NANOFIBER CELLULOSE COCOA'S HARDBOARD ON COMPRESSION STRENGTH AND TERMITE RESISTANCE

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ABSTRACT

Each year's use of wood needs increases, but the resulting wood production is not in proportion to meet that need. The effort is required to overcome this by using a wood substitute that includes wood-based fiberboard. The manufacture of fiberboards requires a chemical base for adhesive, which can be used to reduce the use of chemicals and thus be used in the cacao fruit's nanofibers. Related to wood materials, the natural enemy most damaging of these materials is termites. Termites are wood-eating insects that can reduce the quality of timber, for handling this a curing process can be employed using a sourced leaf with an antifeedant. The purpose of this study is to identify the compression failure and resilience of the fiberboard termites after being given an extract of cocoa skin and soursop leaves. Dimension of compression specimens is 200 mm x 50 mm x 30, compression perpendicular is 150 mm x 50 mm x 30 mm and terminate resistence is 70 mm x 50 mm x 150 mm with hollow's diametres 2 mm deep 1 cm. The standard that used to measure compression is SNI 03-3958-1995 and termite resistance of hardboard is SNI SNI 01-7207-2006. The extra variety used is 0%, 10%, 15%, 20% and 25%. Each variation will be done with a compression failure and termite resistance. Three different test items will be made with a total of 30 test items. Research shows compression failure parallel in strong class V wood, while compression failure perpendicular is included in the E5 quality code. Termite resistance 0%, 10% and 15% include C level damage while at 20% and 25% variation, including B damage.

Keywords: Compression failure; Hardboard; Nanofiber cellulose; Termite resistance

INTRODUCTION

According to data provided by 2020, the company's net profit in 2020 rose to 61,02 million m^3 from the same period last year, according to the company's annual need for timber production. Addressing these needs requires an effort to find an alternative wood substitute, which is the making of a fiberboard (Maftuhatin et. al, 2017). The fiberboard is a homogeneous panel made of wood dust in which lignocellulose fibers are contained. Then, mixed with synthetic resin or natural adhesive, are combined with pressure and temperature of 100°C – 150°C to form the sheet (Indrawan et. al, 2015).

Indonesia's third-largest producer of cacao fruit in the world has yet to lack further use of cocoa butter, whereas Indonesia's cocoa production added some 16% globally, in 2010 producing 574,000 tons. In the skin of one cacao fruit, it contains 32% - 45% fibers of lignin and cellulose (Nisa et. al, 2014). According to Lukmandaru (2018), termites are a natural enemy of the wood that is most damaging because they can damage the quality of the wood. As a result of the termite attack, many studies studied natural preservatives for timber. This treatment is intended to increase the life span of wood, especially timber used as furniture or construction materials. One plant that is effective for the durability of the wood is the soursop leaf because it contains a compound that can impede the growth of insects (Carolina et. al, 2019).

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The study aims to find out the powerful pressure that the fiberboard experiences after adding cacao skin cellulose fibers and know the impact of the fiber-based stick test that the leaf-leaf solution gives on the termite's life force on the fiberboard.

METHODS

The study is done to find out the compression failure and termite resistance on the fiberboard test items with the addition of cocoa skin and soursop extract. The results of the test will be adjusted to the wood design chart in Table 1.; a strong class of wood PKKI 1961 in Table 2. and a table for degrees of wood damage SNI 01-7207-2006 in Table 3.

Research Process

The process of this research can be seen in Figure 1.

The Making of Cocoa Skin Extract

The first step in the study could be a cocoa skin extract which can be seen in the diagram in Figure 2.

The Making of Soursop Leaves Extract

The next addition will be added to the fiberboard, the extract of soursop leaves which can be seen in the diagram in Figure 3.

