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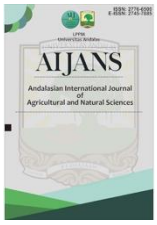

Article

The Effect of Difference In Press Time on Physical Properties and Mechanical Particle Board Without Adhesive From Coconut Fiber and Gambier Processed Pulp

Sahadi Didi Ismanto*[1], Neswati[1] and Ananda Agung Perkasa[2]

[1]Department of Agricultural Industrial Technology, Andalas University
[2] Department of Agricultural Product Technology, Andalas University

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*Corresponding Author

sahadididiismanto@ae.unand.ac.id

Abstract

This study aims to determine the effect of differences in the length of time when pressing for the manufacture of particle board without adhesive from a mixture of coconut coir fiber and processed gambir leaf dregs on the physical and mechanical properties of the resulting non-adhesive particle board. The method used in this study was a completely randomized design with 5 treatments and 3 replications. Data were analyzed using variance, followed by Duncan`s New Multiple Range Test (DNMRT) at 5% level. The comparison ratio used in the manufacture of particle board without adhesive from coconut coir fiber and processed gambir waste is 60% : 40%. The treatments in this study were A (8 minutes of pressing time), B (10 minutes of pressing time), C (12 minutes of pressing time), D (14 minutes of pressing time), E (16 minutes of pressing time). carried out is a test of physical properties and mechanical properties. The results showed that the length of time of compression affected the physical and mechanical properties of the non-adhesive particleboard. The best treatment was treatment A (pressing time 8 minutes). Observation of physical properties obtained density 0.68 g/cm3, moisture content 13.42%, water absorption 132.87%, thickness swelling 66.84%, mechanical properties fracture toughness (MOR) 90.40 kg/cm2, toughness compressive parallel to the surface of 50.07 kg/cm2, and internal bond (IB) 1.45 kg/cm2.

INTRODUCTION

The longer the supply of wood in the forest decreases due to the increasing number of needs for the use of basic wood materials from trees and the supply of land in the forest is decreasing. This causes a new alternative is needed as a substitute for wood. Wood is one of the basic needs for boards after other basic needs, namely food and clothing. One of the materials that can replace wood is waste products from agriculture which contain lignocellulosic, namely components of hemicellulose, lignin, cellulose, pectin which can be further processed into composite boards/particle boards. One alternative that can be used to replace wood is wood particles such as coconut fiber. Coconut coir fiber is a lignocellulosic material which is easy to obtain, resistant to water and mechanical treatment such as rubbing and blowing (Zikri, 2009).

Coconut coir fiber (coco fiber) is a product derived from the process of separating fiber from the fruit skin. The skin of the fruit is the largest part of the coconut fruit, which is about

65% of the total weight of coco fiber. Coconut coir contains hemicellulose (27.7%), cellulose (26.6%), lignin (29.4%), and water (8%) (Suhardiyono, 1998). The utilization of coconut in Indonesia is still largely based on copra and coconut oil processed products. On the other hand, there is an economic potential contained in coconut, namely from its waste. One of the efforts that can be made to increase the economic value of agricultural waste is to make particle board. Coconut coir agricultural waste which contains high cellulose, hemicellulose and lignin can be utilized for the manufacture of particle board.

Gambir plant (Uncaria gambir, Roxb) is one of the superior and specific commodities of West Sumatra Province. According to Bappeda West Sumatra (2012), Gambir is one of the 10 main export commodities of West Sumatra and 80% of Indonesia's gambier exports come from West Sumatra. Most of Indonesia's gambier production is exported to export destination countries, including India, Pakistan, Nepal, Singapore, Bangladesh, Japan, Malaysia, Italy, USA, Thailand and the United Arab Emirates. At this time gambier waste has not been used optimally, especially in processed gambier waste. With an area of one hectare of gambier land aged less than 3 years it produces 4-5 tons of compressed pulp from gambier leaves. Based on observations seen in the gambier processing industry, gambier leaf compression waste is still not optimally utilized. Usually, the compressed pulp of Gambir leaves, which is already considered as waste, is simply sprinkled on the surface of the soil without further processing at all, even though the tannin content in the compressed pulp of Gambir leaves is still present in the leaves. So from that, the compressed pulp of Gambir leaves can be used as an alternative additional material for making particle board without adhesive.

