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Characteristics of Chicken Feather Panels as an Alternative Insulation Material

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Abstract Consumption of chicken and poultry is a major factor in the world's diet. But the growing popularity of eating chicken has significant negative implications for the environment, especially when it comes to waste management. And one of the most important chicken wastes is its feathers. The purpose of this study is to determine the composition of chicken feathers, density, sound absorption, heat resistance, water absorption, ambient durability, and assessment as fiber panels and classification before using them as a substitute for alternative panel materials in the community. As a result, the best composition for alternative panel materials made from chicken feathers: PVAc glue and white cement is a ratio of 70:20:10 in the manufacture of wall application panels and a ratio of 70:30 in the manufacture of finely chopped chicken feathers, and PVAc glue, and water in the manufacture of acoustic application panels. Density 0.38-0.4, the material is categorized as soft fiber board (RF) with low density and stiffness that can withstand loads up to 38.2 kg/cm^2, and absorption value $\bar{\alpha}$ 0.49-0.52, can withstand heat up to 10 ℃. This study also confirms the potential of chicken feathers with adequate adhesive composition as an alternative and advanced material in the field of architecture that has met the criteria as a green panel material, sustainable, and environmentally friendly.

Keywords Chicken Feathers, Characteristic, Insulation Panels, Alternative Materials

1. Introduction

There are billions of chicken feather waste generated by chicken businesses or the chicken slaughtering industry around the world due to the increasing consumption of chicken meat and the appetite for chicken meat in many communities. Chicken or poultry consumption is an important aspect of global food habits. Overtaking pigs and cows, chicken has surpassed pork as the most popular meat worldwide, about 74 billion chickens being raised and consumed by mankind every year; By 2032, that figure is expected to increase to nearly 85 billion [1,2]. To illustrate, every year in the United States, people consume 8 billion chickens. In special events like the Super Bowl, nearly 100 million Americans watched and ate about 1.4 billion chicken wings and drumsticks taken from 700 million chickens, which is a mind-boggling number, a bigger picture of chicken consumption in America. Despite this, the U.S. is the world's largest poultry eater, consuming far more than any other country — about 15,000 metric tons per year. The second largest consumer of chicken is China, consuming about 12,000 metric tons per year while in Europe, chicken consumption is comparable to the combined of China and the US. About 11,000 metric tons of chicken are consumed annually in Europe. This shows that among the wide variety of foods consumed daily throughout Europe, chicken is the most popular food [1].

Over the past ten years, the demand for poultry has increased significantly worldwide, with developing and developing countries driving this expansion. It is expected that poultry meat will continue to be the most popular livestock product consumed worldwide, especially in developing and developing countries where production opportunities are scarce. Statistics show that Brazil will continue to be the world's leading poultry exporter and could take over a percentage of chicken exports from the United States, the world's largest chicken consumer country [2,3]. In addition, KFC – the most well-known chicken-eating brand – continues to expand its business and has more than 24,000 locations in more than 145 countries and regions around the world. These facts highlight the important role that chickens and poultry play in global food consumption patterns.

The current production of broilers in South Sulawesi reaches 2 million chickens per year and increases every year in line with the needs of the community. The waste of chicken feathers produced is 150 tons per year. The results of this poultry slaughter produce an average feather weight of 4 - 9 % of live weight [4]. The weight of chicken feathers, the average weight of chicken slaughter is 1.32 kg, and each slaughtered poultry is obtained feathers as much as 6% of the live weight, with an average slaughter life of 35 days, so that the availability and continuity of raw materials are quite maintained. From 2 million heads per year, with a slaughter weight of 1.32 kg so that the slaughter weight is 264,000 tons, the weight of meat consumed is equivalent to 75% of the slaughter weight, 198,000-tons of chicken meat is consumed every year, and the feather waste produced reaches 15,840-tons per year. Fleece panels for sizing research diameter 10 cm with 3 thicknesses (0.9; 1.6; and 2.5 cm) and square panel size (20x20); (22x30); (24x32) and (33x60) with a thickness of 0.9 cm, the manufacturing process is needed per panel between 10 – 40 large cocks and the required panel thickness.

However, there are substantial environmental effects of the increasing demand for chicken feed, especially when it comes to waste management. A common problem along with mismanagement of chicken waste is emissions from intensive chicken farms that impact air, water, and soil and other environmental components. Human and animal health can be affected by waste products from chicken farms, such as manure, feathers, dead chickens, and manure [2],[5-6]. Improper handling of waste by the chicken industry can lead to excessive concentrations of nutrients in water sources, which can result in the bloom of toxic algae that threatens human health and aquatic life. Rich in minerals such as phosphorus and nitrogen, chicken manure can pollute waterways and lakes, bringing potentially harmful elements to water bodies. Algae blooms caused by pollution can cause oxygen levels in water bodies to drop and result in fish deaths and other ecological imbalances [7-9].

The manufacture of chicken feed also adds to the environmental difficulties, as the poultry business uses many of the world's feed crops. Additionally, the disposal of chicken manure on farmland can result in soil contamination and further environmental damage [10-12]. In addition to affecting the world's water supply, this inefficiency in feed production diverts land that can be used more effectively to grow food directly for human consumption. These reports underscore the negative environmental impact of the increased demand for chicken products, highlighting the need for sustainable practices and waste management techniques in the poultry sector to minimize their impact [10],[13,14].

Feathers as an important waste of the chicken industry are the most widely used waste in the form of household products, to date. The availability and sustainability of chicken feather raw materials for panel products is a promising action. The impact of increasing waste is very large and can cause environmental pollution if it is not immediately processed into products that can be used by the wider community [15]. Disposal management, processing technologies and methods are urged to reduce environmental threats [12],[15-17]. In the view of researchers, the use of feathers as an alternative to panel materials is part of the action in protecting the environment. Chicken feather panel products are an innovation of chicken waste products that have been abandoned in many communities and discarded by the poultry industry and consumption.

