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Utilization of Purun Tikus (*Eleocharis dulcis*) as Bioboard Raw Material with Heat Press

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Abstract. Forests is an abundant natural resource that provide our wood needed. Nowadays, forest barely able to maintain the optimum condition due to the high rate of deforestation because of fulfilled wood consumption and also forest degradation. There is an alternative to substitute wood fiber such as purun tikus. Purun tikus (*Eleocharis dulcis*) are wild plants that can adapt well to tidal swamp land. Research conducted with 2 factors of Factorial Complete Randomized Design. Factor 1 is giving tapioca adhesive with 4 levels of treatment, 0%, 10%, 20%, and 30%. Factor 2 is giving pressure load using hot press with 2 levels of treatment, 5 MPa and 8 MPa. The best treatment to obtain low density according to on SNI 01-4449-2006 fiber board that occurs in the treatment without the provision of adhesives while to get a fiber board with a medium density that occurs in the treatment by giving adhesive 10%, 20%, and 30%.

1. Introduction

Forest as a natural resource provide abundant resources that people need in daily life. Forest management that has been promoting the main results of wood is not able to maintain the condition of the forest, due to high rates of deforestation and forest degredation. Nationally, the current need for raw wood raw material (industrial installed capacity) annually reaches 63 million m^3. While log production from production forests is around 31.9 million m^3 per year [1]. The biggest threat to damage to natural forests in Indonesia is illegal logging, if the damage occurs continuously it can cause disruption of the balance of the forest ecosystem and the surrounding environment. The Ministry of Forestry, through a press release, said the rate of deforestation in Indonesia was at 613 thousand hectares in 2011-2012.

In Indonesia the need for wood raw materials for the forestry industry is currently declining. The availability of wood in the forest both in quantity and quality is increasingly limited, resulting in a wood deficit for industry. This relates to an increase in the population of Indonesia, so that the need for wood also increased. In 2013, the national log requirement was recorded at 49 million m^3. These needs are met from natural forests of 4 million m^3, Perhutani of 922.123 m^3, industrial plantations of 21 million m^3. The remaining wood needs are met from community forests with a supply of 23 million m^3 [2]. The needs of the Indonesian wood industry are inversely proportional to the production of wood from forests. So that consumption of wood usage cannot be fulfilled and a solution is needed by finding substitute raw materials (substitutes) for wood with materials that are environmental friendly and easily found or materials that are not utilized such as waste so that the use of non-wood fiber can be used as material to produce fiber boards can be used as an alternative . One alternative to replacing the wood fiber is the purus tikus.

Purun tikus (*Eleocharis dulcis*) is a aquatic weed that can adapt well to tidal swamps. This plant has many benefits, especially in China and Thailand, purun tikus tubers are used as raw or cooked vegetables, such as omelette, vegetable sauce, salad, cooking with meat or fish and even made cakes. In Indonesia, purun tikus stems are used to make traditional mats [3]. Purun tikus (*Eleocharis dulcis*) is a typical plant of swampy areas that has stiff, branched stems, shades of gray to green with a length of 50-

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200 cm and a thickness of 2-8 mm, leaves shrink to the basal part, thin midribs such as membranes, asymmetrical edges, reddish brown . Based on [4] purun tikus contain 32,6 percent of cellulose and about 26,4 percent of lignin.

Fiberboard is a wood-derived board product, generally made using additives in the form of adhesives, so that it can help form bonds between fibers that are stronger and produce good board properties. Fiberboard is a wood panel that is produced from the hot pressing of a mixture of wood fibers or other lignocellulosic materials with organic adhesives and other materials. The classification of fiberboard is divided into several categories based on the type of raw material, the method of making sheets, the density and the function or use. Making a fiber board involves two main stages, namely processing into pulp (pulping) and formation of fiber board sheets. Making a fiberboard also requires adhesives to tie between the fibers. Natural adhesives (lignin and hemicellulose) contained in biomass can be more effective by increasing the temperature [5]. Through these two stages of processing, where rat purun has the potential to be used as raw material for making fiber boards with the addition of adhesives and applying pressure as a treatment. So it is necessary to do research on the utilization of the mouse's purun with various parameters.