Kasim and Ihsan (2000), it is known that overall the amount of extractable tannins is 93.60% and 61.49% of catechins. Meanwhile, 5.24% tannins and 3.02% catechins were still found in solid waste from raw materials. Tannins and catechins have the potential to substitute natural binding adhesives for particle board. Okuda and Sato (2004), revealed that lignocellulosic materials can be formed into particle boards without additional adhesives or resins and react during the hot pressing process. This means changes in chemical components such as hydrolysis of hemicellulose and solvents that form polymerization of long double bonds.

In the manufacture of particle board usually use the main ingredient, namely organic adhesives with the help of one or more elements of heat, pressure, time and others (Haygreen and Bowyer, 1989). In addition, agricultural waste is also used to manufacture binderless particle boards. Particle board is a type of composite product made of wood particles or other lignocellulosic materials bound together with adhesive or other binder and then hot pressed (Maloney 1993). Particle board without adhesive is very dependent on the chemical properties of the raw material because self-bonding is produced from re-polymerization of the results of degradation of chemical components during the hot pressing process (Widyorini, Xu and Watanabe, 2005). As in the research on making particle board with gambir-processed waste, namely reacting cellulose compounds with tannins from gambir-processed pulp into long-chain bonds called polymerization.

Parameters affecting board properties have been identified and include processing parameters such as pressure, temperature, pressing time and raw material properties such as type, particle size and shape as well as moisture content. Several additional physical and chemical treatments can improve the quality of particle board (Widyorini et al., 2005). In the process of making particle board without adhesive there is an optimum time used for the pressing process. If the time used is less than the optimum time, the resulting board will not stick or the board does not meet the standards. According to Yusuf (2006) if the pressing temperature is above the optimum temperature for a long time it will cause the resulting

particle board to be too mature (overmature) so that it becomes brittle and causes the bonds between the particles to become abnormal, this greatly affects the quality of the particle board when pressing against given temperature.

In the process of making particle board from empty palm fiber fruit bunches without adhesive with a compression time of 5 to 14 minutes at a temperature of 170°C, with a pressing time of 5 to 9 minutes the Modulus Of Rupture (MOR) and Density values do not meet SNI standards No. 03-2015-2016 regarding particle board (Sari, 2011). Therefore the authors would like to add that with the long treatment time of pressing at the optimum temperature it is hoped that it will produce a good quality of particle board adhesion and based on the results of pre-research that has been carried out with the formulation of 60% coco fiber and 40% processed gambier dregs and the formulation of the treatment to be given is long treatment time of pressing for 8 minutes, 10 minutes, 12 minutes, 14 minutes and 16 minutes in order to obtain optimum results of good pressing time and produce good quality particle board in terms of physical and mechanical.

The aim of this study was to determine the effect of different lengths of pressing on the physical and mechanical properties of particle board without adhesive from coco fiber and processed gambir dregs and to obtain the optimum pressing time for particle board from gambir and coconut coir dregs.

EXPERIMENTAL SECTION

Materials

The materials used in this study were chopped coconut fiber cleaned from cork obtained from a factory that processes chopped coconut coir in Pariaman Regency, West Sumatra, then cut into 1-5 cm fiber sizes and processed gambir leaf dregs obtained from community plantations in Siguntur, South Coast, West Sumatra.

Instrumentation

The tools used are 60 mesh sieves, ovens, measuring cups, beakers, buckets, scales, hammer mills, disc mills, machetes, cold presses, hot presses, mold materials, aluminum plates, saws, grinding tools, Universal Testing Machine (UTM) and caliper.