The use of advanced materials with building innovations is in great demand due to the increasing population with housing or residential needs while maintaining environmental, social, economic, and sustainability aspects. Therefore, this research is needed in terms of the development of alternative materials to support human life, such as research on the processing of chicken feather waste into panel materials – sustainable and advanced alternative materials, as a readiness and continuity of raw material supply. Research on chicken feather panel product innovation has been carried out before [18-20], processing chicken feather waste into wall panel materials. There are still many people who are not aware of the economic value of this material, by utilizing local wisdom and the people's economy, then research will be carried out to identify the characteristics of chicken feather panels that have been formed to become alternative materials.

There are many studies related to the identification of the characteristics of chicken feather waste with its advantages, including the keratin levels contained and its effect on chicken feathers. Keratin is a fibrous protein consisting of long-chain peptides with longitudinally arranged fibers that can provide a structural role that can provide mechanical strength characteristics, as well as low solubility in water [6],[21-22]. The use of chicken feather waste in the context of the manufacturing process into panels or composite materials has also been carried out in several other studies, ranging from panels to composites [19-24], its physical and chemical properties [21],[25], modification of the mechanical characteristics of chicken feather fiber material can reduce stiffness and improve the durability of the material [23], lightweight panel structural application made from waste chicken feathers and cartons [26], the use of chicken feather material as a composite material [23],[27-28], and the advantages, privileges and other characteristics contained in chicken feathers that attract a lot of research [9],[29-30].

The resistance of previous research is that with frequent continuous research, the advantages of feather panel research are increasingly discovered, including that this feather panel can withstand heat up to 10 °C and can absorb sound $\bar{\alpha}$ 0.49-0.52. There is a lot of research related to chicken feathers, like this research is the research conducted by Acda from Philippine University by processing chicken feather waste into building materials. Acda processes chicken feather waste with large dimensions because it is intended for residential wall building materials while this research is related to indoor wall materials and as sound damping materials.

The advantage of this research from the research of chicken feathers to be used as panels is that enumeration is carried out on chicken feathers that have been washed and given 2x24 formalin to remove germ larvae on feathers originating from the chicken industry rash, and the resulting panel results are thin to 0.9 cm thick.

Therefore, chicken feather waste that has been finely chopped and shaped into feather panels has wide possibilities as an alternative material in the field of architecture. Several identification of the characteristics of chicken feather panels as an alternative material is needed in supporting the empowerment of renewable, economical, and environmentally friendly materials. This study seeks methods and compositions to make better chicken feather panels through their density as well as knowing the ability of the material to withstand environmental loads, indoors and outdoors.

2. Significance/ Research Problem

In the previous study, the author researched the use of chicken feather waste that is often left in our environment into environmentally friendly panel products and used as an alternative building material in the field of architecture. In this study, chicken feather panels will be identified based on their characteristics as alternative panel materials, composition, sound absorption, durability and durability to the environment. What is more important is the application of alternative materials in the field of architecture to make the design of the space according to the needs.

3. Research Methods

This study will identify the characteristics of chicken feather panels as a continuation of preliminary research on the potential of chicken feather waste as a raw material for panels. The process of making panels begins by collecting chicken feather waste from the industry or from slaughtered chicken business actors. The chicken feather waste that has been collected is cleaned and rinsed several times until the washing water looks clear and clean so that blood stains and other dirt are no longer visible. Next, it is soaked with formalin liquid for 2x24 hours to remove germ larvae so that there is no longer any doubt about the presence of germs on the fur before proceeding to the panel manufacturing process. Before the panels are made, the dried feathers are finely chopped with a feather chopper to facilitate the panel binding process. The composition of the material (70:20:10) feather: PVAc: white cement + water in the manufacture of wall panels and the composition (70:30) feather: PVAc + water) in the manufacture of acoustic panels were carried out. Next, it is stirred from three material elements and put in a mold, compacted and pressed on a two-ton pressure hydrolid press for 60 minutes and then put in a listic oven for 60 minutes at a temperature of 100 degrees and then dried in the sun until dry and stiff and ready to be applied to the grid or design media as an alternative material.

This study continues the previous research on the processing of chicken feathers into panels, then identifies its characteristics by conducting experiments on various panel compositions and their durability, followed by testing the density and compressive strength of the material. Twenty-four panels with a diameter of 10 cm and thickness of 0.9 cm, 1.6 cm and 2.5 cm have been produced for research purposes. One sample with a thickness of 2 cm is prepared for the load test. Rectangular samples with a thickness of 0.9 cm vary in size, namely (20x20); (22x30); (24x32) and (33x60).

The applicable chicken feather panels have undergone an experimental stage to accommodate the understanding of the basic characteristics of the resulting panels, namely soft, flexible, elastic, and lightweight so that they can be optimized into strong and sturdy panel products as well as lightweight and fibrous. This research also applies composite patterns to building structures to obtain feasible and accountable panel construction. Ultimately, the resulting panels should have strength and solidity and will be able to build a functional product with aesthetic value.

Experiments are carried out in the laboratory followed by analyzing and calculating the density of the panels, analysis of the resistance of the panels to ambient conditions (compressive strength, sound absorption, resistance of the material to ambient heat, etc.). The results of laboratory tests are then used as a reference before the development of alternative panel materials in the field of architecture.

The experimental process includes several stages: preparation, production plan, collection of raw materials, collection of supporting materials/equipment, specimen manufacturing process (washing, rinsing, soaking in formalin liquid, fine cutting and mixing other materials based on the mold).

