



Physical, Mechanical, and Acoustic Properties of Particleboard from Durian Peel and Sengon Sawdust

(Sifat Fisik, Mekanik, dan Akustik Papan Partikel dari Kulit Durian dan Serbuk Gergaji Kayu Sengon)

Dina Setyawati^{1*}, Nurhaida¹, Leanindra Sekar Arum¹, & Luhut Pardamean Manik¹

¹Department of Forestry, Faculty of Forestry, Tanjungpura University, Jl. Prof. Dr. H. Hadari Nawawi, Bansir Laut, Kota Pontianak, Kalimantan Barat 78124, Indonesia

Article Information:

Submitted : 18 February 2026
Revised : 01 September 2026
Accepted : 14 September 2026
Published : 03 Oktober 2026

*Corresponding Author:

Dina Setyawati
Department of Forestry, Faculty of
Forestry, Tanjungpura University,
Jl. Prof. Dr. H. Hadari Nawawi, Bansir
Laut, Kota Pontianak, Kalimantan Barat
78124, Indonesia
e-mail: dina@fahutan.untan.ac.id
Telp: +62 813-1036-9457

Makila 20 (2) 2026: 345-357

DOI:
<https://doi.org/10.30598/makila.v20i2.24812>



This article is an open access article distributed under the terms and conditions of the
Creative Commons Attribution-ShareAlike 4.0 International License

Copyright © 2026 Author(s): Dina Setyawati, Nurhaida, Leanindra Sekar Arum, & Luhut Pardamean Manik

Journal homepage:

<https://ojs3.unpatti.ac.id/index.php/makila>

Journal e-mail: makilajournal@gmail.com

Research Article · [Open Access](#)

ABSTRACT

The utilization of agricultural and wood-processing waste as raw materials for particleboard production represents a sustainable strategy to reduce environmental burdens and enhance resource efficiency. This study aims to evaluate the physical, mechanical, and acoustic performance of particleboard manufactured from durian peel waste and sengon (*Falcataria moluccana*) wood sawdust. The boards were fabricated with dimensions of 30 × 30 × 1 cm using 15% urea-formaldehyde adhesive, with varying composition ratios of durian peel to sengon particles (0:100, 25:75, 50:50, 75:25, and 100:0). The panels were manually formed and hot-pressed at 140 °C for 10 minutes under a pressure of 25 kg/cm². The evaluated properties included physical characteristics (density, moisture content, water absorption, and thickness swelling), mechanical properties (modulus of elasticity (MOE) and modulus of rupture (MOR)), and acoustic performance (sound absorption and reflection coefficients). The results indicated that the particleboard density ranged from 0.38 to 0.40 g/cm³, moisture content from 7.46% to 8.48%, water absorption from 160.06% to 187.24%, and thickness swelling from 17.73% to 20.36%. The MOE and MOR values varied between 114.87–317.33 MPa and 1.43–2.85 MPa, respectively. Increasing the proportion of sengon particles improved dimensional stability and mechanical strength; however, the resulting values did not meet the requirements of the JIS A 5908 (2003) standard. In contrast, higher durian peel content enhanced acoustic performance, with the highest sound absorption coefficient observed in the 100:0 composition. The measured normal-incidence sound absorption coefficients indicate promising acoustic performance, particularly for boards containing high proportions of durian peel at medium-to-high frequencies.

KEYWORDS: durian peel waste; particleboard; sengon (*Falcataria moluccana*); acoustic properties; mechanical properties; physical properties

INTISARI

Pemanfaatan limbah pertanian dan limbah pengolahan kayu sebagai bahan baku papan partikel merupakan salah satu pendekatan berkelanjutan dalam meningkatkan efisiensi sumber daya dan mengurangi tekanan terhadap penggunaan kayu solid.

Penelitian ini bertujuan untuk mengevaluasi sifat fisik, mekanik, dan akustik papan partikel yang dibuat dari limbah kulit durian dan serbuk kayu sengon (*Falcataria moluccana*). Papan partikel dibuat dengan ukuran $30 \times 30 \times 1$ cm menggunakan perekat urea-formaldehida sebesar 15%, dengan variasi komposisi partikel kulit durian dan sengon (0:100; 25:75; 50:50; 75:25; 100:0). Proses pembentukan dilakukan secara manual, diikuti dengan pengempaan panas pada suhu 140°C selama 10 menit dengan tekanan 25 kg/cm^2 . Pengujian meliputi sifat fisik (kerapatan, kadar air, penyerapan air, dan pengembangan tebal), sifat mekanik (modulus elastisitas/MOE dan modulus patah/MOR), serta sifat akustik (koefisien serapan). Papan partikel yang dihasilkan memiliki kerapatan $0,38\text{--}0,40\text{ g/cm}^3$, kadar air $7,46\text{--}8,48\%$, penyerapan air $160,06\text{--}187,24\%$, dan pengembangan tebal $17,73\text{--}20,36\%$. Nilai MOE dan MOR masing-masing papan berkisar $114,87\text{--}317,33\text{ MPa}$ dan $1,43\text{--}2,85\text{ MPa}$ dan belum memenuhi persyaratan minimum JIS A 5908 (2003). Proporsi serbuk gergaji sengon yang lebih tinggi cenderung meningkatkan sifat mekanik, sedangkan papan 100% kulit durian menghasilkan koefisien absorpsi suara tertinggi, sekitar 0,73 pada frekuensi 3.150 Hz. Hasil ini menunjukkan bahwa komposisi bahan memengaruhi sifat mekanik dan akustik secara berbeda serta menunjukkan potensi papan tersebut sebagai material nonstruktural untuk aplikasi penyerap suara.