2. Material and Methods

This research was conducted in August - November 2018 in the Lab. Agricultural Power and Machines (DAMP), Department of Agricultural Engineering, Faculty of Agriculture, University of Lampung

2.1 Purun Tikus Bioboard Making

This research using 2 factors of Factorial Complete Randomized Design. First factor is tapioca adhesive with 4 tretatment levels, 0%, 10%, 20%, and 30%. Second factor is load pressure during molding process 2 treatment levels 5 MPa and 8Mpa, heat press temperature are mantainde about 120°C-150°C for 60 minutes. Purun tikus are dried in the sun with a moisture content of about 12%. Dried Purun tikus then cut off into pieces with a size of 1-2 cm, then soaked for 1 week and blended until they become pulp or porridge. The pulp is then printed using a hot press into a 10x10 cm mold.

The parameters observed were the physical properties of the board which included density, moisture content, absorbency, and the development of thick and quality boards based on the appearance of the fiber board produced by referring to SNI 01-4449-2006 [6]. Tools used in this reaearch are ovens, digital scales, knives, scissors, basins, jars, blenders, ruler, 1 ml screen mesh, calipers, gloves, and hot press equipment. While the materials used are purun tikus, tapioca flour, water, and zip plastic.

2.2 Purun tikus Bioboard Density test

Density testing shows the ratio between the mass of the object to the volume at equilibrium water content. Fiber board density functions to determine whether the fiber board class is included in the low density class (PSKR), medium density (PSKS), or high density (PSKT). Test samples measuring 10 cm x 10 cm x 1 cm that are already air dried are weighed. Then the dimensions are measured including length, width, and thickness to determine the volume of the test sample. Board density is calculated using the formula weight (gram) devided by volume (cm^3).

2.3 Purun Tikus Bioboard Water Content

Test sample measuring 10 cm x 10 cm x 1 cm weighed dry air weight (BKU), then oven at 103 ± 2 ° C for 24 hours, after being roasted the test sample was put into the desiccator for 10 minutes, then removed to be weighed. Wet basis moisture content values were calculated using the 1995 AOA moisture content standard formula.

2.4 Purun Tikus Bioboard Water Absorption 2 h and 24 h
Test sample 5 cm x 5 cm x 1 cm in dry air conditions weighed (B0). Then soak in cold water for 2 hours and 24 hours. Then the test sample is removed and drained , then weigh again (B1). water absorption is calculated using the formula: (B1-B0)/B0 x 100 percent.

2.5 *Purun Tikus Bioboard Thickness Development*
This test is related to the water absorption to analyze thickness development characteristic , with a sample size of 5 cm x 5 cm x 1 cm. The formed fiber board is then immersed in water for some time. So it can be calculated the development of particle board thickness that absorbs water.
Thickness Development (%) = (T1-T0) / T0 x 100% .

3. Result and discussion

3.1 Purun tikus Bioboard Density test
Based on data obtained from the density tests that have been done, the average value obtained at 5 MPa pressing loads ranges from 0.43 g / cm³ - 0.72 g / cm³ and at 8 MPa pressing loads 0.47 g / cm³ - 0 , 84 g / cm³ (Figure 7). Based on SNI 01-4449-2006 that the density standard is set at 0.40 g / cm³ - 0.84 g / cm³ where the value is included in the medium density fiberboard (PSKS), therefore from 8 MP loadings it can be determined that the average density value enters the medium density (PSKS). The board which has the highest density value is found on the board with an average of 0.84 g / cm³ (8 MPa).

