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Characteristics of Tobacco Stem Particleboard in Printing Load Variations and Storage Time

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Abstract

Tobacco is an important commodity in the economy in Indonesia. Tobacco stems are worthless waste. Tobacco stems contain 56.10% cellulose, making it high potential as a particle board raw material. The process of making particleboard that affects quality is the pressing process during printing. Greater pressure printing presses make bonds between particles stronger. Strong bonding between particles is intended so that the board does not change during storage. The purpose of this study is to determine the characteristics of particleboard in various variations of printing pressure load and storage time and to find out the best treatment as a recommendation in the manufacture of tobacco stem particleboard. The research method was factorial CRD with a combination of treatments between 2 factors namely printing load (4 kg and 8 kg) and storage time (0, 12, and 24 days). The results showed 1.13 - 1.25 g.cm^{-3} for the density value, water content 4.97 - 12.57%, and water absorption 240.03 - 208.00%. MOE and MOR values were 16000.13 - 36222.77 kgf. cm^{-2} and 824.47 - 1697.83 kgf.cm^{-2}. The recommended treatment load is 8 kg printing pressure with 12 days of storage time.

Introduction

Tobacco is an important commodity in the economy in Indonesia. Indonesian Plantation Statistics Data on Tobacco Commodities in 2015-2017 tobacco production in 2017 reached 198.296 tons with an area of 201.8 Ha. The total production of tobacco stems with 40% of water content that can reach 5 tons per hectare in a 6-month harvest period (Srbinoska et al., 2015). The population range of tobacco plants per hectare is 22.000 trees with an estimated tobacco weight of 0.5 kg, so there are more than 2 million tons per year of tobacco stems (Handayani et al., 2018).

Tobacco stems are worthless waste. Tobacco stems have a cellulose content of 56.10% (Liu, et al., 2015). Cellulose has excellent mechanical properties, low density, biodegradable, abundant, and inexpensive renewable. The forms of cellulose utilization are bioplastics, egg trays, and particleboard.

Particleboard is one of the wood products made from a combination of wood particles or other fibrous materials that are bonded with natural adhesives or synthesized and then printed using a pressing treatment (Fitra et al., 2019). The particleboard manufacturing process affects the quality of the board one of which is the pressing process during printing. Printing pressure serves to force the adhesive to spread evenly on the surface. Printing pressure is also used to force the adhesive into the cell cavity so that the assembly/bond between the particles is maintained and unchanged (Mulyadi and Alphanoda, 2016). Strong bonding between particles

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is intended so that the particle board does not change significantly during storage. Storage time has a fluctuating effect on water content, density, and water absorption, but this storage time tends to increase the modulus of elasticity and modulus of repture.

Methodology

The material researches are tobaco stem powder, NaOH 10%, tapioca and aquades. While the equipment used in this study included glassware, molds, ovens, scales, calipers and Universal Testing Machines.

The research design used was a completely randomized design (CRD) of two factors, namely the difference in printing pressure loads (4 kg and 8 kg) and storage time (0 days, 12 days and 24 days).

All data is processed using two way ANOVA. If you get significantly different results, then continue with the Duncan test with the sig level. 5%.

Particle Board Mold Making Process

Particleboard molds are made of wood. Print measuring 30 cm x 30 cm. Mold height 6 cm with a thickness of wood is 2 cm. The foot height of the mold is 4 cm. The mold is equipped with a lid made of cement. The mold lid functions as a ballast/press that can press the particleboard. The molded lid has a size of 29.25 cm. There are two tyoe of mold loads 4 kg and 8 kg.

Particle Board Manufacturing Process

Tobacco powder was weighed 250 grams, then dignified into 10% NaOH with a ratio of 1:10. Delignified tobacco stem powder then washed with running water 60 L, then drained for 15 minutes. Tapioca is then weighed 20 gram by weight of tobacco stem powder. Tapioca added 1: 2 water then stirred evenly then done cooking for 6 minutes at a temperature of 70^0 C. The glue is then mixed with tobacco stems that have been dignified until smooth for 15 minutes. The material is then weighed 50 grams and put into a perforated plastic measuring 15 cm x 30 cm. The material in the plastic is flattened after that it is arranged into a mold and pressed for 60 minutes. The particleboard is then dried in the oven for 24 hours at a temperature of 80^0 C.

Results and Discussion

Density

The highest density value of particle board was obtained at 8 kg printing load treatment with 12 days storage time of 1.25 $g.cm^{-3}$. Asfarizal, et al (2019) stated that increasing press pressure tends to increase particleboard density. The greater printing pressure makes tapioca gel will increasingly infiltrate and surround the material to be more perfect to produce better material bonding. Mwithiga and Sifuna (2006) stated that the density value is influenced by water content and storage time. This is caused by the higher level of water contained in the board, the heavier, and the greater the mass so that the board density also rises. High density particleboard, the bond between the particles will be more compact and dense so that there are not many cavities or pores between interwoven particles filled with water (Jaya et al., 2018).