Procedure

Research Design

The design used in this study was a completely randomized design (CRD) with 5 treatment levels and 3 replications. The comparison ratio used in the manufacture of particle board without adhesive from coco fiber and gambier leaves is 60%: 40%. The treatment is the difference in the length of hot pressing time when printing and cooking coconut coir fiber and processed leaf dregs. Treatment of long pressing time, namely:

A = 8 minutes of pressing time

B = 10 minutes of pressing time

C = 12 minutes of pressing time

D = 14 minutes of pressing time

E = 16 minutes of pressing time

Research Implementation

a. Preparation of Coconut Coir

Coconut Coir is taken from coconut farmers. Coconut husk is cleaned of impurities. The manufacturing process begins by manually cutting coconut coir into particles with a size of (5 ± 1) cm. Then decomposition, cleaning and then drying until the moisture content reaches 10%.

b. Preparation of Gambir Processed Dregs Particles

Processed dregs of gambier are taken from gambier farmers in the Siguntur Pesisir Selatan area. The gambier processing waste was dried and then ground using a hammer mill machine and then sieved through a 60 mesh sieve.

c. Material Calculation

Material calculations carried out in the process of making particle board are as follows:

1. The size of the panel made is 20 x 20 x 1 cm3

2. The expected board density is 0.8 g/cm3

3. The weight of the raw material for one sample panel is 320 g.

4. 50% NaOH solution is added as much as 8% of the weight of the material, namely 25.6 ml.

d. Manufacture of Particle Board Without Adhesive (Pansuri Modification, 2016)

The stages of making particle board without adhesive are as follows:

1. Materials are weighed according to what is needed

2. Mixing gambier processing waste particles with NaOH solution and adding 10 ml of distilled water.

3. Mixing coconut coir and processed gambir dregs

4. Pouring the mixed material into a 20 × 20 × 1 cm mold placed on an aluminum plate

5. Making the boards as flat as possible

6. Cover the candidate board with another aluminum plate

7. Cold pressing is carried out for 20 minutes until a board sheet with a thickness of approximately 2 cm is formed. after that hot pressing was carried out with a long treatment time of 8,10,12,14,16 minutes using a temperature of 170˚ C

8. Removing the board from the hot press

9. Conditioning before testing is carried out for one week, so that the moisture content of the particle board reaches an equilibrium moisture content of 14%.

e. Observation

In this research, raw material analysis was carried out, namely chemical properties such as water content, hemicellulose, cellulose, lignin content in coco fiber and analysis of water content in the dregs of processed gambir leaves. Observations of particle board such as moisture content, density, water absorption, thickness expansion, fracture toughness, surface parallel compressive strength and internal bonding.

RESULT AND DISCUSSION

Analysis of Raw Materials

In a research it is necessary to know the chemical components contained in the raw materials used. Where the chemical components of the raw material will affect the properties of the particle board without adhesive, therefore it is necessary to analyze the content of the raw material for coconut coir and processed gambier dregs. So that it can be analyzed the effect on the properties of the resulting non-adhesive particle board. The chemical components contained in coconut coir can be seen in Table 1 below.

Table 1. Chemical Composition of Coconut Coir and Gambir Leaf Dregs

Component	Percentage (%)	
	Gambir Coconut	Coir Dregs
Kadar Air	11,36	12
Selulosa	53,54	(-)
Hemiselulosa	18,47	(-)
Lignin	34,97	(-)
Tanin	(-)	3,12

The results of the data analysis obtained in Table 1 show the value of the chemical content of coconut coir, namely 11.36% water content, 53.54% cellulose, 18.47% hemicellulose and 34.97% lignin. According to Fengel and Wegener (1995), the cellulose content in wood ranges from 40-50%, whereas hard wood contains 20-25% lignin content. This shows that coconut coir fiber meets the requirements as a raw material in the manufacture of particle board.

The results of the analysis of processed gambir dregs obtained chemical content values, namely tannins of 3.12% and water content of 12%, these results showed that the tannin content obtained was lower than previous studies. According to Kasim (2011) the tannin content in the processed gambir pulp was 5.24%, the difference in the results obtained could be due to the nature of the tannins themselves which dissolve in water during the boiling process. This is in accordance with the statement (Susanti, 2000) that all types of tannins are soluble in water, their solubility is large and will increase when dissolved in hot water. The purpose of the analysis of the raw material for processed gambier dregs was carried out to determine the chemical content of the material, namely tannins which act as a substitute for artificial adhesives to become natural adhesives in the manufacture of particle boards without adhesives.

