



Water Content and Specific Gravity of Pulai (*Alstonia scholaris*) Coppice Wood: Potential Utilization

Lies Indrayanti^{1*}, Yanarita¹, Desy natalia Koroh¹, Grace Siska¹, Herwin Joni¹, Mahdi Santoso¹, Yan Ciluk¹

¹Jurusan Kehutanan, Fakultas Pertanian Universitas Palangka Raya, Indonesia.

Received: December 14, 2025

Revised: January 29, 2026

Accepted: February 25, 2026

Published: February 28, 2026

Corresponding Author:

Lies Indrayanti

indayantilies@for.upr.ac.id

DOI: [10.29303/jppipa.v12i2.14290](https://doi.org/10.29303/jppipa.v12i2.14290)

 Open Access

© 2026 The Authors. This article is distributed under a (CC-BY License)



Abstract: The study aims to determine the water content and specific gravity and analyze both on the potential utilization of pulai coppice wood. The study was conducted at the Forest Products Technology Laboratory, Forestry Department, Faculty of Agriculture, Palangkaraya University. Pulai coppice wood material was taken around the Palangka Raya University Campus, tree diameter 34cm, branch-free height 7m. Using a 2-factor factorial Randomized Block Design with 3 levels, the first factor is the axial direction, namely the base, middle and tip. The second factor is the radial direction, namely near the heart, between the heart and the bark and near the bark. The parameters observed were green water content, air-dry water content, green specific gravity, air-dry specific gravity and oven-dry specific gravity. The results showed an average value of green water content of 84.75%, air-dry water content of 18%, green specific gravity of 0.29%, air-dry specific gravity of 0.30% and oven-dry specific gravity of 0.31%. All parameter values resulted from the research on pulai coppice wood were lower than the values of the main stem pulai coppice wood from previous studies. In the axial direction, all parameter values show an increasing pattern from base to tip, except for the wind-dry moisture content, which shows the opposite pattern. In the radial direction, the values tend to be uniform, except for the green specific gravity, which decreases from the outside (near the bark) to the inside (near the heart). The results of the analysis of variance indicate that all parameters influence the axial direction, while only the green specific gravity influences the radial direction. This indicates that the axial factor dominates the physical properties of pulai coppice wood. The interaction factors that influence this are green water content and oven-dry specific gravity. Based on the specific gravity and wind-dry moisture content values, pulai coppice wood is lightweight and adapts quickly to its environment, thus quickly achieving dimensional stability. This pulai coppice wood is suitable for light construction and interior use.

Keywords: *Alstonia scholaris*; Moisture content; Physical properties; Specific gravity; Coppice wood

Introduction

Wood is a forest product that plays a vital role in meeting human needs, including for construction, furniture, and other industrial raw materials. Wood quality is largely determined by its physical properties, particularly its moisture content and specific gravity. Moisture content influences dimensional stability, durability, and ease of drying. Specific gravity is often used as a primary indicator of wood quality because it is

closely related to strength, durability, and potential uses (Bowyer et al., 2003).

Pulai (*Alstonia scholaris*) is a fast-growing species widely distributed in Indonesia. This tree is highly tolerant, growing in a wide variety of soils and habitats. It generally grows in areas with an altitude of 0-1000 m above sea level with rainfall intensity of 1000-3800 mm/year. Trees aged 10-12 years can reach a diameter of 30-40 cm and a trunk height of 10-14 m (Arinana & Diba, 2009). This wood is classified as a light wood with

How to Cite:

Indrayanti, L., Yanarita, Koroh, D. N., Siska, G., Joni, H., Santosa, M., & Ciluk, Y. (2026). Water Content and Specific Gravity of Pulai (*Alstonia scholaris*) Coppice Wood: Potential Utilization. *Jurnal Penelitian Pendidikan IPA*, 12(2), 691-701. <https://doi.org/10.29303/jppipa.v12i2.14290>

a low specific gravity, making it widely used as raw material for matches, pencils, containers, and plywood (Martawijaya et al., 2005). However, the physical properties of pulai coppice wood vary greatly depending on age, stem section, and growth origin. One unique feature of this wood is its ability to produce coppice wood. This coppice wood grows from the stump, roots, or base of a tree trunk after it has been felled or damaged. Generally, coppice wood grows faster than seed-grown wood because the root system is already established. However, coppice wood typically has different properties than seed-grown wood, such as a rougher texture, more irregular grain direction, and a tendency to develop defects such as cross-graining or crooked growth (Panshin & Zeeuw, 1980).