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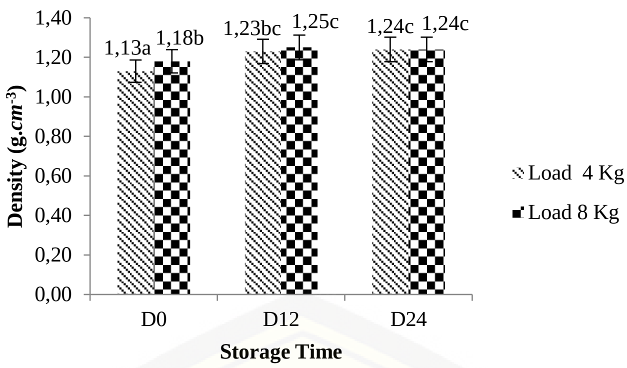

Figure 1. *Density value during storage*

Water Content

The results of the research at 8 kg printing pressure produce higher water content than the particle board with a pressure of 4 kg. The amount of pressure associated with the value of water content, the greater the pressure at the time of printing will cause the value of the water content decreases. Water content decreases due to the high pressure applied so that free water contained in the cell cavity comes out through the pores and is on the surface, then the water will evaporate when it is dried along with the evaporating water that is on the cell wall. High printing pressure makes the water contained in the adhesive trapped into the cell cavity replace free water so that the water does not evaporate when dried (Septian et al., 2017). High and low water levels in addition to being influenced by air humidity and storage time are also influenced by temperature factors. The temperature will affect the movement of water molecules and the dynamic balance between water vapor and absorbate form. This happens because a decrease in temperature during storage can increase the amount of water bound and will be followed by increased water activity (aw).

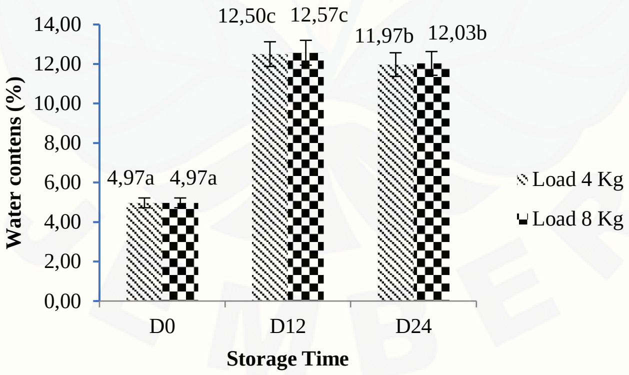

Figura 2. *Water content during storage*

Water Absorption

The highest particle board water absorption value was found in the treatment pressure of 4 kg printing pressure with a storage time of day 0 which is 240.03%. The lowest water absorption value is found on the particleboard with 8 kg printing pressure load and 12 days storage time of 208.00%. The stronger the pressure applied produces greater density and the smaller cavities that appear, the smaller the cavity on the board will cause a smaller tendency of incoming water so that the absorption capacity is smaller (Karyawan et al., 2017). Water absorption is inversely proportional to the particle board moisture content value, the lower the water content, the more

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it will absorb water. High water content makes the product has low absorption. High water content causes pores in the material not formed so that the material is not able to absorb large amounts of water. Low water content due to drying leaves cavities which when immersed the cavity is filled with water so that the resulting absorption becomes high. The higher the board's ability to absorb water, the texture will be less dense (Solihin et al., 2015).

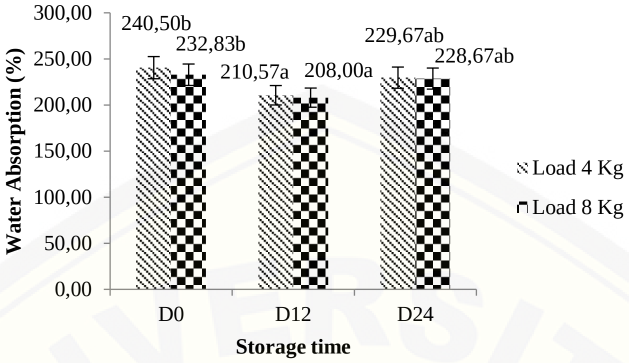

Figura 3. *Water absorption during storage*

Modulus of Elasticity

The highest modulus of elasticity is in the 8 kg printing pressure treatment load with a 24-day storage period of 36222.77 kgf.cm^{-2}. The greater the printing pressure, the modulus of elasticity decreases, this is due to the higher pressure the fiber is getting compressed and the pores will be filled by the adhesive so that this will cause the fiber to lose its elastic properties which will reduce the flexural properties of the composite material. The higher the modulus of elasticity, the object is more resistant to changes in shape, so that the ability to withstand the greater load (Wulandari et al., 2020). The modulus of elasticity is inversely proportional to the value of water content. Water that enters the molecular structure of the material will cause a plasticizing effect, making it easy for wood to be deformed. Low water content causes the constituent elements of the board to be rigid so that the resulting strain is also lower.