Physical Properties of Particle Board Without Adhesive

a. Density

Density is the mutual adhesion and integration between the volume particles and the dry weight of the particle board. The bonding between one particle and another with the help of a press greatly affects the density that will be obtained on the particle board sheets that are made. So that the higher the density produced, it will be directly proportional to the mechanical properties of the resulting non-adhesive particle board. According to Haygreen and Bowyer (1989), the higher the overall density of the board of a particle material, the higher the strength of the board. The results of the analysis of variance showed that the difference in the length of time the board was pressed had a significant effect on the density of the resulting non-adhesive particle board. The DNMRT follow-up test at the 5% significance level is presented in Table 2.

Table 2. Average density of particle board without adhesive with old treatment

Treatment	Density (g/cm3) ± SD
E (16 Minute)	0,63 ± 0,02 a
D (14 Minute)	0,66 ± 0,01 b
C (12 Minute)	0,67 ± 0,01 b
A (8 Minute)	0,68 ± 0,01 bc
B (10 Minute)	0,69 ± 0,01 c
Coefficient of Diversity = 2,19%	

Based on the time treatment given, the density of particle board without adhesive obtained ranged from 0.63 g/cm3–0.69 g/cm3. The highest density was produced in treatment B 0.69 g/cm3 (10 minutes), while the lowest density was produced in treatment E 0.63 g/cm3 (16 minutes). The increase in the value of the density number obtained can be seen based on the treatment given, namely the optimum time for the density value ranges from the time of pressing the board 8 minutes - 12 minutes. The ratio between the weight and volume of the board affects the density of the resulting non-adhesive particle board. The density value obtained shows results with a range of values that are not too far away. The density value decreases with the length of time hot pressing is given which affects the reduced water content in the board. The longer the hot pressing treatment will further reduce the weight and volume of the board obtained so that the density value also decreases. With a lighter volume and weight, the density of the part of the particle board decreases (Amelia, 2009).

From the results of the average value obtained, it can be seen that the density of particle board without adhesive has met the minimum standard of particle board density. The density of the resulting board is compared based on the provisions of SNI 03-2105-2006, the density value of particle board is 0.4 g/cm3-0.9 g/cm3. Particle board without adhesive which has an average density value of 0.68 g/cm3–0.63 g/cm3 is classified as medium density particle board.

b. Water content

Widarmana (1977), stated that the moisture content of particle board depends on the condition of the surrounding air, because particle board consists of materials containing lignocellulose so that it is hygroscopic. The water content of the particle board will be lower as the density value decreases, because the contact between the particles will be tighter so that water will be difficult to enter. The water content analyzed refers to the percentage of water bound by the particle board without adhesive to the dry weight obtained. The value of the water content obtained was 13.42% for the treatment time of 8 minutes to 6.53% for the duration of 16 minutes of pressing. The results of the analysis of variance showed that the difference in the length of time the board was pressed had a significant effect on the moisture content of the resulting non-adhesive particle board. DNMRT follow-up test at 5% significance level which can be seen in the table in Table 3.

Table 3. Average moisture content of particle board without adhesive with the long time of pressing used

Treatment	Water Content (%) + SD
E (16 Minute)	6,53 + 0,04 a
D (14 Minute)	6,97 + 1,09 a
C (12 Minute)	9,45 + 0,54 b
B (10 Minute)	11,62 + 0,31 c
A (8 Minute)	13,42 + 0,37 d
Coefficient of Diversity = 6,15%	

In Table 3, it can be seen that the average moisture content of the particle board without adhesive obtained complies with SNI 03-2105-2006 standards with a maximum value of 14%. The longer the pressing time of the particle board without adhesive used, the lower the moisture content of the particle board without adhesive produced, where during the long treatment time of pressing with a hot press it causes the moisture content of the particle board without adhesive to evaporate from the raw material. The lowest average water content value

was found in the 16-minute long pressing time treatment, which was 6.53% and the highest water content value was found in the 8-minute long pressing time treatment, which was 13.42%, where the pressing time on the board was still too short to evaporate. water contained in the raw material of particle board.