Vegetative growth through coppice wood is a natural and artificial regeneration strategy for fast-growing species. Wood originating from the trunk often shows differences in properties compared to the main stem wood, both in terms of anatomy, water content, and specific gravity (Panshin & Zeeuw, 1980). The results of research by Meiganati et al. (2023) showed that the specific gravity of teak wood from the trunk was 0.62, lower than that of teak wood from the main stem which could reach 0.72. This difference has the potential to affect the use of teak wood in various applications. Another type of wood that also produces trunk wood is pulai coppice wood, but to date there has been no research on the properties of pulai coppice wood, such as the physical properties of wood and other properties. Water content and specific gravity are interrelated physical properties of wood. Generally, the higher the water content, the lower the specific gravity of the wood will appear when calculated in dry conditions. Conversely, wood with a high specific gravity tends to have better dimensional stability after drying (Vieilledent et al., 2018). The relationship between these two parameters is very important for determining the quality of wood, especially from vegetative growth sources such as trunk, because it can provide an overview of its potential use in industry.

Research on the moisture content and specific gravity of pulai coppice wood is important to determine the relationship between these two physical properties and its potential uses. The results of this study are expected to provide basic information on the quality of pulai coppice wood and serve as considerations in the management and development of plantation forests as

alternative raw materials for the forestry industry. This study aims to determine the moisture content and specific gravity of pulai coppice wood. Another objective is to analyze the relationship between moisture content and specific gravity and the potential uses of pulai coppice wood. The expected benefits of this study are to provide basic information on the physical properties of pulai coppice wood. In addition, it can be used as a consideration in the utilization of pulai coppice wood from vegetative growth. Ultimately, it can support the development of fast-growing timber plantations as an alternative raw material for the forestry industry.

Method

The research was conducted in the Forest Products Technology Laboratory, Department of Forestry, Faculty of Agriculture, Palangka Raya University. The research period from felling to testing was one month. The research material used was a pulai coppice tree with a diameter of 37 cm and a branch-free height of 7 m. The ordinate of the sample tree was Lat -2.215212° Long 113.898505°. Other materials included a large plastic bag to wrap the felled log, a small plastic bag to wrap the green sample, duct tape, and a permanent marker for marking the sample. The tools used included a chain saw for felling, a tape measure for measuring, a machete to help clear branches and twigs, rope to help guide the direction of the tree's fall, a GPS to determine its geographic position, an analytical balance, a ruler, a pen, a mitotoyo sigmat, an oven, a stand, a needle, and a measuring cylinder.

Tree felling, trunk division, and sample preparation

The pulai trees were selected with straight trunks free from defects. Before felling, the felling position is determined first, namely at breast height or 1.3 m. Then, the direction of the tree fall is determined to avoid damage to other trees or the surrounding environment. The felling process begins by cutting the roof of the notch exactly at the breast height position. Next, a counter notch is cut on the opposite side to bring the tree down. After the tree falls, the cut is carried out to the first branch. The tree trunk is then divided into three equal parts and labeled Base, Middle, and Tip (treatment 1). Sample trees, trunk sections and cross sections (Figure 1).



Figure 1. Pulai Coppice Tree: (a) Trunk before felling; (b) Trunk section of Pulai Coppice Wood; and (c) Cross-sectional view of Pulai Coppice wood

Then each part of the trunk is divided again in the radial direction to obtain samples near the bark, between the bark and the heart and near the heart which is the second treatment. Sampling was made using the British standard 373:1958. The sample size for water content and specific gravity was 2 x 2 x 2 cm (Figure 2).

Sample Testing

The parameters tested included green water content, air-dry water content, green specific gravity, air-dry specific gravity, and oven-dry specific gravity.

The tested parameters, sample sizes, and formulas used are presented in Table 1.



Figure 2. Shape and size of water content and specific gravity test samples (British standard 373:1958)

Table 1. Tested Parameters, Sample Sizes, and Formulas Used for Testing the Physical Properties of Pulai Coppice Wood Using British Standard 373:1958

Parameters tested	Sample size (cm)	Formula application	Note
Green water Content	2x2x2	$\mu_B = \frac{W_b - W_o}{W_o} \times 100\%$	Wb = maximum wood weight (g) Wo = oven dry wood weight (g)
Air Dry Moisture Content	2x2x2	$\mu_B = \frac{W_a - W_o}{W_o} \times 100\%$	Wa = air-dried wood weight (g) Wo = oven dry wood weight (g)
Green Specific Gravity	2x2x2	$BJS = \frac{bkt}{V_s} \left(\frac{g}{cm^3} \right)$	BJS = Green Specific Gravity bkt= Dry weight of the oven Vs = Green volume (gram/cm ³)
Air Dry Specific Gravity	2x2x2	$BJKa = \frac{Ma}{vKa} \left(\frac{g}{cm^3} \right)$	BJKa= BJ air-dried wood bkt= Dry weight of the oven VKa= Dry Air Volume (gram/cm ²)
Oven Dry Specific Gravity	2x2x2	$BJKt = \frac{Mo}{Vo} \left(\frac{g}{cm^3} \right)$	BJKt= BJ oven dried wood (g/cm ³) bkt= Dry weight of the oven VKa= Dry Volume of Oven (gram/cm ³)