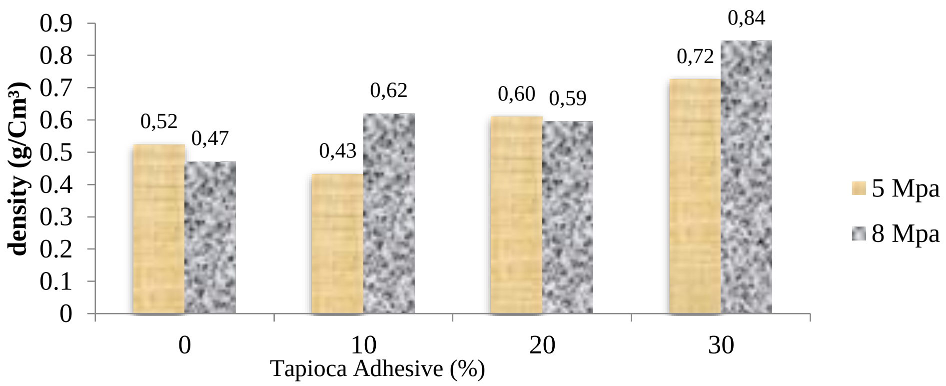


Figure 1. Density values based on the of tapioca adhesive concentration

The higher the density of particle board, the higher the strength and stiffness [7]. So based on the results of the data obtained, the more glue is given, the density is also increasing. In the graph (Figure 1), the adhesive that has been applied to the printed board has a high rigidity and density. After the board is printed cleaning is done on the fiber board if there is aluminum foil attached to the fiber board. There are some fiber boards that are difficult to clean, this is because the temperature exceeds 120 ° C.

ANOVA test result with α 0,05 shown that tapioca adhesive factor Pr > F is 0,0004 so Pr < α , the tapioca adhesive as single factor is significantly different and give effect to bioboard density. Duncan test were conducted as further test, the result shown that 30percent of tapioca adhesive is significantly different that other tapioca adhesive treatment level.

3. 2 Purun Tikus Bioboard Moisture Content
Moisture content purun tikus bioboards is an average value from 9.14% to 15.45% for 5 MPa pressing loads and an average value of 9.73% - 14.37% for pressing 8 MPa loads. The standard figure of the fiber board moisture content according to SNI 01-4449-2006 is <13%. Thus, there are some boards that do not meet these standards [8]. states that the addition of liquid adhesives can increase water content by

about 2-4%. The average value of the test can be seen in Figure 8. The highest moisture content is obtained from boards with 30% adhesive content and with Pressing 5 MPa is 15.45%. The lowest moisture content is obtained from non-adhesive boards with a 5 MPa pressing load of 9.14%. Some of the boards have high moisture content and exceed the maximum moisture content value of 13%. That is because during the molding process, there are some moist left inside board pores.

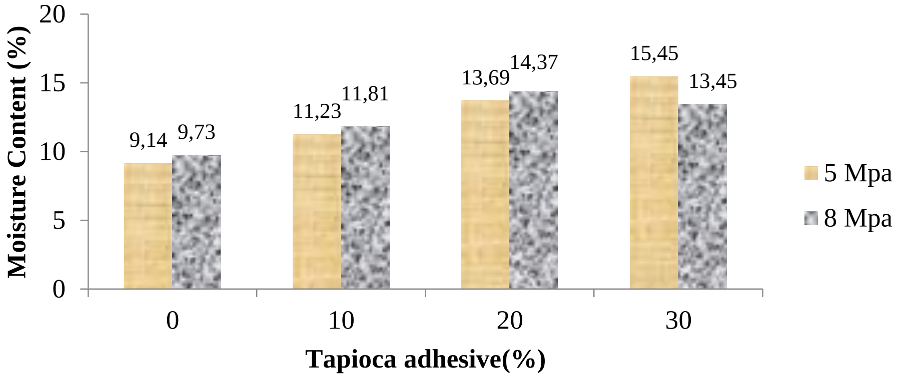


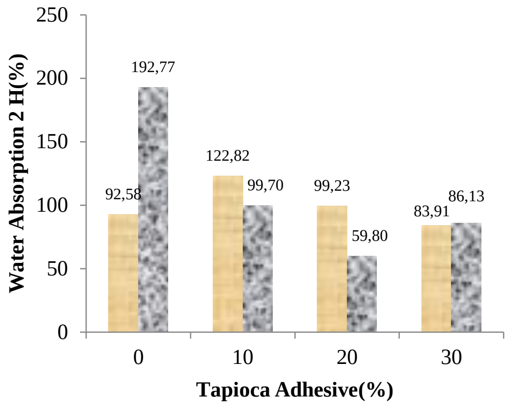
Figure 2. Purun tikus bioboard moisture content

According to [9] the ability to bind and remove water from a particle board depends on the surrounding humidity and temperature. If the humidity and temperature around it are lower, there will be release of water (desorption). Conversely, if the humidity around is higher, there will be absorption of water (absorption). The high water content produced can be caused by the absorption of water vapor during the conditioning process [10]. Furthermore, to determine the effect of different tapioca flour adhesives, ANOVA test have been carried out.