KATA KUNCI: kulit durian, papan partikel, sengon, sifat fisik, sifat mekanik, sifat akustik

INTRODUCTION

The increasing demand for sustainable construction materials has accelerated research on lignocellulosic composite panels derived from agricultural and forestry residues. Engineered wood products, such as particleboard, provide an efficient approach for utilizing low-value biomass while reducing dependence on solid wood resources. These materials have been widely used to support the needs of the furniture, construction, and interior industries due to their versatility and cost-effectiveness (Okeke *et al.*, 2024).

Durian peel waste (*Durio* sp.) represents one of the most abundant agricultural residues in Indonesia. According to the Central Statistics Agency, durian production reached approximately 1.98 million tons in 2024 (BPS, 2025), with peel waste accounting for about 60% of the total fruit mass (Khaksar *et al.*, 2024). Improper management of this biomass can lead to environmental pollution due to its large volume and unpleasant odor. Chemically, durian peel contains high levels of cellulose (57–64%), hemicellulose (~30%), and lignin (~15.6%), indicating its strong potential as a raw material for particleboard production Gamay *et al.*, (2024).

In addition to its favorable chemical composition, durian peel exhibits a porous internal structure, which makes it potentially suitable for acoustic applications (Putra *et al.*, 2022). Noise

pollution has become an increasingly critical environmental and public health issue, particularly in urban and industrial areas (Jakubowski *et al.*, 2025). Prolonged exposure to high-intensity noise can lead to adverse health effects, including sleep disturbances, stress, reduced cognitive performance, and even permanent hearing loss (Tao *et al.*, 2021). Therefore, the development of environmentally friendly sound-absorbing materials is essential. Previous studies have explored natural fibers for acoustic applications, such as bamboo (Karlinasari, *et al.*, 2012b) and oil palm empty fruit bunches (Raman & Samsudin, 2022). Notably, durian peel fibers have demonstrated sound absorption coefficients exceeding 0.5 at frequencies above 1 kHz (Putra *et al.*, 2022), while particleboards derived from durian peel have shown moderate acoustic performance depending on binder type and panel configuration (Zahrah *et al.*, 2024).

Despite these advantages, particleboards derived from non-wood materials, particularly low-density biomass such as durian peel, often exhibit limited mechanical strength (Kariuki *et al.*, 2020). Previous studies have indicated that the composition of raw materials significantly influences particleboard quality (Putra *et al.*, 2022). For instance, the incorporation of wood-based materials, such as sawdust, has been shown to enhance mechanical properties (Olupot *et al.*, 2022). Similarly, Tang & Nguyen, (2025) reported that combining durian peel with bamboo particles improved board performance when bonded with urea-formaldehyde resin. However, studies integrating durian peel with fast-growing wood species, such as sengon (*Falcataria moluccana*), to simultaneously optimize mechanical and acoustic performance remain limited.

Therefore, this study aims to evaluate the physical, mechanical, and acoustic properties of particleboard manufactured from durian peel waste and sengon wood sawdust with varying composition ratios. This research also seeks to identify the optimal material composition to achieve balanced performance characteristics. The findings are expected to contribute to the development of sustainable bio-based materials, promote efficient utilization of biomass waste, reduce pressure on forest resources, and provide environmentally friendly alternatives for construction and acoustic applications.

RESEARCH METHODS

Materials and Equipment

The raw materials used in this study consisted of durian peel waste collected from local fruit vendors and sengon wood (*Falcataria moluccana*) sawdust obtained from a furniture industry in Pontianak, Indonesia. The adhesive employed was urea-formaldehyde (UF) resin with a solid content of 52%, supplemented with liquid paraffin (40% solid content) and ammonium chloride (NH₄Cl) as a catalyst (25% solid content), all sourced from PT. SAL, Sambas Regency, West Kalimantan.