The binding material is white cement and PVAc adhesive. The composite chicken feather particle board was then bonded together, tested to withstand forces in the compressive and transverse directions suggested in previous studies [23],[31].

4. Results and Discussion

4.1. Panel Formation and Composition and Density

The nature of chicken feathers is light, smooth, and slippery due to the presence of keratin in the feathers, therefore, care is needed to make it easier for the feathers to stick to each other in the layers as designed. This process requires adhesives and other substances in the panel forming process.

Figure 1 is a sample of chicken feathers with 3 thicknesses (0.9. 1.6. 2.5 m) with each thickness made 8 samples which will be the test material to determine the density of chicken feather panels.

Figure 1. 10 cm circular test sample with 3 thicknesses (0.9; 1.6; 2.5 cm) a total of 24 pieces

4.2. Identify Panel Tests for Density

Figure 2 shows the wavy shape following the density and thickness of eight different panels. The sample panels are made in the same dimensions and to ascertain the physical characteristics then each sample is measured for density and weight. The density of the samples of 0.9 cm is close to each other, in the range of 0.37-0.40 gr/c because the weight is almost the same in the range of 26 – 28 grams each.

Figure 3 shows the wavy shape following the density and thickness of eight different panels. The sample panels are made in the same dimensions and to ascertain the physical characteristics then each sample is measured for density and weight. The density of the samples was 0.9 cm close to each other, in the range of 0.38-0.40 gr/cm^3 because the weight was almost the same in the range of 46 – 49 grams each.

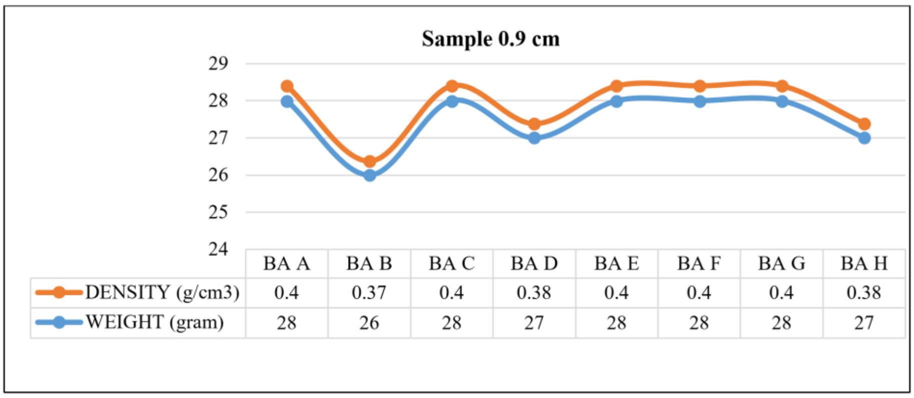

Figure 2. Specimen density 0.9 cm thick

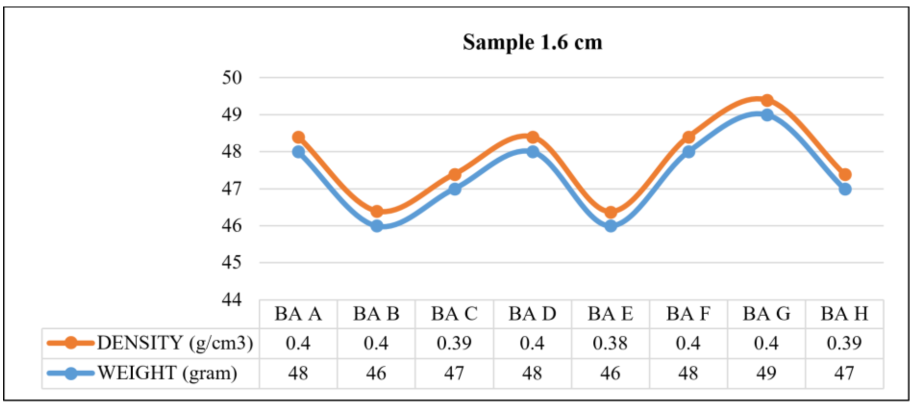

Figure 3. Specimen density 1.6 cm thick

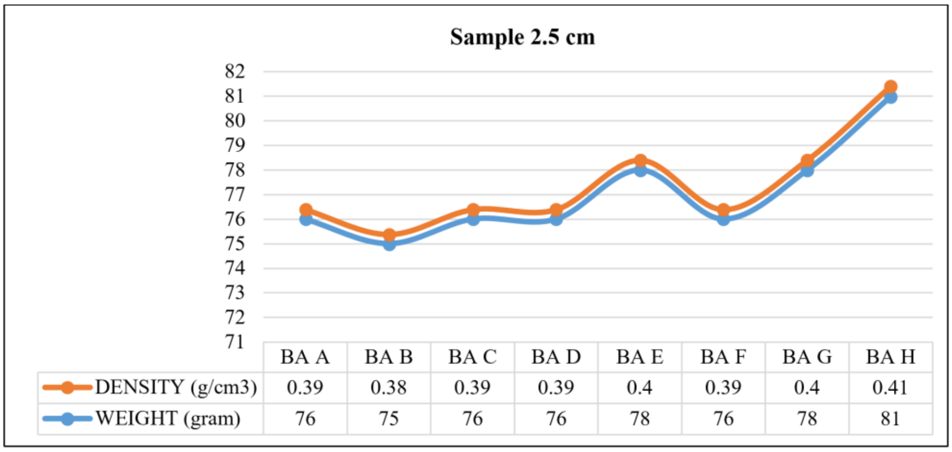

Figure 4. Specimen density 2.5 cm thick

Figure 4 shows the wavy shape following the density and thickness of eight different panels. The sample panels are made in the same dimensions and to ascertain the physical characteristics then each sample is measured for density and weight. The density of the samples of 2.5 cm was close to each other, in the range of 0.38-0.41 gr/cm^3 because the weight was almost the same in the range of 75-81 grams each.