Making Specimens

Prior the initial testing began with the making of specimens for each test dimension. Dimension of compression specimens is 200 x 50 x 30 mm, compression perpendicular is 150 x 50 x 30 mm and terminate resistence is 70 x 50 x 150 mm with hollow's diametres 2 mm deep 1 cm. Specimen's Matrices in Table 4**.** The making of these fiberboards is composed of a mixture of powdered wood, glue, cocoa skin extract, and extract of soursop leaves. The making of an object for a test can be seen in the diagram in Figure 4.

RESULTS AND DISCUSSION

Compression Failure Parallel

The compression failure of the wood is the force of press per unit of the area of the press expressed in unit N/mm^2. The examination is done in accordance with the SNI 03-339-1995 and the results of the examination can be seen in Figure 5. From this result, it can be explained the maximum value of compression failure in the fiber parallel is obtained at a 25% variation of 0,52 N/mm^2. From earned results, it is suggested that compression failure parallel fibers each variation increases. The greater the value of pressing gained, the better its resistance to receiving such a burden. This is influenced by the adhesive used in polyurethane that has a good adhesive when used on wet materials as well as the addition of cacao skin extracts in each variation that contain cellulose nanofibers, an addition to the fibers' manufacture. Involuntary cellulose fibers in the peel affect the tensile strength between the sawdust particles to produce solid and glued fibers.

Compression Failure Perpendicular

The compression failure of the wood is the force of press per unit of the area of the press expressed in unit N/mm^2. The examination is done in accordance with the SNI 03-339-1995 and the results of the examination can be seen in Figure 6. From this result, it can be explained the maximum value of compression failure in the fiber perpendicular is obtained at a 25% variation of 0,55 N/mm^2. From earned results, it is suggested that compression failure perpendicular fibers each variation increases. The greater the value of pressing gained, the better its resistance to receiving such a burden. This is influenced by the adhesive used in polyurethane that has a good adhesive

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when used on wet materials as well as the addition of cacao skin extracts in each variation that contain cellulose nanofibers, an addition to the fibers' manufacture. Involuntary cellulose fibers in the peel affect the tensile strength between the sawdust particles to produce solid and glued fibers.

From compression failure results press it can be redated from compression failure parallel fibers and perpendicular fibers in Figure 7.

Based on Figure 7. it may be known that compression failure results in fiber parallel have better results than compression failure the fiber perpendicular. It can be seen from a strong, significant increase in pressure from 0% to 25% variation.

Termite Resistance

The termite resistance results by comparing mass before and after termite decoy, after which will be obtained a percentage of damages from the item consistent with SNI 01-7207-2006. The results of the test can be seen in Figure 8. From these results, it can be explained that the maximum value of the termite's resistance is obtained on a 25% variation of 21,79%. It has been suggested that the value of the termite resistance in each variety is reduced because of the amount extracted from the leaf of soursop. In this termite resistance testing when the percentage is gained is smaller, the resistance is improved because the object when it is picked off by the termite is small, thus reducing its mass to less than when it is time for deductions. Hence, it could be deduced that the smaller percentage of the value of the termite resistance obtained, the better the effectiveness of the item in receiving termite decoy. This has been influenced by the increased amount of extract from antifeedant leaves in each variation containing an antifeedant compound, which can choke the life force of insects on a fiberboard. It affects the fiberboard when the bait is used, which is how low the fiberboard damage from termite fishing is made.

Overall, current results have been sufficiently expressed. However, the adequate discussion is not yet revealed related to previous similar findings.

In 200 sheets with a concentration of 6.04% soursop leaf powder were used to preserve mango wood, the results were 34.15% durability while with the addition of 15% borax liquid, the durability results were 39.11%.

CONCLUSION

Based on the research that has been done it could be summed up as follows in compression failure specimens parallel fibers, an average value of 5,2 kg/cm^2 falls in the strong V-wood class. While compression failure specimens perpendicular fibers with an average value of 0,55 MPa in the wood quality code E5. The termite resistance test on 0%, 10%, and 15% of the C damage rate includes small, non-broad, non-deep channels, while 20% and 25% of the test materials are below the b damage level.