The main equipment included a hot press machine (CHPM-100), a Universal Testing Machine (UTM) for mechanical testing, and a two-microphone impedance tube system (BSWA

SW477, serial number 500054) for acoustic measurements. The fabrication process and physical-mechanical testing were conducted at the Biomaterials Laboratory, Faculty of Forestry, Tanjungpura University, while acoustic testing was performed at the Vibration and Acoustics Laboratory, Bandung Institute of Technology (ITB).

Raw Material Preparation

Durian peels were cleaned to remove adhering dirt and other foreign materials, then cut into smaller pieces to facilitate drying and grinding. The durian peel pieces and sengon sawdust were sun-dried to approximately 15% moisture content. The dried durian peels were mechanically ground with a hammer mill and subsequently sieved to obtain particles that passed through an 8-mesh sieve (approximately 2.36 mm) and were retained on a 10-mesh sieve (approximately 2.00 mm). Sengon sawdust was similarly sieved to obtain the same particle-size fraction. The selected particles were then oven-dried at approximately 60 °C until the moisture content reached approximately 5%. After drying, the particles were stored in sealed plastic bags until particleboard manufacture to minimize changes in moisture content. The raw materials and prepared particles used in this study are shown in **Figure 1**, including whole durian peel, sengon sawdust, and the particles obtained after grinding and sieving.



Figure 1. Raw materials and prepared particles: (a) whole durian peel, (b) sengon sawdust, and (c) ground and sieved durian peel (D) and sengon sawdust particles (S)

Particleboard Manufacturing

Particleboards were manufactured at a target density of 0.4 g/cm³ with board dimensions of 30 × 30 × 1 cm. The adhesive content was fixed at 15% (based on oven-dry particle weight), with the addition of 0.1% catalyst and 1% paraffin. Five treatment compositions of durian peel to sengon particles were applied, namely 0:100, 25:75, 50:50, 75:25, and 100:0. The detailed material composition is presented in Table 1.

Table 1. Raw material composition of particleboards

Material composition (Durian Peel: Sengon Sawdust Ratio)	Particle Weight (grams)		Adhesive Weight (grams)			Total material weight (grams)
	Durian Peel	Sengon Sawdust	UF (15%)	Catalyst (0,1%)	Paraffin (1%)	
A (0: 100)	0	325,58	97,64	1,24	3,16	427,62
B (25: 75)	81,40	244,18	97,64	1,24	3,16	427,62

C (50: 50)	162,79	162,79	97, 64	1,24	3,16	427,62
D (75: 25)	244,18	81,40	97, 64	1,24	3,16	427,62
E (100: 0)	325,58	0	97, 64	1,24	3,16	427,62

For each treatment, the required quantities of durian peel and sengon particles were weighed on an oven-dry mass basis according to the experimental formulation. The particles were manually mixed to obtain a uniform distribution of the two raw materials. UF resin, paraffin, and catalyst were then added and thoroughly mixed with the particles to obtain a homogeneous furnish. The furnish was manually formed into a mat in a 300 × 300 mm forming mold. The mat was then hot-pressed at 140 °C for 10 min under a pressure of 25 kg cm⁻² to obtain a nominal board thickness of 10 mm. Following hot pressing, the boards were cooled and conditioned for 7 days at room conditions before specimen preparation. After conditioning, specimens for physical and mechanical testing were cut from each board in accordance with JIS A 5908 (2003). Specimens for acoustic measurements were cut into circular samples with a diameter equal to the internal diameter of the impedance tube (100 mm) and a thickness equal to the board thickness (approximately 10 mm).

Physical and Mechanical Testing

The physical properties evaluated were density, moisture content, water absorption, and thickness swelling, while the mechanical properties evaluated were modulus of elasticity (MOE) and modulus of rupture (MOR). Density and moisture content were determined after conditioning. Water absorption and thickness swelling were determined by measuring the specimen mass and thickness before and after water immersion, in accordance with the procedures specified in JIS A 5908 (2003). Mechanical properties were evaluated using a universal testing machine, and MOE and MOR were determined from static bending tests.

Acoustic Testing

The acoustic property evaluated in this study was the normal-incidence sound absorption coefficient (α) of the particleboards, measured using a two-microphone impedance-tube system using a two-microphone impedance-tube system according to the transfer-function method specified in ISO 10534-2 (**Figure 2**). The experimental setup consisted of a sound source (A), a main impedance tube (B), a smaller-diameter tube for high-frequency measurements (B1), a specimen holder (C), and two microphones (D) connected to a data acquisition and frequency-analysis system.



Figure 2. Experimental setup of the two-microphone impedance-tube system: (A) sound source, (B) main impedance tube, (B1) smaller-diameter tube for high-frequency measurements, (C) specimen holder, and (D) microphones.