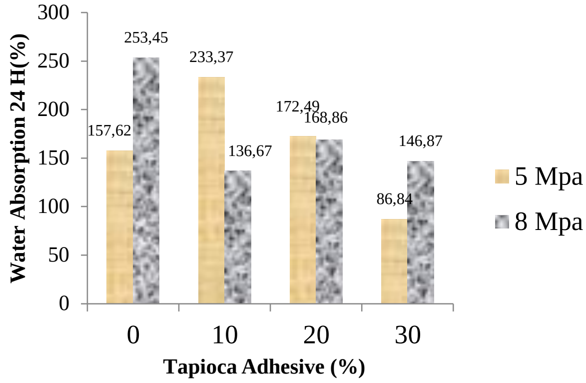
From ANOVA test with α 0,05 , Pr > F value is 0,0002, it is known that the value of Pr <α so it can be concluded that the treatment of the adhesive content affects the water content parameters. Then further tests are carried out on the treatment of the adhesive content. The results of further tests can be shown that the treatment of 10% and 0% adhesive is significantly different but the treatment of adhesive 30% and 20% is not significantly different.

3.3 Purun Tikus Bioboard Water Absorption 2 h and 24 h

Considering that the raw material of the fiberboard is not made of wood, the water absorption results show that the absorption of the fiberboard water from purun tikus plants has a relatively high value. The absorption value can be influenced by the density, the higher the concentration of tapioca adhesive given to the fiber board, the higher the density will also cause the lower the water absorption. The average value of water absorption after 2 hours soaking at pressures of 5 and 8 MPa each ranged between 83.91% - 122.82% and 59.80% - 192.77%. The average value of water absorption after 24 hours soaking at pressures of 5 and 8 MPa each ranged between 86.84% -233.37% and 136.67% - 253.45%. This can be caused by the nature of the raw material ,purun tikus plants, are hygroscopic and contain lignin and cellulose, where materials containing lignin and cellulose are very easy to absorb and release water [11].



(a)



(b)

Figure 3. Water absorption of purun tikus bioboard (a) after 2 hours soaking and (b) after 24 hours soaking

However, the resulting graphs such as Figure 3a and Figure 3b showed differences in fluctuative trends. That is because in the manufacturing process there are several obstacles in the pressing tool. When mixing the adhesive and put it in molding, adhesive clumping occurs which makes water absorption difficult and some boards also easily absorbed by water. That makes the results on the graph fluctuate, some are high and some are low.

From ANOVA of treatment effect on water absoprtion after 2hours soaking it is known that the value of Pr $<\alpha$ so that it can be concluded that the treatment of the adhesive content affects the water absorption parameter after 2 hours soaking and the interaction of the pressing treatment * the adhesive content also influences the water absorption parameter after 2 hours soaking. Then a further test of the effect of the adhesive content and a further test of interaction between pressing * adhesive levels and loading pressure parameters Pr> α, so it does not affect the water absorption after 2 hours soaking.

Further test for tapioca adhesive affect on water absorption after 2 Hours shown that all the treatments of adhesion to absorption after 2 hours soaking were not significantly different. But in the treatment of 0% adhesive significantly different from 20% and 30% tapioca adhesive . Further test of interaction of loading pressure and tapioca adhesive treatment effect on water absorption after 2hours revealed that the effect of pressing interactions and adhesive levels on each treatment is very significantly different, T2P1 (8MPa loading pressure with 0percent tapioca adhesive) , T1P2 (5MPa loading pressure with 10 percent tapioca adhesive), and T2P3 (8MPa loading pressure with 20 percent tapioca adhesive) are significally different than other treatments.

From ANOVA of treatment effect on water absoprtion after 24hours soaking it is known that the value of Pr $<\alpha$ so that it can be concluded of it is known that the value of Pr> α, it can be concluded that the treatment of adhesive content and pressing does not affect water absorption after 24hours soaking with the interaction of pressing *adhesive level, so the further test were not conducted.

3.4 Purun Tikus Bioboard Thickness Development

Bioboard thickness development is one of the physical properties which is analyse the bioboard changes in the dimensions with increasing thickness of the board expressed in percent. Thick development testing is done by soaking the board with water for 24 hours.