c. Water Absorbency

The property of water absorption is the addition of water content to the particle board when the board is immersed in water for 24 hours. Lignocellulosic materials have high water absorption properties so that they will expand and contract according to the water content in the material. SNI (2006) does not set a standard for the value of water absorption. However, this test is important to do to determine the board's resistance to water, especially if it is used for exterior manufacturing purposes where the board will be in direct contact with weather conditions such as humidity and rain (Lestari, 2013).

The results of the analysis of variance showed that the difference in the length of time the board was pressed had a significant effect on the water absorption capacity of the non-adhesive particle board from coconut coir and the resulting gambir pulp. DNMRT follow-up test at 5% significance level which can be presented in Table 4.

Table 4. Average water absorbency of non-adhesive particle board with long treatment time of pressing used

Perlakuan	Daya Serap Air (%) ± SD
E (16 Minute)	126,60 ± 3,31 a
A (8 Minute)	132,87 ± 2,93 b
C (12 Minute)	132,97 ± 1,66 b
D (14 Minute)	134,89 ± 3,40 b
B (10 Minute)	139,99 ± 0,57 c
Coefficient of Diversity = 1,96%	

The lowest water absorption value lies in the 16 minute long pressing time treatment which is 126.60% and the highest water absorption power lies in the 10 minute long pressing time treatment which is 139.99%. The value of water absorption obtained from particle board without adhesive cannot be separated from the basic properties of the raw materials used, which are hygroscopic to absorb water but dry faster. Where coconut coir contains lignin which makes it more resistant to water and cellulose which reacts with tannins which forms a strong bond structure to the board. However, due to the area on the surface of the particles

that cannot be covered with adhesive, water enters more quickly if it is directly exposed to water.

If at the time of hot pressing given a longer treatment time it will reduce the water content contained in the board. When compared with Sari's research, N (2018) has a water absorption capacity ranging from 155.6% - 183.0% and compared to the water absorption value of boards from coconut coir which can have lower water absorption. This shows that the longer the pressing time given makes the board drier and makes it less easy to absorb water

The water absorption value of particle board without adhesive varied, in the treatment (8 minutes) 132.87%, (10 minutes) 139.99%, (12 minutes) 132.97%, (14 minutes) 134.89% and (16 minutes) 126.6%. This is because the raw material used for coconut coir absorbs less water, dries easily and also the volume of empty space between the coconut coir particles and the tannins contained in the gambir processed waste is less and the tannins have water-soluble properties when soaked in water.

d. Thick Development

Coconut coir particle board and processed gambir waste are materials whose main components are lignocellulosic materials, so their properties are affected by the presence of water and moisture. The increased strength of particle board sheets can be caused by the strengthening of the bonds between the particles.

Thickness expansion is a quantity that expresses the increase in thickness of the test sample in percent of the initial dimensions after the test sample is immersed in water for 24 hours. The thickness expansion test was carried out to determine how resistant the particle board is when interacting with water. Because particle board without adhesive can be applied for interior and exterior purposes. This is in line with the water absorption capacity of the board, if the water absorption properties of a board are low, the swelling properties of the particle board thickness are also low (Subiyanto, et al, 2003).

The swelling value of the thickness of the particle board from coconut coir and gambir pulp was obtained A (8 minutes) 66.84 %, B (10 minutes) 66.68 %, C (12 minutes) 66.03 %, D (14 minutes) 55.86 % and E (16 minutes) 54.13 %. The highest thickness expansion value was found in the 8-minute compression time, which was 66.84%, and the lowest thickness expansion was in the 16-minute compression time, which was 54.13%.

The results of the variance of the difference in the length of pressing time had a significant effect on the development of the thickness of the non-adhesive particle board from

coconut coir and gambir pulp which was produced after soaking for 24 hours. The DNMRT follow-up test at the 5% significance level is presented in Table 5.