Prior to testing, the microphones were calibrated to correct for amplitude and phase mismatch in accordance with ISO 10534-2. The specimens were tightly fitted into the specimen holder (C) to minimize air gaps between the specimen and the tube wall. A broadband acoustic signal was generated by the sound source and propagated along the tube toward the specimen. The sound pressures were simultaneously measured at two microphone positions (D) and used to determine the complex transfer function. From the transfer function, the complex normal-incidence reflection factor was determined, and the normal-incidence sound absorption coefficient (α) was subsequently calculated in accordance with ISO 10534-2. The sound absorption coefficient was reported as a dimensionless quantity.

Experimental Design and Statistical Analysis

The experiment followed a Completely Randomized Design (CRD) with five durian peel-to-sengon sawdust ratios (0:100, 25:75, 50:50, 75:25, and 100:0), with three replicates for physical and mechanical testing. These data were analyzed using one-way ANOVA, followed by Tukey's HSD test at $p < 0.05$ when significant differences were detected. Sound absorption measurements were performed once for each particleboard composition and were therefore analyzed descriptively based on the sound absorption coefficient (α) across the measured frequency range.

RESULTS AND DISCUSSION

Physical Properties of Particleboard

The physical properties evaluated in this study included density, moisture content, water absorption, and thickness swelling after 24 h of water immersion. The results are presented in **Table 2**.

Table 2. Physical properties of particleboards manufactured at different durian peel-to-sengon sawdust ratios.

Durian peel sengon sawdust ratio	Testing Parameters			
	Density (gr / cm ³)	Moisture content (%)	Thikness Swelling (%)	Water absorption (%)
A (0:100)	0.38±0.01	7.46±0.17 ^a	18.74±2.22	169.88±15.27
B (25:75)	0.38±0.01	7.55±0.24 ^{ab}	17.73±2.04	160.06± 6.26
C (50:50)	0.38±0.02	7.95±0.33 ^{abc}	20.21±4.16	174.60±20.27
D (75:25)	0.40±0.01	8.48±0.05 ^c	20.36±1.16	187.24±11.37
E (100:0)	0.38±0.01	8.40±0.18 ^c	20.16±1.89	181.91±19.50

Notes: Values are means ± standard deviations. Means followed by the same lowercase letter within a column are not significantly different at $p < 0.05$. No superscript letters are presented for parameters for which the effect of composition was not significant.

The results of the study showed that particleboard density ranged from 0.38 to 0.40 g/cm³ and was not significantly affected by the durian peel-sengon sawdust ratio. The narrow density range indicates that boards with different raw material compositions were produced at comparable densities. Low *et al.*, (2021) similarly reported that differences in raw-material composition do not necessarily result in significant differences in particleboard density. Minor deviations from the target density may be attributed to variations in mat formation, adhesive distribution, and material loss during manual forming and pressing, as also reported by (Karlinasari, *et al.*, 2012) and Iswanto *et al.*, (2021). Since density did not differ significantly among treatments, the subsequent physical and mechanical properties were compared across durian peel-sengon sawdust compositions at comparable densities.

Moisture content, water absorption, and thickness swelling are closely related to the moisture response and dimensional stability of particleboard. In this study, moisture content ranged from 7.46% to 8.48%, water absorption from 160.06% to 187.24%, and thickness swelling from 17.73% to 20.36%. Material composition significantly affected moisture content, with the lowest value observed for the 0:100 treatment and the highest for the 75:25 treatment. The 0:100 treatment differed significantly from the 75:25 and 100:0 treatments, whereas the remaining comparisons showed no significant differences according to the statistical groupings in Table 2. A similar tendency was reported by Indrayani *et al.*, (2025), who observed higher moisture content in boards with a greater proportion of oil palm mesocarp fibers than sengon particles. In contrast, material composition had no significant effect on water absorption or thickness swelling. Although both properties tended to be numerically higher in boards with higher proportions of durian peel, the differences were not statistically significant.

The differences in moisture-related properties may be associated with the chemical characteristics of the raw materials. Trisanti *et al.*, (2018) reported that sengon contains 41.1% cellulose, 22.26% hemicellulose, and 17.51% lignin, whereas Gamay *et al.* (2024) reported 57–64% cellulose, approximately 30% hemicellulose, and 15.6% lignin in durian peel. Cellulose and hemicellulose contain hydroxyl groups that readily interact with water, whereas lignin is comparatively less hydrophilic (Xu *et al.*, 2022). The higher polysaccharide and lower lignin contents

reported for durian peel may therefore partly explain the numerical tendency toward greater moisture uptake with increasing durian peel proportion. However, because water absorption and thickness swelling did not differ significantly among treatments, this relationship should be interpreted cautiously.