Table 1 represents the average values generated from the three thicknesses of the 10 cm circle test sample. It shows that the panel density values for each thickness (0.9, 1.6, and 2.5 cm) are close to each other, the values are between 0.38 - 0.40, and it can be seen that the sample weight is consistent.

Table 1. Average density values for each panel thickness

Thickness, *t* (cm)	0.9	1.6	2.5
Average mass, *m* (gr)	27.2	47.4	77
Volume, *v* (cm^3)	70.65	125.6	196.25
Density, ρ (gr/cm^3)	0.38	0.38	0.39

The average table drawing of the three thicknesses of the 10 cm circle test sample shows that the panel density values for each thickness (0.9, 1.6, and 2.5 cm) are close together, the value is between 0.38-04, it can be seen that the sample weight is consistent, and these include rigid type, RF (rigid), 0.15-0.40 g/cm^3 soft fiber board, and according to ASTM 1974 is categorized as Low-density Particle Board in the standard designation 1554-67, classify. A low-density particle board is a particle board that has a density of less than 37 lb/ft ^{3}or a specific gravity of less than 0.59 g/cm^3.

4.3. Identification Testing the Compressive Strength of Chicken Feather Panels

In the compressive strength test of chicken feather panel materials, it was found that chicken feathers have high durability and resistance to degradation because they have significant cross-linking and strong bonding in their structure [13], to determine the ability of the chicken feather panel material to withstand the compressive weight of the material. Conducted at the Structural Laboratory of the Muslim University of Indonesia, the experiment was carried out by measuring the compressive strength of the material after the panel was formed.

The process of observing the resistance of materials to loads was carried out in the Structural Laboratory of the Muslim University of Indonesia.

The flow of the procedure is as follows: Preparation of chicken feather panel test sample materials; Placing the test sample on the base of the prepared panel; Adjusting the position of the test material on the CSCM machine.D. Observing the pressure generated by the CSCM tool. Results of the tested material.

Figure 5 shows the results of the 10 m diameter panel compressive test before the compressive load and after the compressive load and the results of the quill panel sample cracking.

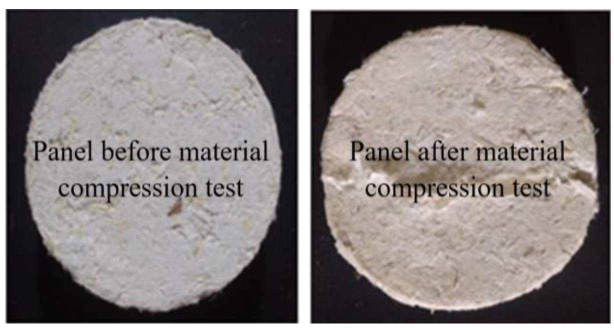

Figure 5. Panel before material compression test, Panel after compression test

In the compressive strength test, the panel is molded in the form of a cylinder, with a wall panel material composition ratio of 70:30:10 as a thermal wall material to retain heat from the outside to the room (referring to the SK SNI M-62-1990-03 Concrete Compressive/ Compressive Strength Test Standard). In this test, a diameter of 10 cm with a reference thickness of 2 cm is used.

E Testing material:

Weight: 112 g, width 10 cm, thickness 2.5 cm

Compressive strength: 30 kN (direct compressive strength): 30 kN x 100 kg = 3,000 kg

L = R ²(cross-sectional area) = 3.14 x 25 = 78.5 cm^2

$$Crushed\ \ Load = \frac{Press\ \ Firmly}{Cross\ \ sectional\ \ area} = \frac{38.2}{78.5}$$

The value for analyzing the compressive strength of the chicken feather panel material was 38.2 Kg/cm^2 and the result was a fracture. The material cannot withstand large loads because the material is categorized as a low-density particle board and is an RF rigid soft fiber board (right) with a specific gravity of 0.15-0.40 gm/cm^3, or in other words, chicken feather panels are materials with low-density values and can later be used as wall materials and sound-absorbing materials.

4.4. Identify the Panel's Ability to Diffuse Sound

Measurement of panel material against material absorption value or panel absorption is carried out in an unechoic room with an area of 40.5 m^2, with the aim of ensuring that when taking measurements there is no outside noise that can affect the measurement results

Figure 6 is a tool used in the process of measuring the sound absorption value of the chicken feather panel which is the research material. Explaining each image code starting from: (A) impedance tube type 4206, (B) type 3560-B-130, (C) power amplifier type 2716 C and (D) FFT analyzer, (E) computer sound recording.

Figure 6. B&K impedance Tu be type 4206

Figure 7 shows the testing process, seen from the method (A) impedance tube type 4206, with acoustic material testing, by placing a 10 cm diameter chicken feather sample material, then processed on a tube (B) type 3560-B-130 which is given sound from a predetermined frequency ranging from 100-1600 Hz, then (C) power amplifier type 2716 C and (D) FFT analyzer carried out with pulse lab shop software that can measure the sound waves generated between the specimen and the speaker, (E) the computer records the sound, source and impedance tube process and displays the measurement data.