Table 5. Average Thickness Development of Particle Board Without Adhesive with Treatment Effect of Length of Time Used

Treatment	Thickness Development (%) ± Standard Deviation
E (16 Minute)	54,13 ± 0,93 a
D (14 Minute)	55,86 ± 2,96 a
C (12 Minute)	66,03 ± 2,75 b
B (10 Minute)	66,68 ± 1,59 b
A (8 Minute)	66,84 ± 1,38 b
Coefficient of Diversity = 3,37 %	

In Table 5, it can be seen that observations of the thickness development of particle board without adhesive from coconut fiber and processed gambier dregs show that there is a decrease in the thickness development of particle board due to the effect of the long pressing time given. In treatments A (8 minutes), B (10 minutes) and C (12 minutes) it shows that the thickness expansion response given is decreasing, but the value obtained is not too far off. In the long treatment, the compressing time D (14 minutes) and E (16 minutes) only showed a lower thickness swelling response.

The most important factor in thickness development is water absorption. The higher the water absorption, the higher the thickness expansion will be. This is because the water absorbed by the particle board will affect the expansion of the volume of each particle and cause pressure release from the particle board which is exerted during the compression process during sheet formation. Where the pressure between the particle boards obtained is influenced by the long pressing time given. The longer the heat pressure on the particle board is, the lower the thickness expansion value obtained.

Mechanical Properties of Non-adhesive Particle Board

a. Fracture Firmness (Modulus of Rupture/MOR

MOR is a value that describes the load-bearing strength of a material, which is defined as the maximum load capacity that can be accepted by the material. The higher the MOR of the particle board, the better the quality of the board (Adibrata, AS. 2001). Just like MOE, the MOR value is also affected by the content and type of adhesive used, the bonding power of the adhesive and the length of the fibers that form long polymerization chain bonds. Based on

the analysis of variance, it was shown that the difference in the length of time of pressing had a significant effect on the fracture toughness of the non-adhesive particle board from coconut coir and the resulting gambier dregs. The DNMRT follow-up test at the 5% significance level is presented in Table 6.

Table 6. Average Fracture Strength of Particle Board Without Adhesive with Long Pressing Time Used

Treatment	MOR (kg/cm2) ± Standard Deviation
E (16 Minute)	63,20 ± 1,38 a
D (14 Minute)	64,00 ± 3,66 a
C (12 Minute)	84,80 ± 8,42 a b
A (8 Minute)	90,40 ± 15,42 b
B (10 Minute)	99,20 ± 18,01 c
Coefficient of Diversity =14,18 %	

From the presentation of table 6. It can be seen that the highest fracture toughness value lies in the long pressing time B (10 minutes), namely 99.20 kg/cm2 and the lowest fracture toughness value lies in the 16 minute pressing time, namely 63.20 kg/cm2. In this test, the MOR value has reached the SNI standard (2006) (minimum 82 kg/cm2), namely in treatment A (8 minutes) 90.40 kg/cm2, B (10 minutes) 99.20 kg/cm2, C (12 minutes) 84.80 kg/cm2 and in the long treatment time of pressing D (14 minutes) 64.00 kg/cm2, E (16 minutes) 63.20 kg/cm2 which does not meet SNI (2006). According to Haygreen and Bowyer (1982) that a good bond between the particles associated with the process of mixing, shaping and compression. This shows that in pressing particle board without adhesive, the optimum time is obtained in the cooking process with hot compresses. The optimum time to obtain the MOR value in this study was obtained at the time of pressing A (8 minutes) where the value obtained met the requirements of SNI (2006) above 82 kg/cm2, namely 90.40 kg/cm2. This shows that the bonds between the particles are strong enough.