All treatments had moisture contents within the 5–13% range specified in JIS A 5908 (2003), whereas their thickness swelling values exceeded the maximum requirement of 12%. The relatively high water absorption and thickness swelling indicate limited dimensional stability under prolonged water exposure. Therefore, further improvement in moisture resistance would be required for applications exposed to humid or wet conditions. In their current form, these low-density boards are better suited to dry, non-structural interior applications, particularly where low weight and acoustic performance are more important than load-bearing capacity or moisture resistance.

Mechanical Properties of Particleboard

The mechanical properties of particleboard indicate its ability to resist deformation and failure under applied loads. In this study, mechanical performance was evaluated using the modulus of elasticity (MOE) and the modulus of rupture (MOR). The mean values are presented in **Table 3**.

Table 3. Mechanical Properties of particleboard made from durian peel and sengon sawdust

Material composition	Testing Parameters	
	MOE (MPa)	MOR (MPa)
Durian: Sengon		
A (0:100)	310.16±10.19bcd	2.75±0.19b
B (25:75)	317.33±31.51d	2.85±0.21b
C (50:50)	203.04±66.21ab	2.20±0.79ab
D (75:25)	214.92±13.73bc	2.45±0.43ab
E (100:0)	114.87±25.97a	1.43±0.24a

Notes: Values are means ± standard deviations. Means followed by the same lowercase letter within a column are not significantly different at $p < 0.05$. MOE = modulus of elasticity; MOR = modulus of rupture

The MOE and MOR values ranged from 114.87 to 317.33 MPa and from 1.43 to 2.85 MPa, respectively. Analysis of variance showed that material composition significantly affected both MOE and MOR ($p < 0.05$), indicating that the proportions of durian peel and sengon sawdust influenced the boards' mechanical performance. Jamaluddin, (2018) similarly reported that variations in the proportions of sorghum and acacia sawdust significantly affected the mechanical properties of particleboard. Zulkifli *et al.*, (2024) using a different combination of lignocellulosic materials, also reported that the proportions of wood particles and rice straw influenced the mechanical properties of particleboard.

The 25:75 durian peel-sengon sawdust ratio produced the highest numerical MOE and MOR values, reaching 317.33 and 2.85 MPa, respectively. However, according to the post hoc groupings in Table 3, the 25:75 treatment did not differ significantly from the 0:100 treatment for either property. For MOE, the 25:75 treatment differed significantly from the 50:50, 75:25, and 100:0 treatments, whereas for MOR, it differed significantly only from the 100:0 treatment. Thus, incorporating 25%

durian peel maintained mechanical performance comparable to that of particleboard made from 100% sengon sawdust. At higher durian peel proportions, MOE and MOR generally decreased, although the differences were not always statistically significant.

All MOE and MOR values measured in this study were below the minimum requirements specified in JIS A 5908 (2003) – 2000 MPa for MOE and 8.04 MPa for MOR—indicating that the panels did not meet the standard's bending stiffness and strength requirements. The relatively low mechanical performance may be partly attributable to the low target density of 0.40 g/cm³ used in this study. At low board density, reduced particle contact and consolidation can limit stress transfer under bending loads. Maraghi *et al.*, (2018) reported that MOE and MOR increased with increasing particleboard density, while Marwanto *et al.*, (2018) reported higher mechanical performance for sengon particleboard manufactured at a higher density.

In addition to board density, the characteristics of the raw materials may have contributed to the low mechanical performance, particularly at higher proportions of durian peel. Savitri *et al.*, (2023) stated that durian peel fibers are coarse and brittle, which can limit effective stress transfer within the board and affect its strength properties. Moreover, the high cellulose and hemicellulose content of non-wood particles promotes water absorption, which can reduce board stiffness (Namwong *et al.*, 2024). This hydrophilic behavior is a major limitation of natural fibers, as moisture uptake can weaken adhesive bonding and reduce board strength. These factors may explain the lower MOE and MOR at higher durian peel proportions.

The contribution of sengon sawdust to mechanical performance is consistent with previous studies combining wood and non-wood lignocellulosic materials. Olupot *et al.*, (2022) reported improved mechanical properties of rice husk particleboard with the addition of sawdust. Similarly, Zulkifli *et al.*, (2024) observed higher MOE and MOR with increasing proportions of wood particles in wood-rice straw particleboard. These findings support the potential of wood particles to improve the mechanical performance of particleboards containing non-wood lignocellulosic materials. Consequently, the low-density boards developed in this study are more appropriate for non-structural applications where high load-bearing capacity is not the primary requirement.

Acoustic properties of Particleboard

The acoustic performance of particleboard in this study was evaluated based on the sound absorption coefficient (α), which indicates the proportion of incident sound energy absorbed by the material. The α value ranges from 0 to 1, with higher values indicating greater sound absorption. The sound absorption coefficients were measured over a frequency range of 64–6400 Hz, as presented in **Figure 3**.