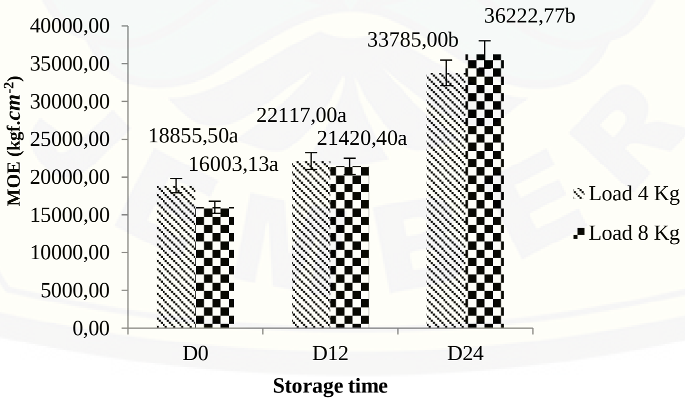

Figura 4. *Modulus of Elasticity during storage*

Modulus of Repture

The highest fracture modulus was found in the treatment of an 8 kg printing load with a 24-day storage period of 1697.83 kgf.cm-3. Greater printing pressure causes the starch's ability to spread and infiltrate the material to be better so that the board becomes denser and the proportion of empty space is less. Increased board density provides a large compressive force

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when testing compressive strength (Septiari et al., 2014). The greater emphasis also results in a reduced volume fraction of the fiber compared to the adhesive, thereby resulting in an increase in the hardness of the composite material which will then increase the compressive ability of the test specimens. The higher the water content value, the lower the fracture modulus value, so that the modulus value is inversely proportional to the water content value. Water content is directly related to the strength of the board where the higher the water content, the board will get heavier and wetter so that the board is easy to break (less strong boards) (Erma et al., 2019).

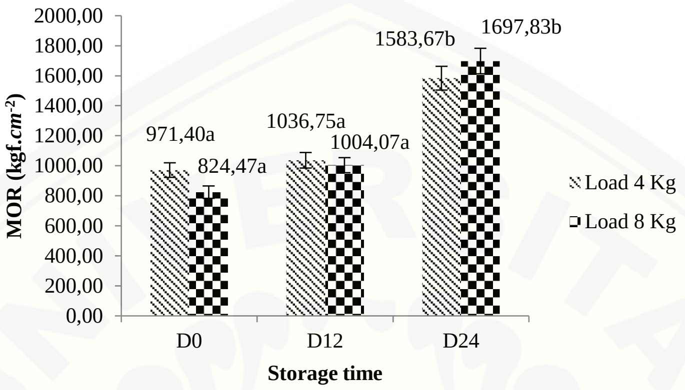

Figura 6. *Modulus of repture during storage*

The Best Treatment Recommendations

The best treatment in particleboard manufacturing is at 8 kg printing pressure load with 12 days storage time (A_2B_2) with a total priority value of 1.8. The density value for the best treatment is 1.25 g.cm^{-2}, while the water absorption is 208.00%. The higher the density value, the bond between the particles is stronger and more compact so that the cavity on the board is smaller, the smaller the cavity causes the tendency of water to get smaller as well so that the absorption value is smaller. High-density particleboard is able to sustain changes in shape from the outside and is able to withstand high loads. The recommendation for making particleboard is to choose a higher printing pressure load of 8 kg with a storage time of 12 days.

Table 1. The best treatment of particleboard

Parameter	Priority level	Treatment					
		A1B1	A2B1	A1B2	A2B2	A1B3	A2B3
Density	1				√		
Water Content	0,9					√	
Water Absorption	0,8				√		
MOE	0,7						√
MOR	0,9						√
Total					1,8	0,9	1,6

A : Printing load B : Storage time

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A_1 : 4 Kg	B_1 : Day 0
A_2 : 8 Kg	B_2 : Day 12
	B_3 : Day 24

Conclusion

The recommended pressure load in making particleboard is a printing pressure with a load of 8 kg and a storage time of 12 days so that the resulting particleboard density is 1.13 - 1.25 $g.cm^{-3}$ and water absorption 240.03 - 208.00 %.

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