Further research is needed to obtain the compressive strength and termite resistance values by increasing the percentage of cocoa husk extract mixture above 25% in order to find the optimum percentage composition.

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REFERENCES

Badan Standarisasi Nasional. (1995). SNI 03-3958-1995 : Metode Pengujian Kuat Tekan Kayu di Laboratorium. Jakarta.

Badan Standarisasi Nasional. (2006). SNI 01-7207-2006 : Uji Ketahanan Kayu dan Produk Kayu Terhadap Organisme Perusak Kayu. Jakarta.

Badan Standarisasi Nasional. (2013). SNI 7973-2013 : Spesifikasi Desain Untuk Konstruksi Kayu. Jakarta.

Carolina, Selvi, Wiwin, T. I., & Sunardi. (2019). *Utilization of Soursop (Annona Muricata L) Leaf Ektract as Natural Wood Preservative*, *2*.

Indrawan, D. A., Sulastiningsih, I. M., Rossi, M. T., Gustan, P., & Adi, S. (2017). *Quality Hardboard Two Types of Bamboo with the Addition of Tannins resorcinol Formaldehyde*. Bogor: Center for Research and Development of Engineering and Processing of Forest Products.

Lukmandaru, G., Mauidhotul, H., & Nuridha, I. R. (2017). *Termite Resistance, Chemical Properties, and Color of Teak Wood from Community Forests in Kulon Progo. Forest Products Technology*, Gadjah Mada University.

Lukmandaru, G., Pito, W., Arsy, R. M., & Vendy, E. P. (2018). *Resistance to Subterranean Termites*. Forestry Science, Gadjah Mada University.

Maftuhatin, Mahardika, Yuliati, I., & Ahmad, Y. (2017). *Physical and Mechanical Properties of a Fibre Board Made from Kepok Banana Stem (Musa Paradisiaca L at Various Pressing Temperatures and Times)*, *5*.

Nisa, D., & Widya, D. R. P. (2014). Utilization of Cellulose from Cocoa Fruit Peel (Theobroma cacao L.) as Manufacturing Material CMC (Carboxymethyl Cellulose). *Journal of Food and Agroindustry*. *2* (3) : 34 – 42.

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Appendix

Table 1. The Wood Design Chart

Quality Code	Reference Design Value (MPa)					Reference Elasticity Modulus (MPa)	
	Fb	Ft	Fc	Fv	Fc⊥	E	Emin
E25	26.0	22.9	18.0	3.06	6.11	25000	12500
E24	24.4	21.5	17.4	2.87	5.74	24000	12000
E23	23.2	20.5	16.8	2.73	5.46	23000	11500
E22	22.0	19.4	16.2	2.59	5.19	22000	11000
E21	21.3	18.8	15.6	2.50	5.00	21000	10500
E20	19.7	17.4	15.0	2.31	4.63	20000	10000
E19	18.5	16.3	14.5	2.18	4.35	19000	9500
E18	17.3	15.3	13.8	2.04	4.07	18000	9000
E17	16.5	14.6	13.2	1.94	3.89	17000	8500
E16	15.0	13.2	12.6	1.76	3.52	16000	8000
E15	13.8	12.2	12.0	1.62	3.24	15000	7500
E14	12.6	11.1	11.1	1.48	2.96	14000	7000
E13	11.8	10.4	10.4	1.39	2.78	13000	6500
E12	10.6	9.4	9.4	1.25	2.50	12000	6000
E11	9.1	8.0	8.0	1.06	2.13	11000	5500
E10	7.9	6.9	6.9	0.93	1.85	10000	5000
E9	7.1	6.3	6.3	0.83	1.67	9000	4500
E8	5.5	4.9	4.9	0.65	1.30	8000	4000
E7	4.3	3.8	3.8	0.51	1.02	7000	3500
E6	3.1	2.8	2.8	0.37	0.74	6000	3000
E5	2.0	1.7	1.7	0.23	0.46	5000	2500