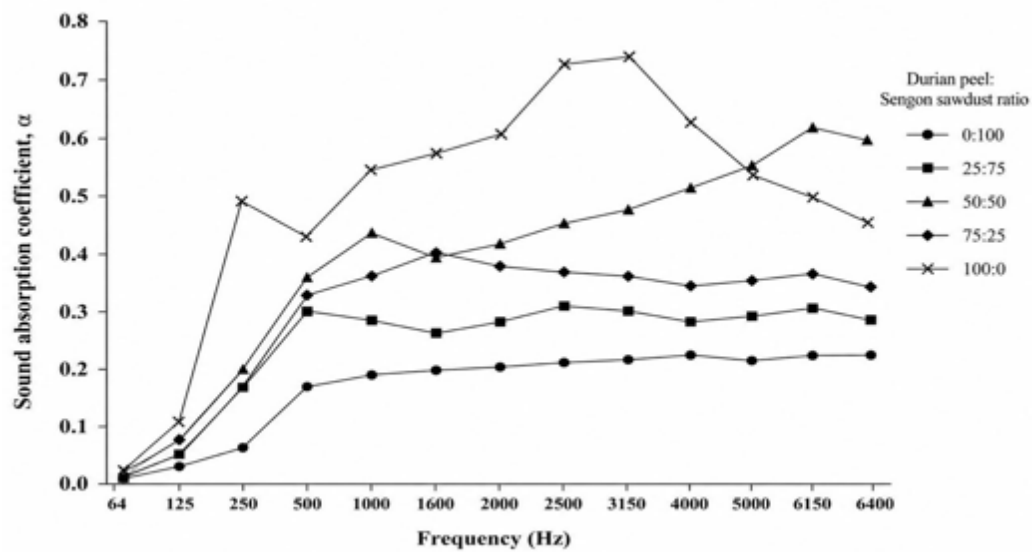


Figure 3. Sound absorption coefficients of particleboards with different durian peel:sengon sawdust ratios

The results of the study indicate that the sound absorption coefficient of particleboard varies across the frequency range. At low frequencies (0 - 250 Hz), the sound absorption value of all particleboard compositions is below 0.2, except for the 100:0 durian peel-to-sengon sawdust ratio, which reaches 0.5. This result is consistent with Karlinasari *et al.*, (2012a), who reported that at low frequencies (<250 Hz), sound absorption fluctuations are nearly identical across particleboards with the same density. This behavior may be related to the response of specific wood or other natural fiber to low sound frequencies in boards of the same density. In the medium frequency range (1000-2000 Hz), the highest sound absorption value was found in the 100:0 durian peel-to-sengon sawdust ratio (0.61 at 2000 Hz), followed by the 50:50 ratio (0.44 at 1000 Hz) and the 75:25 ratio (0.41 at 1600 Hz), while the 0:100 ratio showed the lowest value. At frequencies above 2000 Hz, the sound absorption of the durian peel-to-sengon sawdust ratio 100:0 increased to 0.72 at 2500 Hz and 0.73 at 3150 Hz; above these frequencies, the sound absorption value gradually decreased. The 50:50 ratio showed an interesting trend, with absorption increasing at high frequencies, reaching 0.63 at 6150 Hz.

Overall, the particleboards exhibited better sound absorption at high frequencies than at low and medium frequencies. This behavior can be attributed to the interaction between sound waves and the board's internal voids. Yuliantika & Elvaswer (2019) explained that incoming acoustic energy can be dissipated as heat through friction within a material's porous structure, thereby increasing sound absorption. Similarly, Karlinasari *et al.* (2012a) reported that porous materials and open fiber structures facilitate air-friction mechanisms that dissipate acoustic energy, particularly at mid- to high frequencies. Furthermore, Istana *et al.*, (2025) noted that the shorter wavelengths of high-frequency sound waves enable more effective interaction with pores and cavities within the material. These mechanisms support the present results, in which sound absorption was generally more pronounced at higher frequencies.