The average MOR value of particle board without adhesive with long pressing time treatment was obtained by the results of long pressing times A (8 minutes), B (10 minutes), C (12 minutes) having a high fracture toughness value and meeting the SNI 03-2015 standard - 2006 when compared with the pressing time of 14 minutes and 16 minutes does not pass SNI (2006). According to Haygreen and Bowyer (1982), the higher the overall board density of certain materials, the higher the strength of the board. This is in line with the average value of particle board density obtained. The density values in the treatments that passed SNI (2006)

also passed SNI for the MOR strength test obtained. Another factor that influences the unequal MOR strength of the boards obtained is that the fiber lengths are not the same length so that the response between the bonds received to withstand the load is not the same as a whole on each part of the board. Boimau (2010) also added that the more equal the length of the fibers, the greater the reinforcement given to the bond so that the strength between the particles is stronger.

b. Compressive Firmness Parallel to Surface

In the manufacture of particle board testing, the compressive strength parallel to the surface is the mechanical property of the board that must be tested. Compressive strength parallel to the surface is the strength of particle board to withstand a given load until it breaks perpendicular to the surface. The results of variance analysis show that the length of pressing time does not have a significant effect on the parallel compressive strength of the surface of particle board without adhesive from coconut fiber and processed gambir dregs. DNMRT follow-up test at 5% significance level which can be seen in Table 7.

Table 7. Average Parallel Compressive Strength of the Surface of Particle Board Without Adhesive with Long Pressing Time Used.

Treatment	TSP (kg/cm2) ± Standard Deviation
E (16 Minute)	34,87 ± 4,10
D (14 Minute)	42.80 ± 4,77
A (8 Minute)	50,07 ± 11,43
B (10 Minute)	54,93 ± 17,73
C (12 Minute)	57,00 ± 11,43
Coefficient of Diversity = 23,28 %	

In Table 7. shows that the compressive strength values obtained parallel to the surface in the particle board test without adhesive ranged from 57.00 – 34.87 kg/cm2. The average value of parallel compressive strength of all particle boards without adhesive produced is 47.93 kg/cm2. The highest value of compressive strength parallel to the surface was found in the 12-minute compression time treatment, namely 57.00 kg/cm2 and the lowest value in the 16-minute compression time treatment, namely 34.87 kg/cm2. The pressure value parallel to the surface has no maximum requirement in SNI. When compared to Sari's study (2018), the compressive strength parallel to the surface of particle board without adhesive was obtained higher, the value of particle board from OPEFB and processed gambir pulp with a surface parallel compressive strength value ranging from 44.62-21.46 kg /cm2.

The difference in the length of pressing time has no significant effect on the compressive strength parallel to the surface of the particle board without adhesive. Based on the results of the research that has been carried out, it shows that the pressure value parallel to the surface decreases with increasing length of time of compression given. This can be due to chemical reactions that occur between the bonds in the resulting overcooked particle board. According to Yusuf's statement (2006), if the pressing temperature is above the optimum temperature for a long time it will cause the resulting particle board to be too mature (overmature) so that it becomes brittle and causes the bonds between the particles to become abnormal, this greatly affects the quality of the particle board when compression to a given temperature.

c. Internal Bonding Firmness (IB)

Internal bond strength is a value that indicates the strength between particles, so that internal bond strength can be used as a good guide in determining sheet quality in connection with the particle board manufacturing system implemented (Haygreen and Bowyer, 1989). Internal bond strength is an indicator of the bond between wood particles and other objects. The internal bond strength value of the board ranges from 1.45 - 1.66 Kg/cm2. The resulting average value was 1.49 Kg/cm2 with the lowest value obtained at a pressing time of 12 (minutes) 1.43 Kg/cm2, the highest value was obtained at a pressing time of 14 (minutes) 1.66 Kg/cm2.

The results of the analysis of variance showed that the length of time of pressing had a significant effect on the internal bonding strength of the non-adhesive particle board from coconut coir and the resulting gambier dregs. The DNMRT further test at a real level of 5% can be presented in Table 8.