Data Analysis

The study used a 3 x 3 factorial completely randomized design with two factors. The first factor was the axial direction of the stem (A) with three levels: Base (P), Middle (T), and Tip (U). The second factor was the radial direction of the stem with three levels: Near the bark (R1), between the heart and bark (R2), and near the bark (R3). This resulted in nine treatment combinations. The test data were then analyzed using variance analysis to determine the effect of the treatments. For treatments

with significant effects, a difference in means was tested using the Honestly Significant Difference Test.

Result and Discussion

The average test values for green water content, air-dry water content, green specific gravity, air-dry specific gravity and oven-dry specific gravity of pulai coppice wood are presented in Figure 3, while the analysis of the effect of axial and radial direction treatment on green

water content, air-dry water content, green specific gravity, air-dry specific gravity and oven-dry specific gravity of pulai coppice wood are presented in Table 2.

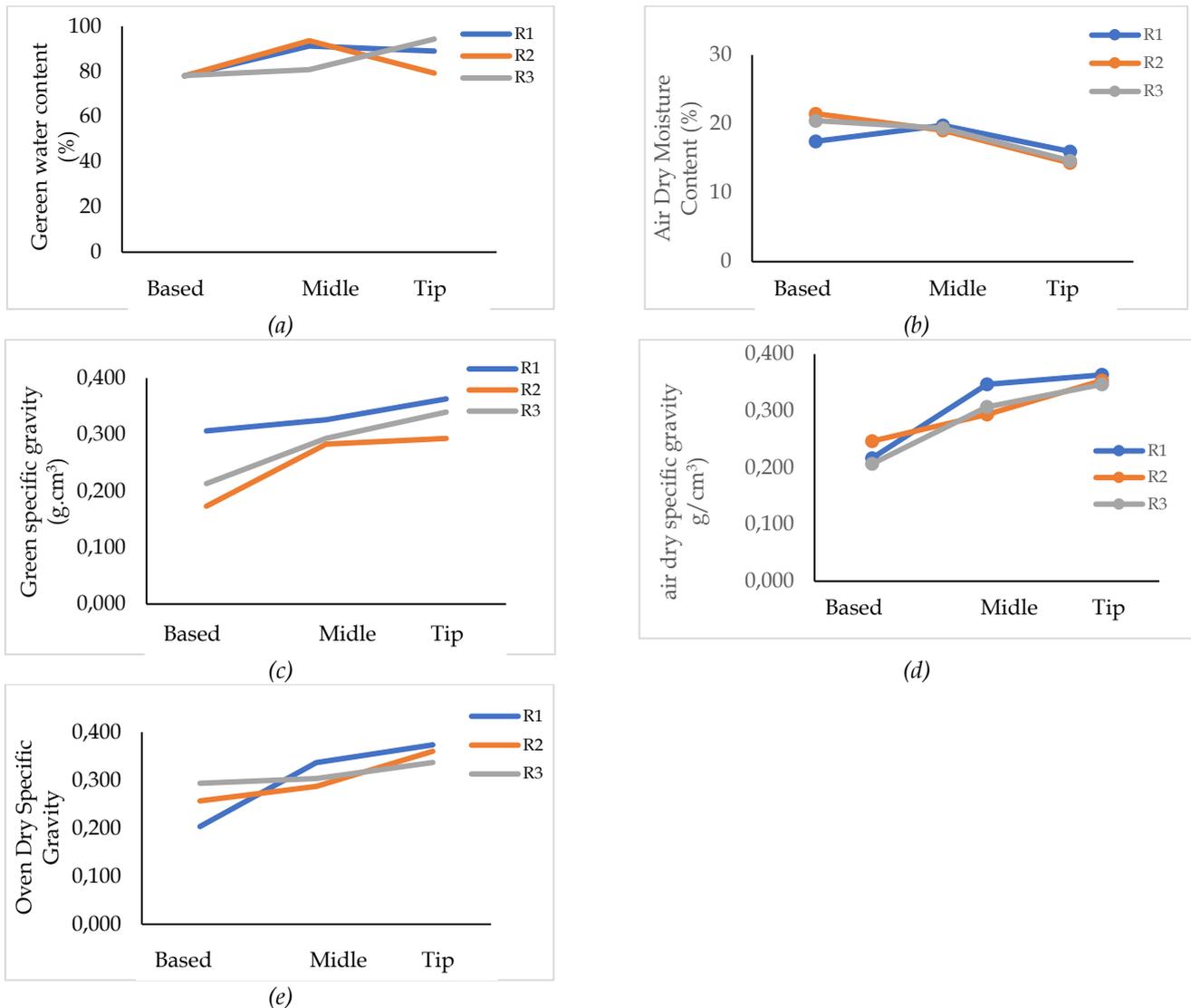


Figure 3. Results of data analysis of Coppice Island wood: (a) Average value of green water content; (b) Average value of dry water content; (c) Average value of green specific gravity; (d) Average value of dry air specific gravity; and (e) Average value of dry air specific gravity

Table 2. Analysis of the various effects of axial direction and radiation treatment on green water content, wind-dry water content, green specific gravity, wind-dry specific gravity and oven-dry specific gravity

Parameters	SK	DB	JK	KT	F. Count	F.tab 5%	Ftab 1%
Green water content	A	2	601.59	300.79	7.65**	3.63	6.23
	R	2	28.18	14.09	0.36	3.63	6.23
	AR	4	597.24	149.31	3.80*	3.01	4.77
Air dry moisture content	A	2	127.88	63.94	14.87**	3.63	6.23
	R	2	1.48	0.74	0.17	3.63	6.23
	AR	4	30.36	7.59	1.77	3.01	4.77
Green Specific Gravity	A	2	0.048	0.02	17.92**	3.63	6.23
	R	2	0.03	0.02	11.47**	3.63	6.23
	AR	4	0.01	0.0019	1.47	3.01	4.77
Air Dry Specific Gravity	A	2	0.08	0.041	51.92**	3.63	6.23
	R	2	0.002	0.001	1.41	3.63	6.23

Parameters	SK	DB	JK	KT	F. Count	F.tab 5%	Ftab 1%
	AR	4	0.0054	0.001	1.72	3.01	4.77
Oven dry	A	2	0.0502	0.025	80.82**	3.63	6.23
specific gravity	R	2	0.00047	0.00023	0.75	3.63	6.23
	AR	4	0.0178	0.0044	14.287**	3.01	4.77