In this study, sound absorption generally increased with increasing proportions of durian peel in the particleboard. This trend differs from that reported by Indrayani *et al.*, (2025) who found that particleboards composed of sengon sawdust and oil palm mesocarp showed the highest sound absorption for the 100:0 sengon sawdust ratio. This difference may be related to variations in treatment and the characteristics of the non-wood raw materials. Chaydarreh *et al.*, (2022) reported that board porosity influences particleboard properties. Materials with greater porosity will increase the board's sound absorption capacity

The particleboard with a 50:50 durian peel-to-sengon sawdust ratio showed slightly higher sound absorption than the 75:25 ratio at certain frequencies. This difference may be associated with the combined characteristics of the two raw materials. Sengon sawdust consists of relatively fine particles that can contribute to board compactness and adhesive bonding (Mirza *et al.*, 2020), whereas durian peel particles may provide void spaces that facilitate the dissipation of sound energy (Savitri *et al.*, 2023). The interaction between these characteristics may contribute to the sound absorption behavior observed in the 50:50 particleboard. Considering its sound absorption performance, particularly at higher frequencies, durian peel-sengon sawdust particleboard has potential as a non-structural acoustic material for indoor applications, such as wall or ceiling acoustic panels. This application could also provide an alternative use for durian peel and sengon sawdust residues. However, further improvement in mechanical and dimensional properties is required before practical application.

CONCLUSION

The incorporation of durian peel into low-density sengon sawdust particleboard produced a clear trade-off between mechanical and acoustic performance. Material composition significantly affected moisture content, MOE, and MOR, whereas density, water absorption, and thickness swelling did not differ significantly among treatments. The 25:75 durian peel-to-sengon sawdust composition produced the highest numerical MOE and MOR values, although its mechanical performance was statistically comparable to that of the 0:100 composition for both properties. All boards exceeded the specified thickness-swelling limit and exhibited MOE and MOR values below the applicable JIS A 5908 (2003) requirements, restricting their suitability for structural applications. In contrast, boards containing higher proportions of durian peel exhibited greater measured sound absorption at several medium-to-high frequencies, with the 100:0 composition reaching the highest observed absorption coefficients. These findings demonstrate the potential of durian peel-sengon particleboard for lightweight, non-structural indoor acoustic applications. Further research should focus on increasing board density, improving adhesive distribution, enhancing moisture resistance, and replicating acoustic measurements to establish statistically robust acoustic performance.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Faculty of Forestry, Universitas Tanjungpura, for funding this research through the 2025 DIPA program.

REFERENCES

- BPS. (2025). Statistik Indonesia. In Badan Pusat Statistik Indonesia (Vol. 53).
- Chaydarreh, CK., Lin, X., Guan, L., & Hu, C. (2022). Interaction between particle size and mixing ratio on porosity and properties of tea oil camellia (*Camellia oleifera* Abel.) shells-based particleboard. *Journal of Wood Science*, 68(1). <https://doi.org/10.1186/s10086-022-02052-3>
- Gamay, R. A. J., Botecario, P. M. N., Sanchez, P. D. C., & Alvarado, M. C. (2024). Durian (*Durio zibenthinus*) waste: a promising resource for food and diverse applications-a comprehensive review. In *Food Production, Processing and Nutrition* (Vol. 6, Number 1). <https://doi.org/10.1186/s43014-023-00206-4>
- Indrayani, Y., Ferdiansyah, A., Setyawati, D., & M., I. A. (2025). Tingkat Redam Suara Dan Ketahanan Papan Partikel Campuran Serbuk Kayu Sengon Dan Mesocarp Kelapa Sawit Terhadap Serangan Rayap Tanah. *Jurnal Penelitian Hasil Hutan*, 43(2). <https://doi.org/10.55981/jphh.2025.10713>
- Istana, B., Sutikno, S., Batan, I. M. L., & Utami, L. P. (2025). Effect of Alkali Treatments on Morphology and Acoustic Properties of Oil Palm Frond Fibers in Low-Density Composite Particleboards. *AIP Conference Proceedings*, 3223(1). <https://doi.org/10.1063/5.0243155>
- Jamaluddin, Y. I. , S. S. M. (2018). Kualitas Papan Partikel Dari Campuran Batang Sorgum (*Sorghum Bicolor* L.) Dan Kayu Akasia (*Acacia Mangium* W.) Berdasarkan Konsentrasi Perekat Urea Formaldehida. *Jurnal Hutan Lestari*, 6 (3): 486 - 498.
- Japanese Industrial Standard. (2003). JIS A 5908 2003 : Particleboards. Japan
- Jakubowski, WJ. L., Harabin, R., Pawlik, L., & Wilk-Jakubowski, G. (2025). Noise Annoyance in Physical Sciences: Perspective 2015-2024. In *Applied Sciences* (Switzerland) (Vol. 15, Number 12). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/app15126559>
- Karlinasari, L., Hermawan, D., Maddu, A., Martiandi, B., & Hadi, Y. S. (2012a). Development Of Particleboard From Tropical Fast-Growing Species For Acoustic Panel. *Journal of Tropical Forest Science*. 24(1).
- Karlinasari, L., Hermawan, D., Maddu, A., Martianto, B., Lucky, I. K., Nugroho, N., & Hadi, Y. S. (2012b). Bamboo acoustical properties. *BioResources* (Vol. 7, Number 4). <https://doi.org/10.15376/biores.7.4.5700-5709>
- Khaksar, G., Kasemcholathan, S., & Sirikantaramas, S. (2024). Durian (*Durio zibethinus* L.): Nutritional Composition, Pharmacological Implications, Value-Added Products, and Omics-Based Investigations. In *Horticulturae* (Vol. 10, Number 4).(MDPI). <https://doi.org/10.3390/horticulturae10040342>
- Marwanto, Maulana, S., Maulana, M. I., Wistara, N. J., Nikmatin, S., & Febrianto, F. (2018). Peningkatan Sifat Papan Partikel Sengon dengan Perlakuan Perendaman Air Dingin (Improvement the Properties of Particleboard Made from Sengon with Cold Water Immersion Treatment). *J. Ilmu Teknol. Kayu Tropis*, 16(2).
- Maraghi, MMR., Tabei, A., & Madanipoor, M. (2025.). Effect Of Board Density, Resin Percentage And Pressing Temprature on Particleboard Properties Made From Mixing of Poplar Wood Slab, Citrus Branches And Twigs Of Beech. *Wood Research* 63 (4): 2018 669-682
- Mirza, H., Mahdie, M. F., & Thamrin, G. A. R. (2020). Sifat Fisik Dan Mekanik Papan Partikel Dari Serbuk Gergajian Kayu Sengon Laut (*Paraserianthes Falcataria*) Menggunakan Perekat Pvac. *Jurnal Sylva Scientee*, 3(5). <https://doi.org/10.20527/jss.v3i5.2536>