Table 8. Average Value of Internal Adhesive Firmness of Particle Boards without Adhesive with Long Treatment Time of Pressing Used

Treatment	Internal Bonding (kg/cm2) ± SD
C (12 Menit)	1,43 ± 0,01 a
A (8 Menit)	1,45 ± 0,03 a
B (10 Menit)	1,47 ± 0,01 a
E (16 Menit)	1,48 ± 0,12 a
D (14 Menit)	1,66 ± 0,05 b
Coefficient of Diversity = 4,14 %	

From Table 8 it can be seen that the average IB value for each treatment has varying internal adhesive strength values. From the long treatment the pressing time complied with the internal adhesive firmness standard set by SNI 03-2105-2006, namely 1.5 kg/cm2 in treatment D (14 minutes). In other treatments it does not meet SNI (2006) standards, but the average value obtained is almost close to the set standard value. This is because maybe in the process of forming bonds between particles the raw material has not decomposed optimally so that the adhesive strength on the board is not strong enough. According to Sutresno (2004), the internal bonding will be better with the large number of components contained in the raw materials that are decomposed optimally.

The value of internal bonding firmness of particle board without adhesive obtained a value that complied with SNI (2006) in treatment D (14 minutes). In treatment A (8 minutes) 1.45 kg/cm2 , B (12 minutes) 1.47 kg/cm2 , C (12 minutes) 1.43 kg/cm2 , E (16 minutes) 1.66 kg/cm2 not yet comply with SNI (2006) regarding internal bonding firmness of particle board. If we look at the MOR fracture strength test at the same time, we get a value that meets SNI (2006) but the IB test does not meet the requirements. If you look at previous studies, the results obtained should be comparable to the results of each strength test obtained. This is because the particle components on the board do not respond differently to the internal adhesive strength value of the coconut coir particle board. The low value of internal bond strength of particle board is also influenced by poor mixing, forming and compression processes. Which results in • weak bonds between particles which also include bonds between particles on the surface of the particle board, Haygreen and Bowyer (1996) stated that the value of good internal bonding is influenced by particles related to the mixing, forming and compression processes.

d. Recapitulation of the Properties of Non-Adhesive Particle Board Made from Coconut Coir and Gambier Dregs

Recapitulation of data on the physical and mechanical properties of non-adhesive particleboard made from coconut fiber and processed gambier dregs is presented in Table 9.

Table 9. Recapitulation of Physical and Mechanical Properties of Particle Board Without Adhesive from Coconut Coir with Gambir Dregs compared to SNI 03-2105-2006

Pressing time	Density (g/cm3)	WC (%)	WAC (%)	TD (%)	MOR (kg/cm2)	PPS (kg/cm2)	IB (kg/cm2)
SNI	0,4–0,9	<14	-	-	Min 82	-	Min 1,5
8	0,68	13,42	132,87	66,84	90,40	50,07	1,45
10	0,69	11,62	139,99	66,68	99,20	54,93	1,47
12	0,67	9,45	132,97	66,03	84,80	57,00	1,43
14	0,66	6,97	134,89	55,86	64,00	42,80	1,66
16	0,63	6,53	126,60	54,13	63,20	34,87	1,48

The average value of each treatment the length of time for pressing the average value of each treatment for the length of time for pressing does not fully meet the requirements of SNI 03-2105-2006. The average density test value obtained from all treatments meets the requirements set by SNI (2006). The average water content test value obtained from each treatment meets the requirements set by SNI (2006). In the fracture toughness test (MOR) of particle board without adhesive, not all values met the set standards, in treatment A, (8 minutes), B (10 minutes), C (12 minutes), which already fulfilled SNI (2006) and in the treatment D (14 minutes) and E (16 minutes) do not meet the specified requirements. In the internal bond test (IB), only the long pressing time D (14 minutes) met the standard requirements set by SNI (2006) for particle board, namely above 1.5 kg/cm2 and other treatments did not meet the standard. For water absorption test standards, thickness development and compressive strength parallel to the surface are not specified in SNI 03-2105-2006.

CONCLUSION

The difference in the length of pressing time has a significant effect on the physical and mechanical properties of the resulting board, namely water content, water absorption, density, thickness expansion, fracture toughness (MOR), internal bonding toughness (IB) and has no significant effect on parallel compressive strength surface. The optimum hot pressing time

which has complied with SNI 03-2105-2006 in the manufacture of particle board is 8 minutes treatment.

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