Description: A= Axial Direction; R= Radial Direction; AR: interaction; *= significant effect; **= very significant effect

Green water Content

The average green water content ranges from 78.03% to 93.33%, or a general average of 84.75% (Figure 4). The green water content of this pulai coppice wood is lower than that of the main stem pulai coppice wood, which ranges from 90–130% (Martawijaya et al., 2005). Understanding the green water content is necessary to determine how to regulate drying, both in terms of drying time and determining the appropriate treatment, as it is related to dimensional stability (Skaar, 1988). Adjustments are made to prevent defects such as

cracking, warping, or splitting (Bowyer et al., 2003). Wood with a high green water content is susceptible to disease, such as fungal attack, if the moisture content is not immediately reduced after felling. Results of the analysis of variance for the influence of treatment factors in the axial and radial directions of the stem indicate that the axial direction and interaction factors have a significant effect at the 5% level (Table 2). The results of the average difference test for green water content of pulai coppice wood in the axial and interaction directions are presented in Table 3.

Table 3. Results of the Average Difference Test (LSD) for Green water Content of pulai coppice wood in the axial and radial directions (interaction)

Treatment	PR1	PR2	PR3	UR1	UR2	UR3	TR1	TR2	TR3
Median	78.057a	78.03a	78.207a	89.00a	79.33a	94.333b	91.293a	93.36b	80.837a

Means followed by the same letter indicate no significant difference according to the 5% LSD test; LSD ($\alpha = 0.01$) = 14.74.

The results of the mean difference test (Table 3) indicate that all treatments did not differ except for TR2 and UR 3. Differences in green water content of this pulai coppice wood are evident in the radial direction depending on the axial position of the stem. Figure 9 shows interactions between the middle-radial 3 (TR3) and the tip-radial 2 (UR2), indicating water content

values differing from the general pattern at other positions. The average green water content tends to increase from base to tip in radials R1 and R3. However, in radial R2 (between the bark and the heart), there is a deviation at the tip of the stem (UR2), indicating a lower water content than in R1 and R3. The lines between the radials are not parallel and intersect, indicating an interaction factor.