The results of the measurement of the absorption coefficient of chicken feather panel material by the impedance tube method with two microphones with the selection of tubes with a diameter of 10 cm, presented in the form of a curve, data at a frequency of 100 Hz - 1,600 Hz, in accordance with the limitations of this study.

a. Sample Panel Thickness 0.9 cm

In the measurement of the BA.0.9 cm sample as shown in Figure 8, at each frequency there is a fairly rhythmic wave game, with wave toys going up and down, starting from a frequency of 100 Hz to a maximum frequency of 1600 Hz. It can be seen that at a frequency of 100-1050 Hz there is an increase from the value of the coefficient α 0.03 increasing to - α 0.46, then decreasing from a frequency of 110-1400 Hz to α 0.43- α 0.41 and then rising continuously to α 0.52 at the maximum frequency 1600 Hz

Figure 9, shows the average value of the absorption coefficient of 8 samples 0.9 cm thick. In the frequency of 100 Hz to 700 Hz, it can be seen that the absorption value increases gradually from a α value of 0.03 to α 0.23 and experiences an acceleration of sound waves at the frequency of 700 Hz to 1050 Hz reaching α 0.46 and decreasing again α 0.44-α 0.41 at the frequency of 1250-1400 Hz, then increasing again to a maximum frequency of 1600 Hz from a α value of 0.41 to α 0.52

In the measurement of the BA sample of 0.9 cm as seen in Figure 9, it shows the average value of the absorption coefficient of 8 samples. At the frequency of 100 Hz to 700 Hz, the absorption value increases gradually with a α value of 0.03 to α 0.23 and experiences sound wave acceleration at the frequency of 700 Hz to 1050 Hz with a α of 0.23 to α 0.44 and again decreases α 0.43-α 0.41 at the frequency of 1250-1400 Hz, then continues to increase until the maximum frequency of 1600 Hz from a α value of 0.41 to α 0.52

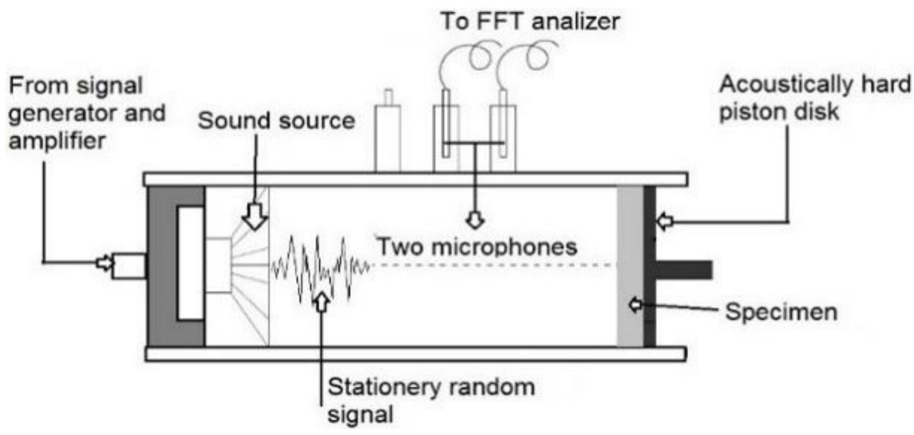

Figure 7. Tube Impedance Measurement Method

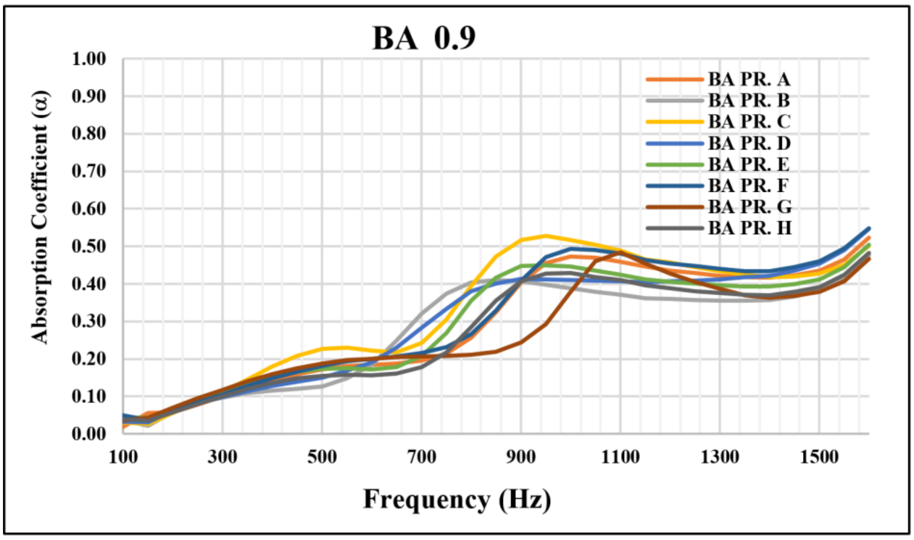

Figure 8. BA Absorption Coef Curve 0.9 (A, B, C, D, E, F, G, H)