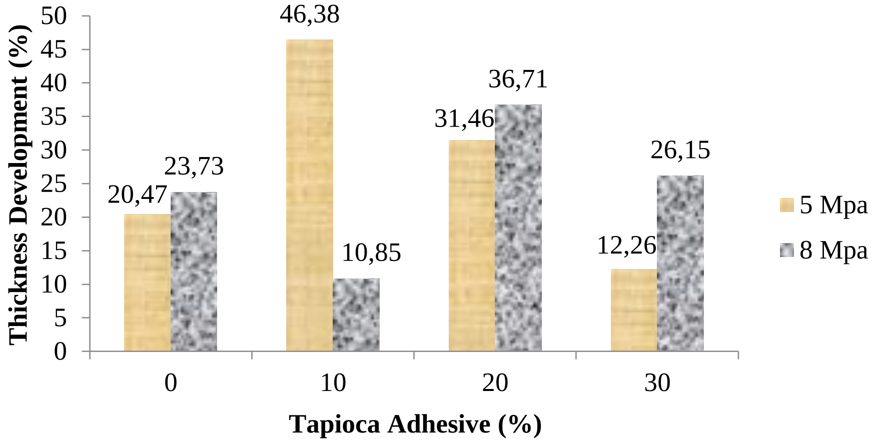


Figure 4. Purun Tikus Bioboard Thickness Development

Based on Figure 4 it can be seen that there is a development of thick fiber board that varies from each adhesive. The average value obtained at 5 MPa pressing loads ranges from 12.26% - 46.38% and at 8 MPa pressing loads around 10 , 85% - 36.71% . For the average value of the lowest thickness development with a pressure of 5 MPa is the application of 30% adhesive and the highest 10%. Then for the average value of the lowest thickness development with a pressure of 8 MPa is the 10% adhesive and the highest 20%. The results of the graph also show that the results are fluctuative.

From ANOVA of treatment effect on bioboard thickness development result, it is known that the value of Pr <α, so it can be concluded that the interaction of pressing * adhesive level affects the thickness development parameter, then further interaction interactions are conducted to see the effect of the parameters on the thickness development. In the treatment of pressing and applying adhesive values of Pr> α it can be concluded that the pressure of pressing and applying adhesive does not affect the thickness development, so no further testing is carried out. Further test on interaction of pressing * adhesive shown that T1P2 (5MPa with 10 percent tapioca adhesive), T1P4 (5MPa with 30 percent tapioca adhesive), and T2P2 (8MPa with 10 percent tapioca adhesive) are significantly different that others treatment.

4. Conclusion

Based on the results of research that has been done, some conclusions that can be drawn are as follows ; The treatment of adhesive content affects the density, water content, and water absorption capacity of 2 hours, while the treatment of adhesive content for water absorption 24 hours and thickness development has no effect; The pressure treatment has no effect on the observed physical property parameters; Purun tikus bioboard has a density value with a pressing load of 5 MPa is 0.43 to 0.72 g / cm³ and a pressing load of 8 MPa from 0.47 to 0.84 g / cm³, the value of water content with a pressing load of 5 MPa is 9.14 - 15.45% and 8 MPa pressing load is 9.73 - 14.37%, the value of water absorption after 2 hours immersion with 5 MPa pressing load is 83.91 - 122.82% and 8 MPa pressing load 59.80 - 192.77%, the value of water absorption after 24 hours immersion with 5 MPa pressing load is 86.84 - 233.37% and 8 MPa pressing load is 136.67 - 253.45%.

The development value is thick with 5 MPa pressing load is 6.97 - 47.06% and pressing 8 MPa is 10.85 - 36.71%; The best treatment according to SNI 01-4999-2006 for density with the treatment of giving 0-30% adhesive that is 0.43-0.72 g / cm³ pressure of 5 MP categorized into medium density (PSKS), the best treatment of water content is on the adhesive application 0 % and 10% namely 9.14% and 11.23% 5 MPa pressure, 9.73% and 11.81% pressure 8 MPa, for thick development values with 5

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MPa pressing loads are 6.97 - 47.06% and pressing 8 MPa is 10.85 - 36.71% then from this value can be categorized as PSKS type 25 (Middle Density Board type 25)

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