0C.

- **Sample construction**

The extracted LDPE plastic was melted at 160^0C, after melting it was mixed with coffee husk with Fenton's reagent and nitrogen gas to remove oxygen. Furthermore, the composite is printed using a printing machine (press mechine).

- **Testing**

Physical testing is carried out on the density and water absorption test then mechanical testing includes fracture modulus and elastic modulus. This test was carried out by means of the Electronic System Uniersal Testing Machine Type SC-2DE MFG No.6079. 2000 kgf stamp.

III. RESULTS AND DISCUSSION

a. Density

The average density test results can be seen in Figure 1. From Figure 1 shows that the presence of coffee husk affects the density value, including the lowest density value found in samples with a composition of 70: 30 of 0.65 gram / cm3, while the highest density value obtained in sample 1 with compositions without coffee husk particles are 1, 05 gram / cm3.

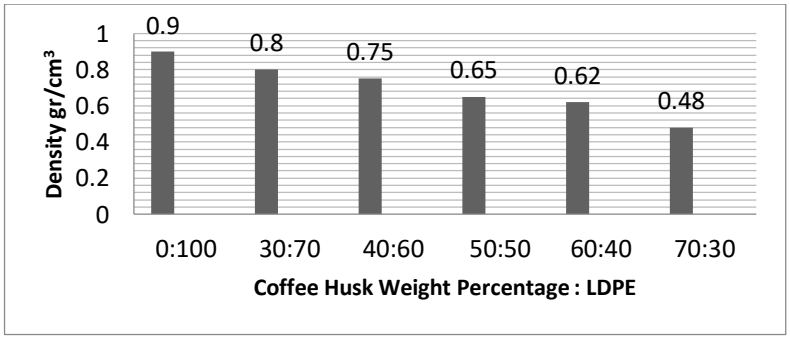

Figure 1: Relationship between density and coffee husk weight percent.

The density value is influenced by the sample volume fraction, the decrease in density along with the reduction in weight of LDPE and the addition of coffee husk particles results in the addition of volume fraction, this is due to differences in the density of LDPE and coffee husk, with the same mass but the volume of both is different so with the reduction of LDPE and addition coffee husks in the same weight fraction can increase the volume of particle board produced, and this will affect the density value. The greater the volume produced, the smaller the density value will be.

Particle board density tends to increase along with the addition of the amount of adhesive, this is due to the physical interaction force between the adhesive and the filler through the cavities that are filled [11]. The results of this study indicate that the existence of the addition of coffee husk can improve the physical properties of the resulting particle board, but if the particles used have exceeded the limit of the matrix's binding ability to the fiber, the resulting composite will be damaged.

b. Water Rate

The average moisture content of the samples produced ranged from 10.5% to 14%. Figure 2 shows the results of the water content to weight percent coffee husk. The results showed the lowest water content occurred in samples without coffee particles. Increasing the composition of the coffee husk causes increased water content so that the particle content reduces the resistance of the LDPE mixture, causing erosion. The highest water absorption is in sample 5 with a composition of 70: 30, the presence of coffee husks that are hydrophilic, ie materials that tend to absorb water, therefore increasing the percentage of coffee husk will cause more water to be contained in the sample during the manufacturing process.

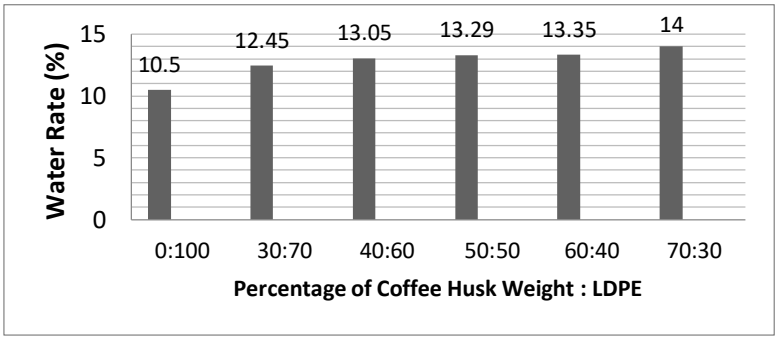

Figure 2: Relation of Water Rate to Percentage of Coffee Husk Weight.

Water content increases with the addition of coffee husk weight percent, this happens because the coffee husk is a lightweight aggregate that has many pores, so the percent water absorption is greater than the water absorbency without fiber. According to SNI 03-2105-2006 concerning particle board, it requires water content values for all samples <14%. Almost all samples meet the standards except for samples with a composition of 70:30. This result is very good for the use of interior or exterior panels because the moisture content is very small.

c. Broken Modulus (MOR)

The average MOR strength values range between 70.45 - 100.6 kgf / cm2. In Figure 4 shows that the addition of coffee husk particle composition tends to increase the strength of MOR.