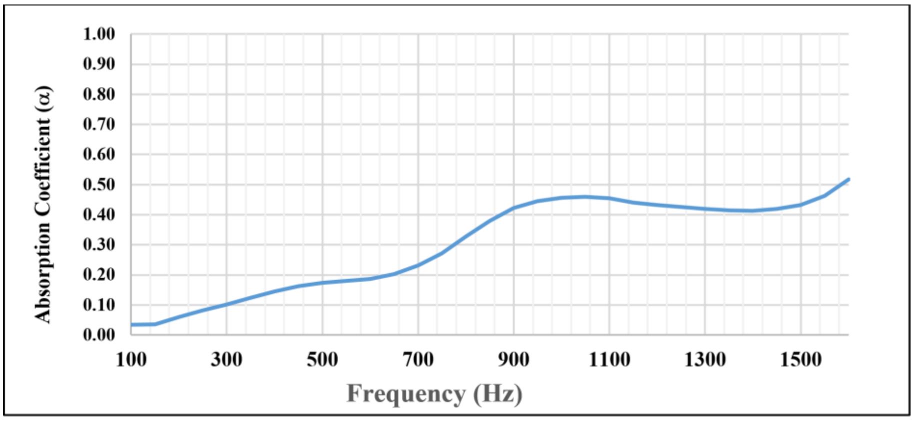

Figure 9. The average curve of the BA Absorption Coefficient is 0.9

Table 2. Average absorption coefficient of BA sample 1,6 cm

Freak (Hz)	Absorption coefficient	Strange (Hz)	Absorption coefficient
100	0,03	900	0,42
150	0,04	950	0,44
200	0,06	1000	0,46
250	0,08	1050	0,46
300	0,10	1100	0,45
350	0,12	1150	0,44
400	0,14	1200	0,43
450	0,16	1250	0,43
500	0,17	1300	0,42
550	0,18	1350	0,41
600	0,19	1400	0,41
650	0,20	1450	0,42
700	0,23	1500	0,43
750	0,27	1550	0,46
800	0,33	1600	0,52
850	0,38		

b. Sample Panel Thickness 1.6 cm

The BA.1.6 cm sample measurement contained in Figure 10, shows that for a frequency of 100 Hz to a frequency of 1600 Hz, the coefficient value is α 0.06-α 0.52, which shows that the value of the BA sample coefficient is 0.52. Table 2 shows that the average absorption coefficient of the BA 1.6 cm sample increases with frequency.

Figure 11 for BA sample measurements. 1.6 cm clearly shows the average absorption coefficient values of 8 samples from 100 Hz ferevency to a maximum frequency of 1600 Hz.

From Table 3, it can be seen that starting from a frequency of 100 Hz to a maximum frequency of 1600 Hz, there is a balanced rhythm of sound wave movement for the BA 1.6 sample test, from α 00.6 to a maximum frequency of α 0.52.

In the measurement of the BA.1.6 cm sample as seen in Figure 11, it shows the average absorption coefficient value of 8 samples. From Table 3, it can be seen that starting from a frequency of 100 Hz to a maximum frequency of 1600 Hz, there is a balanced rhythm of sound wave movement for the BA 1.6 sample test, from α 00.6 to a maximum frequency of α 0.52.

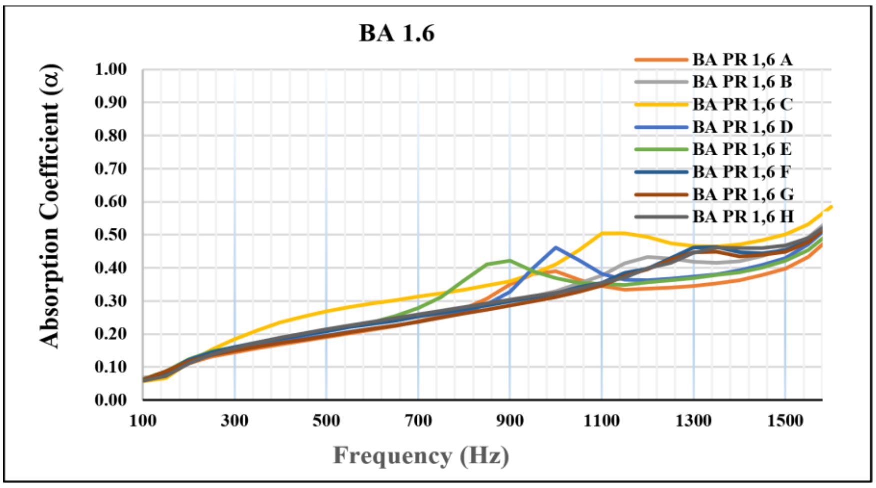

Figure 10. BA 1.6 Absorption Coefficient Curve (A, B, C, D, E, F, G, H)

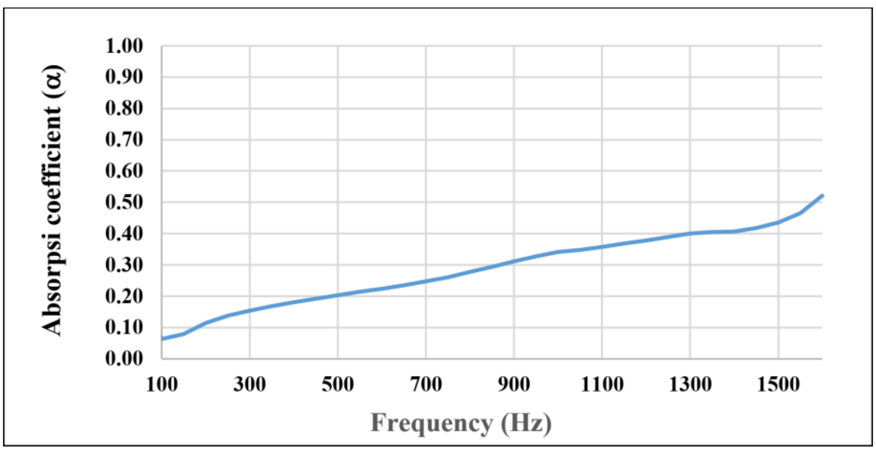

Figure 11. Average curve of BA absorption coefficient 1.6

Table 3. BA Absorption Coefficient 1.6 cm

Strange (Hz)	Absorption coefficient	Strange (Hz)	Absorption coefficient
100	0,06	**900**	0,31
150	0,08	**950**	0,33
200	0,11	**1000**	0,34
250	0,14	**1050**	0,35
300	0,15	**1100**	0,36
350	0,17	**1150**	0,37
400	0,18	**1200**	0,38
450	0,19	**1250**	0,39
500	0,20	**1300**	0,40
550	0,21	**1350**	0,40
600	0,22	**1400**	0,41
650	0,23	**1450**	0,42
700	0,25	**1500**	0,44
750	0,26	**1550**	0,47
800	0,28	**1600**	0,52
850	0,29		