Table 2. Strength Class of Wood

Strong Class	Specific gravity	Absolute Arch Strength (kg/cm^2)	Absolute Compressive Strength (kg/cm^2)
I	≥ 0.90	≥ 1100	≥ 650
II	0.90 - 0.60	1100 - 725	650 - 425
III	0.60 - 0.40	725 - 500	425 - 300
IV	0.40 - 0.30	500 - 360	300 - 215
V	< 0.30	< 360	< 215

Table 3. Degrees of Wood Damage

Level	Test Sample Condition	Value
A	Whole, no attack	0
B	There are bite marks	40
C	Light attacks, in the form of channels that are not deep and not wide	70
D	Heavy attack, in the form of a deep and wide channel	90
E	The wood is destroyed, approximately 50% of the wood is eaten by termites	100

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Table 4. Specimen's Matrices

Test	Cellulose Fiber	Soursop Leaf Extract	Number of specimens
Compression Tes	0 %	0 %	3
	10 %	10 %	3
	15 %	15 %	3
	20%	20%	3
	25%	25%	3
Termite Resistence	0 %	0 %	3
	10 %	10 %	3
	15 %	15 %	3
	20%	20%	3
	25%	25%	3

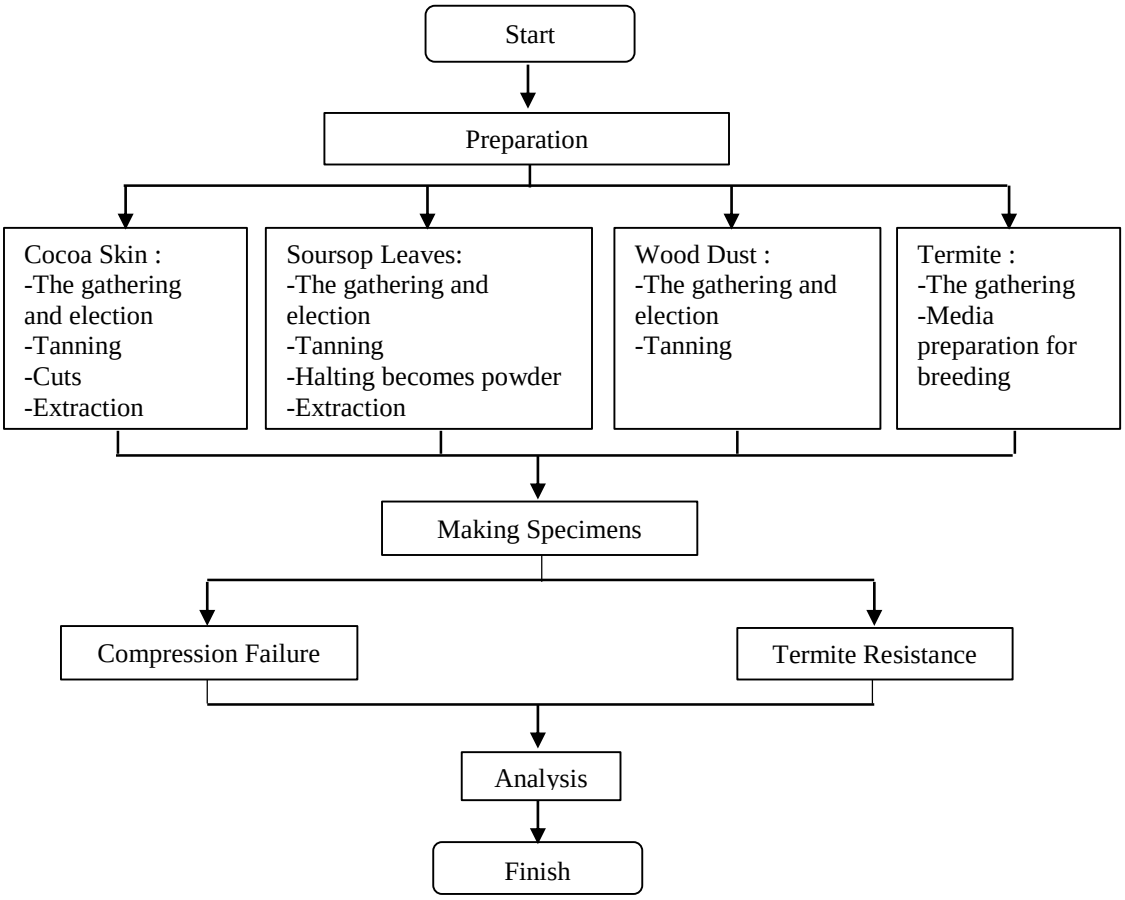

Figure 1. Flowchart

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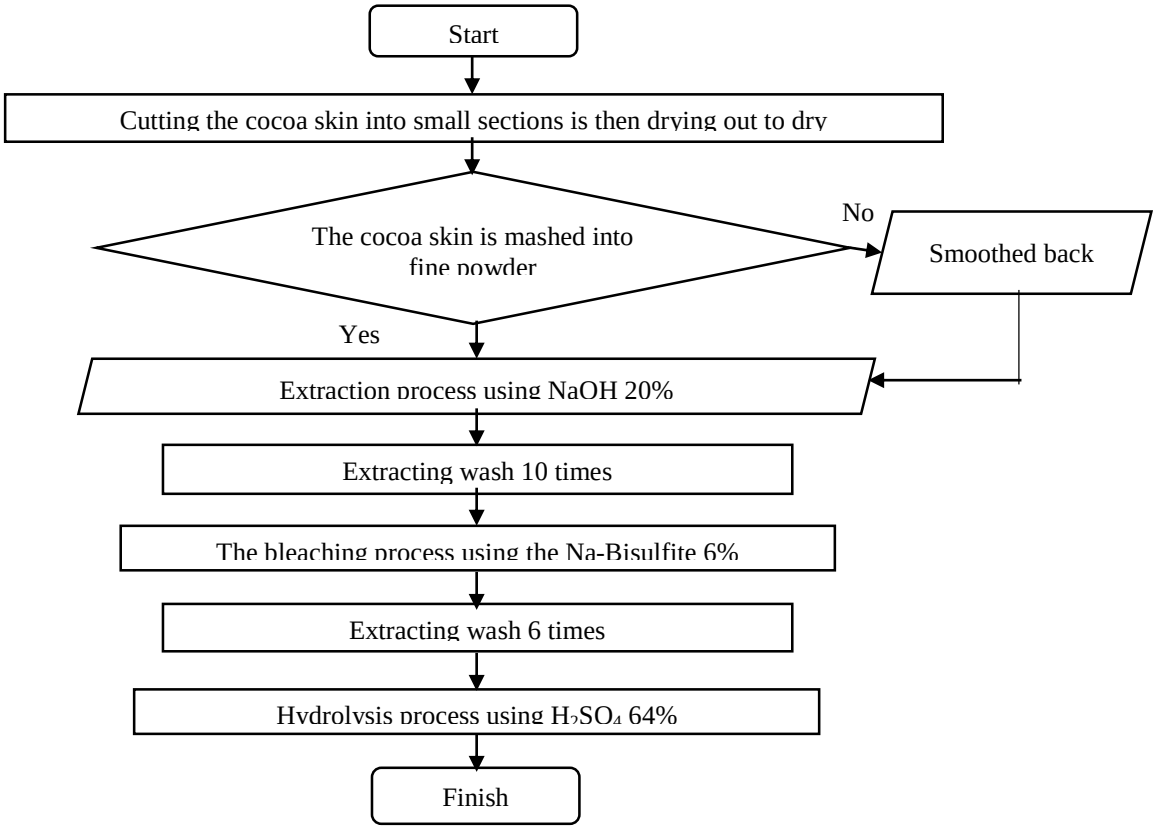