This increase in strength indicates that the presence of coffee husk particles can increase the MOR strength of the particle board material. The maximum value for the sample with a composition of 60: 40, due to the strong adhesive force of the coffee husk makes the bond better. In samples with a composition of 70:30 it tends to decrease because the inability of the matrix to bind the filler is no longer uniform.

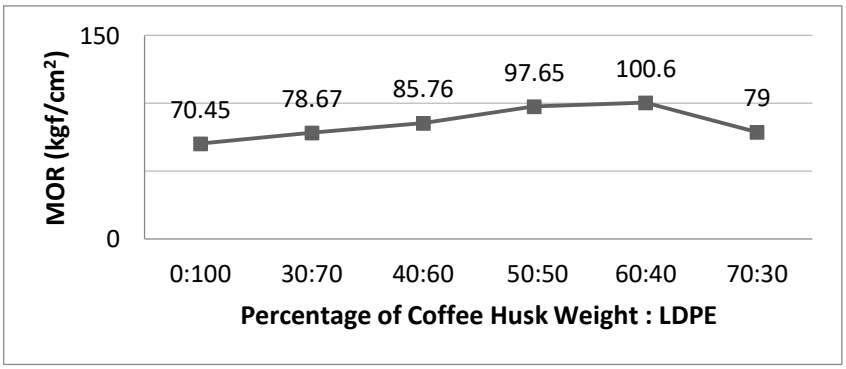

Figure 3: Relationship of MOR to percent coffee weight

SNI 03-2105-2006, particle board requires a minimum MOR value of 82 kgf / cm2. Thus the particle board almost all samples produced meet the specified standards except in the composition 70:30.

D Modulus of Elasticity (MOE)

The average MOE value ranges from 10000.23-13000.07 kgf / cm2. The maximum MOE value is obtained at the composition of 60:40 while the minimum value on the composition without the coffee husk particles.

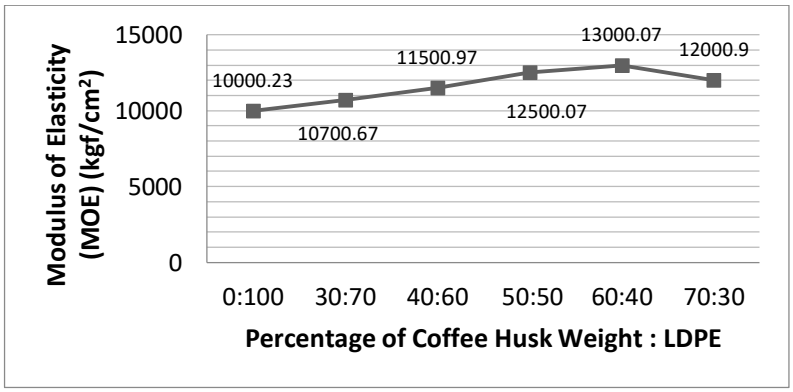

Figure 4: Relationship between MOE and coffee husk weight percent.

Figure 4 shows the MOE value tends to increase with the increasing percentage of coffee husk weight. This is caused by the effect of coffee husk which is a natural fiber that has good elasticity. The increase in MOE value tends to increase to 60% coffee husk weight but at 70% coffee husk weight intervals the MOE value decreases this is due to a gap in the particles, so if the composite receives a load then the voltage area will move

to the void area so that it will reduce the strength of the board the particle. All samples have not met the requirements for SNI 03-2105-2006 which is at least 15,000 kgf / cm2.

IV. CONCLUSION

From the results of a series of tests on the physical and mechanical properties of the particle board, discussion and interpretation of the results of research that have been carried out, it is concluded that, among other things, the characteristics of the particle board can be seen from the test results of the density values ranging from 0.48 to 0.9 gr / cm 3 and the maximum value of density with the addition of coffee husk particles is in the composition 30:70 of 0.8 gr / cm3 while the water content values range between 10.5 -14% and the minimum water content value with the addition of coffee husk particles of 12, 45% are in the composition 30:70. In mechanical testing, the MOR strength values ranged from 70.45-100.6 kgf / cm2 and the optimum value was in the composition of 60: 40. From the MOE test results ranged from 10.00.23-13.000.07 kgf / cm2. Where the maximum MOE value is in the composition of 60:40. The use of coffee skins in this study as a material for making particle board is very good in composition is 60 40, according to SNI 03-2105-2006.

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