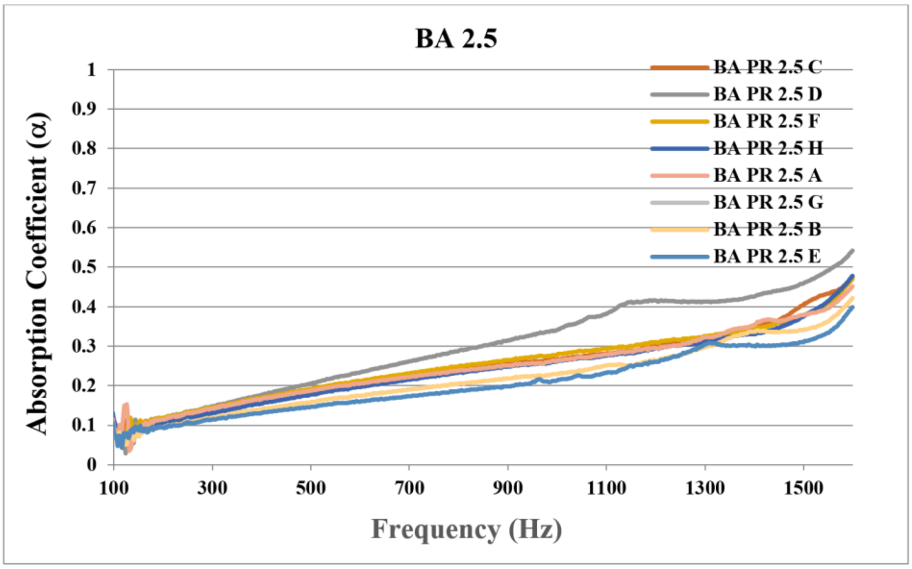

Figure 12. BA 2.5 Absorption Coefficient Curve (A, B, C, D, E, F, G, H)

c. Sample Panel Thickness 2.5 cm

In the measurement of the BA.2.5 cm sample as shown in Figure 12, at a frequency of 100 Hz to a maximum frequency of 1600 Hz, the coefficient value obtained is α 0.09- α 0.49, which indicates that the coefficient value of the sample has experienced an increase in frequency that increases in harmony.

Results: The absorption coefficient measurement for the existing 2.5 cm thick sample was flattened in the shape in Figure 13, and the change in absorption value from the presence of 100 to 1600 Hz was clearly visible.

In the measurement of the BA.2.5 cm sample as shown in Figure 13, at a frequency of 100 Hz to a maximum frequency of 1600 Hz, the coefficient value obtained is α 0.09- α 0.49, which indicates that the coefficient value of the sample has experienced an increase in frequency that increases in harmony.

The measurement value of a 2.5 cm thick sample is shown in table 4, which illustrates the change in the value of the absorption coefficient with the increase in frequency carried out.

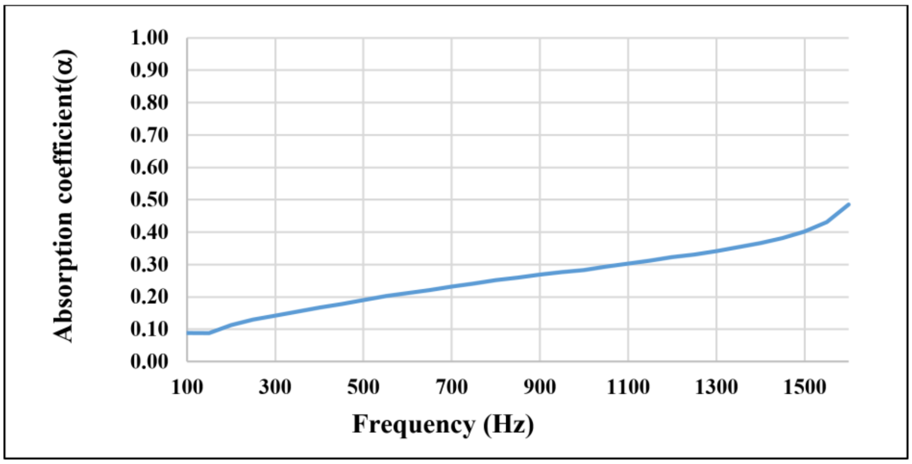

Figure 13. Average curve of BA absorption coefficient 2.5

Table 4. BA Absorption Coefficient 2.5 cm

Strange (Hz)	Absorption coefficient	Strange (Hz)	Absorption coefficient
100	0,09	**900**	0,27
150	0,09	**950**	0,28
200	0,11	**1000**	0,28
250	0,13	**1050**	0,29
300	0,14	**1100**	0,30
350	0,15	**1150**	0,31
400	0,17	**1200**	0,32
450	0,18	**1250**	0,33
500	0,19	**1300**	0,34
550	0,20	**1350**	0,35
600	0,21	**1400**	0,37
650	0,22	**1450**	0,38
700	0,23	**1500**	0,40
750	0,24	**1550**	0,43
800	0,25	**1600**	0,49
850	0,26		

The three measurement treatments with different thicknesses are combined into a single image model and shown in figure 14.