Figure 2. Flowchart Extraction Cacao Skin

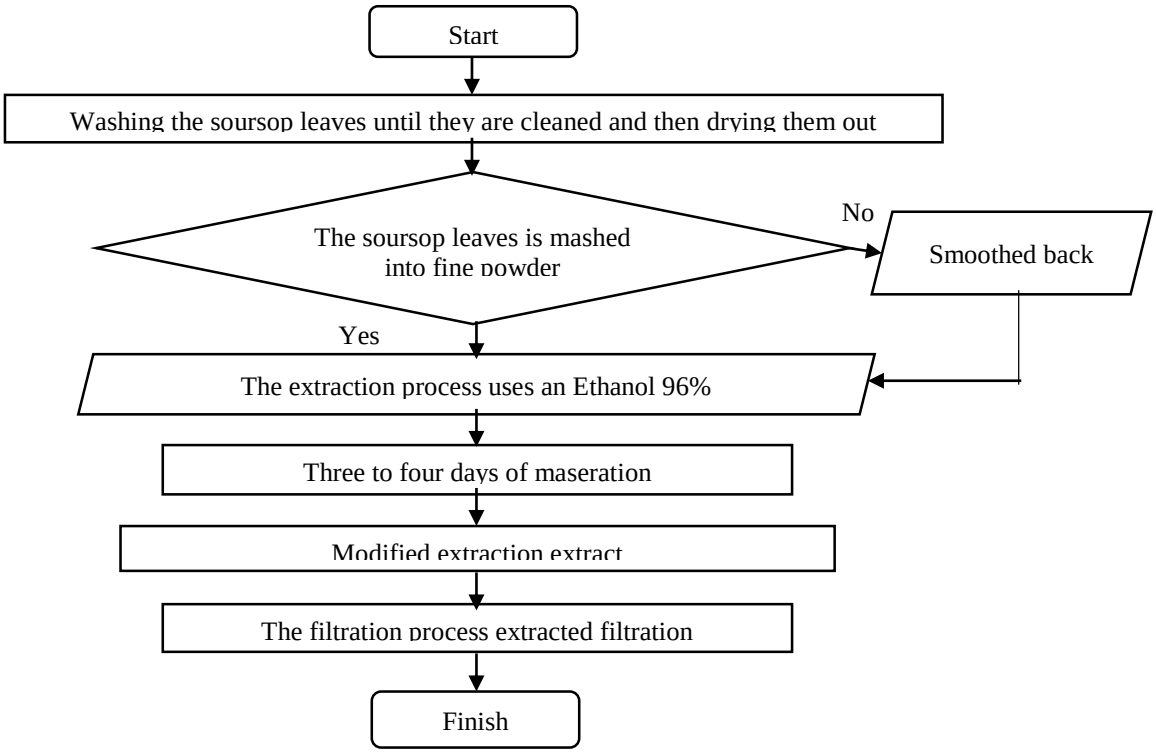

Figure 3. Flowchart Extraction Soursop Leaves

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