- Namwong , J., Cheychom , K., Lertcumfu , N., & Panyata , S. (2024). Study Of Physical Properties Mechanical Properties And The Development Of Particleboard From durian Peel Using A Compression Molding Process. *Journal of Industrial Education*. 23(1): 43-53. doi:10.55003/jie.23108
- Okeke, F. O., Ahmed, A., Imam, A., & Hassanin, H. (2024). Study on agricultural waste utilization in sustainable particleboard production. *E3S Web of Conferences*, 563. <https://doi.org/10.1051/e3sconf/202456302007>
- Olupot, P. W., Menya, E., Lubwama, F., Ssekalu, L., Nabuuma, B., & Wakatuntu, J. (2022). Effects of sawdust and adhesive type on the properties of rice husk particleboards. *Results in Engineering*, 16. <https://doi.org/10.1016/j.rineng.2022.100775>
- Putra, A., Othman, M. N., Oliveira, T., Souli, M., Kassim, D. H., Irianto, & Herawan, S. (2022). Waste Durian Husk Fibers as Natural Sound Absorber: Performance and Acoustic Characterization. *Buildings*, 12(8). <https://doi.org/10.3390/buildings12081112>
- Raman, K. V., & Samsudin, Dr. E. M. (2022). Sound Absorption Performance of Oil Palm Empty Fruit Bunch Fibreboards using different Fibre Lengths. *Recent Trends in Civil Engineering and Built Environment*, 3(1).
- Savitri, E., Waluyo, P. W., Layantara, L. E., & Rusly, N. F. (2023). Delignification and Characterization of Fiber from Durian Peel Waste (pp. 102-113). https://doi.org/10.2991/978-94-6463-288-0_11
- Tang, T. K. H., & Nguyen, N. Q. (2025). Investigation of Particleboard Production from Durian Husk and Bamboo Waste. *Journal of Composites Science*, 9(6). <https://doi.org/10.3390/jcs9060276>
- Xu, F., Xu, L., Zheng, C., Wang, Y., & Zhang, H. (2022). Effect of Lignin Removal on the Hygroscopicity of PMMA/Wood Composites. *Polymers*, 14(16). <https://doi.org/10.3390/polym14163356>
- Yuliantika, S., & Elvaswer, E. (2019). Karakterisasi Koefisien Absorpsi Bunyi Dan Impedansi Akustik Dari Limbah Serat Kayu Meranti Merah (*Shorea Pinanga*) Dengan Menggunakan Metode Tabung. *Jurnal Ilmu Fisika Universitas Andalas*, 10(1), 28-37. <https://doi.org/10.25077/jif.10.1.28-37.2018>
- Zahrah, Y., Yu, J., & Liu, X. (2024). How Indonesia's Cities Are Grappling with Plastic Waste: An Integrated Approach towards Sustainable Plastic Waste Management. *Sustainability (Switzerland)*, 16(10). <https://doi.org/10.3390/su16103921>
- Zulkifli, M. E., Zulkefli, Z., Afif, M., Azeli, D., & Kadir, A. A. (2024). Physical and Mechanical Properties of Particle Board Produced by Sawdust and Straw Rice. *Multidisciplinary Applied Research and Innovation*, 5(1).