In Figure 14 of the panel combined curve (BA), it can be seen that the α absorption value for each thickness at the peak frequency of 1600 Hz reaches 0.49 - 0.52, and for the thickness of BAPR 1.6 cm at the frequency of 650 Hz to 1000 Hz, there is a slightly different sound pressure from the BAPR samples of 0.5 cm and 2.5 cm, namely the absorption value of α 0.25 to α 0.46

The stages of the thermal testing process of chicken feather panel material can be seen in Table 5, that the panel material can lower the temperature by 10 ℃, with a conductivity value of 0.7317 (watt/m℃) so that the chicken feather panel material can be classified as a good material and can be used in tropical areas such as Indonesia, referring to the Indonesian Lifecycle Assessment (LCA) standard, so that the chicken feather panel material meets the criteria as a green and sustainable material [32].

Table 5 shows the results of the thermal testing process made from chicken feathers that are formed into panel materials, which can be seen that the chicken feather panel material can reduce the temperature by 10℃, with a conductivity value of 0.7317 (watts/m℃).

As a comparative material from the research on thermal materials, it is with saffron leaf stalk laminated board material at a variable that lasts five hours of felt/pressing with a low density so that the thermal condicativity is small, namely 0.74 watts/m ℃, in table 6 [33].

As a comparative material, it is seen in Table 6 that the value of thermal conductivity, is affected by the thickness of the material where the thicker the material, the greater the value of thermal conductivity.

4.5. Identify the Thermal Resistance of the Panel to room Conditions

According to Kock [34], chicken feathers have unique characteristics including relatively low density and good thermal and acoustic insulation properties.

Evidence of this statement is by processing chicken feather waste into panel materials. Chicken feathers contain fibers that have good physical and mechanical properties, are quite durable, and can be used for material engineering purposes. Soft feathers and acoustic feathers are made of keratin with a protein content of 85-90%, so they are difficult to dissolve in water, making chicken feathers quite durable [35-38]. Feathers are very good for use in panel components, flooring or building materials as an alternative to composites thereby contributing to an increase in the waste value of chicken feathers as a renewable material.

Identification of the ability of chicken feather panel materials to withstand heat was carried out in a science and technology laboratory using a thermal test box and the results are shown in table 5.

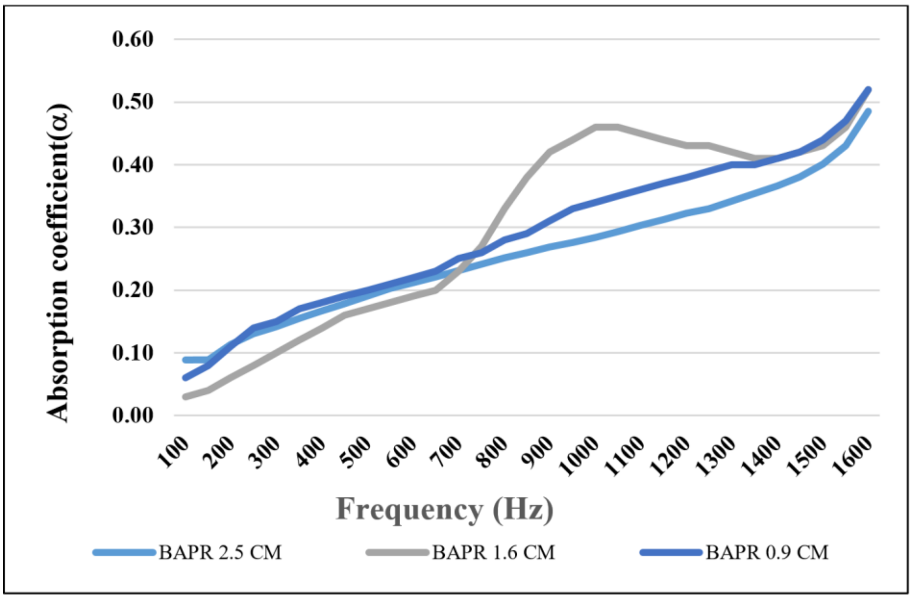

Figure 14. BA Composite Curve (0.9. 1,6. 2,5)

Table 5. Thermal measurement of chicken feather panels

Material	Initial Size (m)			Air Temperature (℃)					Temp Drop
	Long	Wide	Thick	T1	T2	T3	T4	(watt /m ℃)	Rooms (℃)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Panel	0,190	0,180	0,090	52,000	42,000	32,000	30,000	0,732	10,000

Table 6. Thermal Conductivity Testing of Saffron Leaf Stalk Laminated Board

Sample	KK (kg/cm^2)	LTK (Hours)	Thermal Conductivity (W/m ℃)
MUL A 2 cm	400 kg/cm^2	12 Hours	0,42
MUL B 2 cm	400 kg/cm^2	5 Hours	0,38
MUL A 2 cm	400 kg/cm^2	12 Hours	0,83
MUL B 2 cm	400 kg/cm^2	5 Hours	0,74
MUL A 2 cm	400 kg/cm^2	12 Hours	0,96
MUL B 2 cm	400 kg/cm^2	5 Hours	0,92

5. Conclusions

Based on the results of the research on Waste Management and Product Recycling: Chicken Feather Panels as an Alternative Green Material, it was concluded that the composition of making chicken feather panels for use on building walls as a thermal material with a ratio of 70% chicken feather waste material, 20% for white cement, and 10% PVAc and sufficient water (100-120%) and for the use of acoustic materials a ratio of 70% chicken feathers and 30% PVAc is used. The density of chicken feather panels was found to be 0.38-0.4, which means that the panels meet the standards of SNI 03-2105-1996 and JIS A 5908-2003 as particle boards, with the classification of rigid type soft fiber board, RF (rigid), with a load bearing capacity of 38.2 kg/cm^2, is a wall material, a low-density material that can absorb sound ᾱ 0.49-0.52 and the ability to withstand heat in ambient conditions is 10 ºC which can be used as a tropical material according to the conditions in Indonesia, so that it can be recommended as a renewable, sophisticated and environmentally friendly alternative material

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