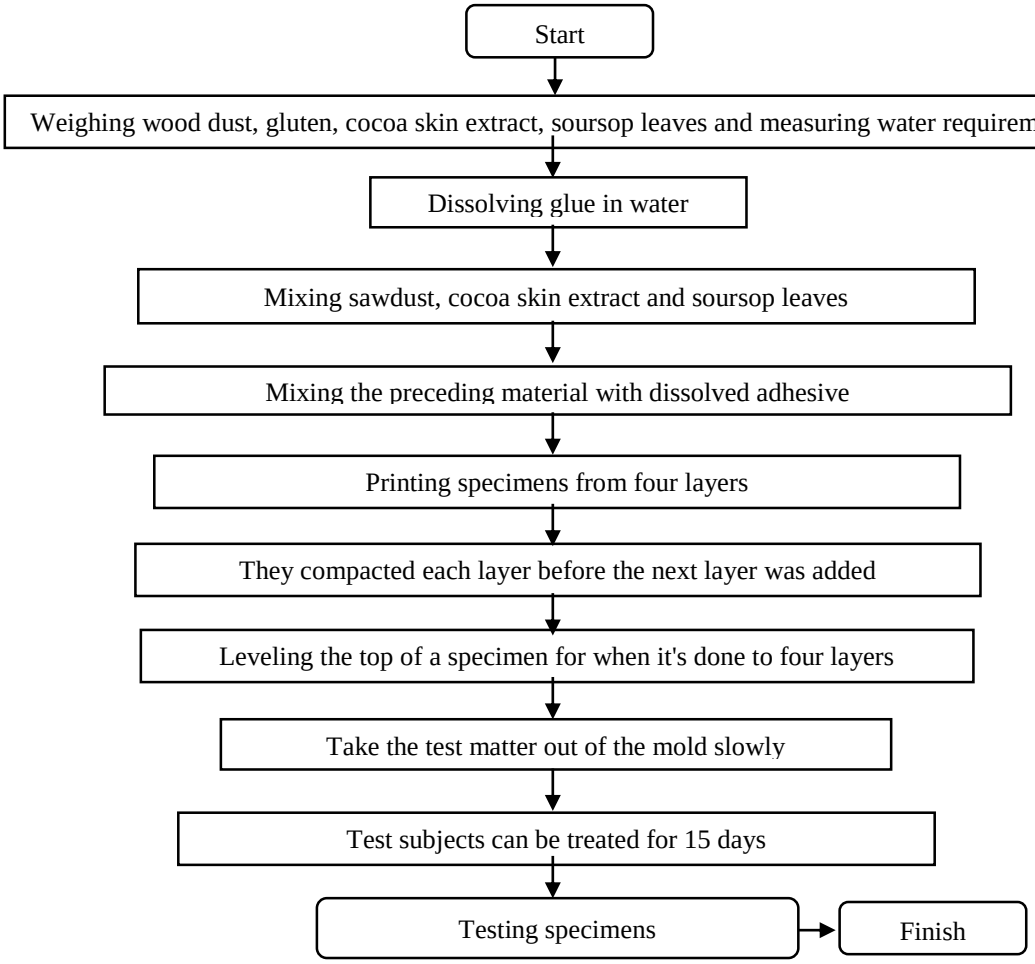

Figure 4. Flowchart Making Specimens

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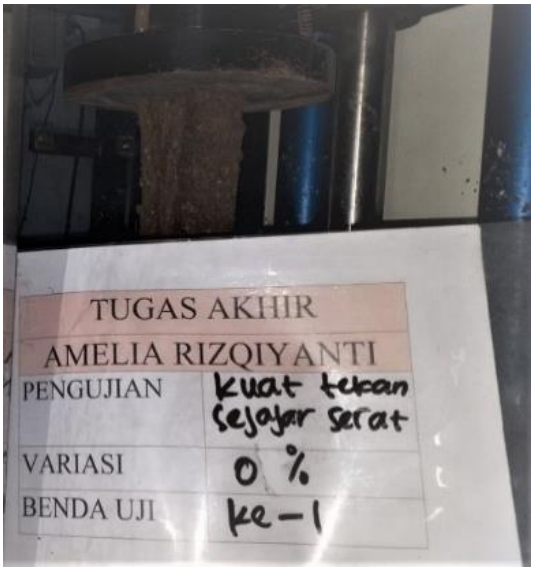

Figure 5. Specimens Condition of Compression Failure Parallel

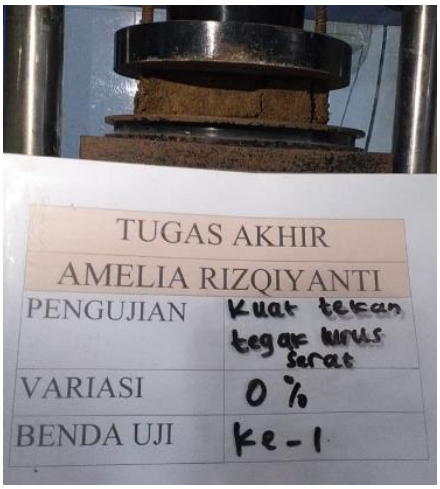

Figure 6. Specimens Condition of Compression Failure Perpendicular

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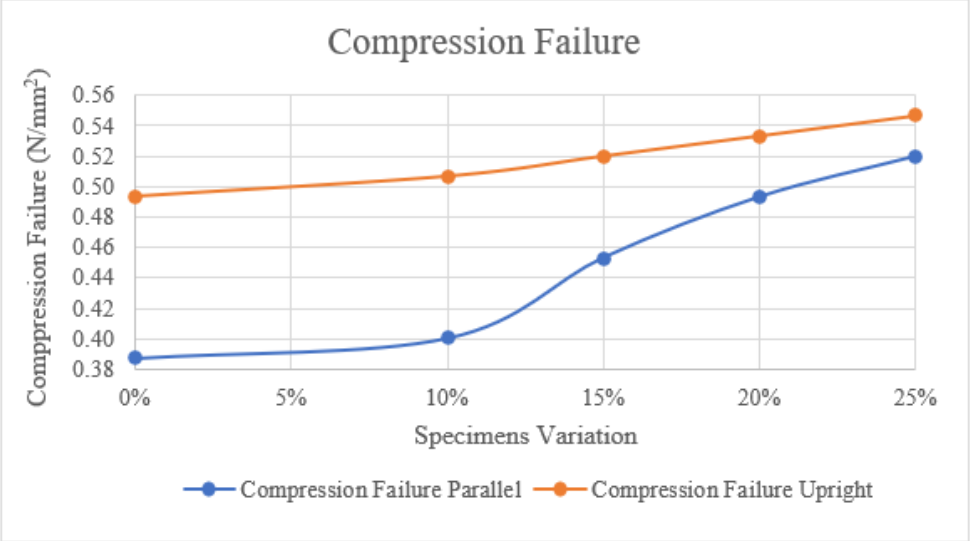

Figure 7. The Result of Compression Failure

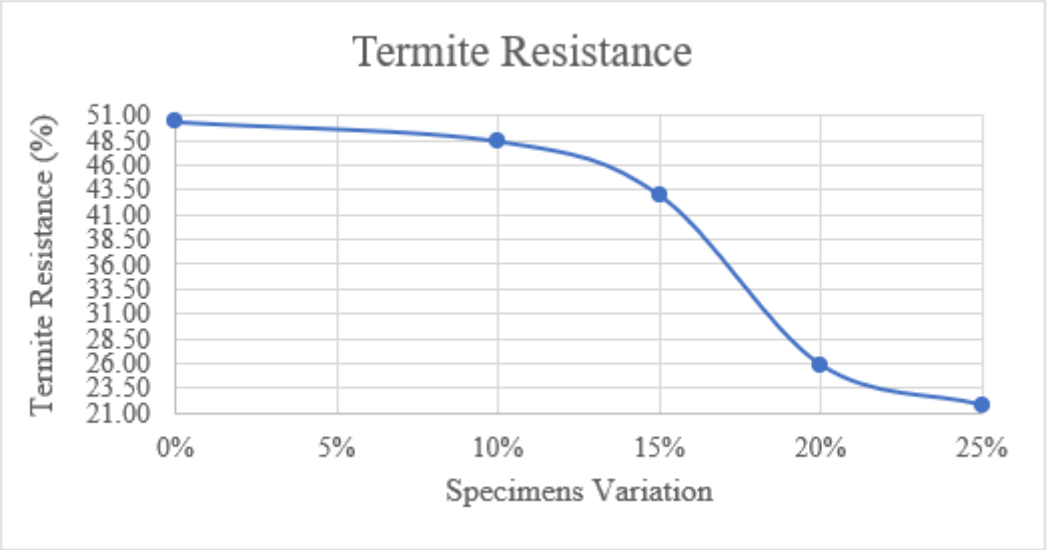

Figure 8. The Result of Termite Resistance

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Figure 9. Specimens Condition of Termite Resistance

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