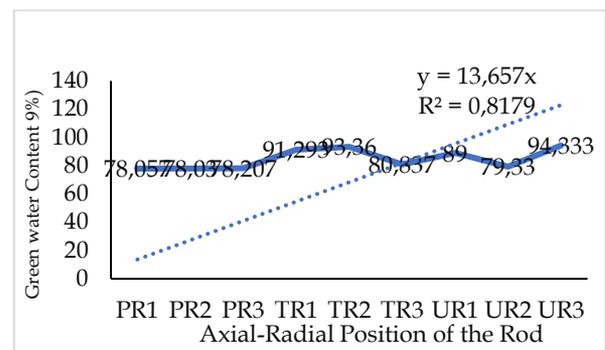
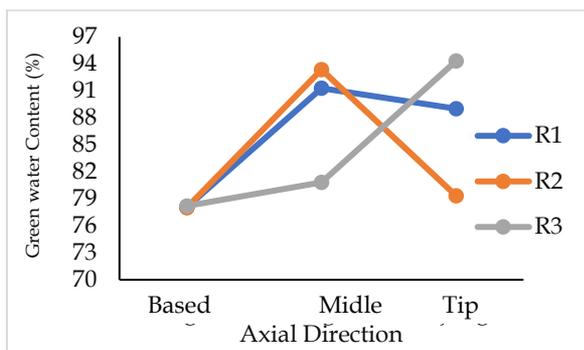


Figure 4. Interaction of: (a) Axial and Radial direction factors green water content of Coppice pulai coppice wood; (b) The relationship between the axial and radial directions with the green water content of Coppice pulai coppice wood

In general, the green water content of wood tends to be higher in the middle and tip of the stem compared to the base, this condition is in accordance with the theory proposed by Panshin & Zeeuw (1980) that the distribution of water content is influenced by the physiological activity of the tree. Variations in the radial direction indicate that the part near the bark (R1)

generally has a lower water content than the part near the heart (R3), because the bark area is close to the tissue that is more active in transpiration and relatively quickly loses water after felling (Sallenave, 1971). The deviation in the green water content pattern at the tip-radial position 2 (UR2) is thought to be caused by the heterogeneity of the shoot tissue, especially in the

transition between young wood (juvenile wood) and mature wood, which have different fiber structures and permeability (Zobel & van Buijtenen, 1989). This condition results in inconsistent water content between radial directions, especially at the tip of the stem which is still dominated by young wood. Variations in green water content along the axial and radial directions generally show an increasing pattern from the base to the tip. Figure 4 shows the relationship between the axial and radial directions of the green water content of pulai coppice wood. The figure shows an increasing trend in the green water content of pulai coppice wood from the base to the tip of the stem, indicated by a positive linear regression of $y = 13.657x$. The relationship between axial and radial positions and the green water content of pulai coppice wood is indicated by an R2 value of 0.8179, indicating that 82% of the variation in water content can be explained by changes in the stem's axial position.

Air-Dry Moisture Content

The air-dry moisture content ranged from 14.33% to 19.78%, or an average of 18.06%. This air-dry moisture content is higher than the research results of Arinana & Diba (2009); Riana et al. (2025) on pulai coppice wood from the main stem or non-truncages, which were 15.9% and 15.8%, respectively. This difference in air-dry moisture content is suspected to be due to environmental factors. During drying, local air humidity is high, so the air-dry moisture content of pulai coppice wood adapts to the humidity of the surrounding air. Air-dry moisture content varies across locations due to environmental conditions (Glass & Zelinka, 2010). Wood is hygroscopic (Bahanawan et al., 2020). This property causes it to absorb water in humid environments and, conversely, to evaporate water in low humidity environments. Therefore, wood moisture content is influenced by the environment and storage methods (Salahuddin et al., 1995). Air-dry moisture content is useful for determining the appropriate use time, as dimensions are stable at this point. Analysis of variance for the influence of treatment factors in the axial and radial directions of the stem indicates that the axial direction factor has a very significant effect at the 1% level (Table 2). The results of the BNT test are presented in Table 4.

Table 4. Results of the Average Difference Test (LSD) for the dry air moisture content of pulai coppice wood in the axial direction

Treatment	Base	Middle	Tip
Median	19.8a	19.407a	0.15a

Average numbers followed by the same letter indicate no significant difference according to the 5% BNT test; BNT ($\alpha = 0.05$) = 37.8.

The BNT test results indicate that the air-dry moisture content of pulai coppice wood at the base, middle, and tip of the stem is not significantly different ($p > 0.05$). However, descriptively, the axial moisture content indicates a pattern where the air-dry moisture content tends to be higher at the base of the stem than at the tip.

This difference is related to the anatomical structure and physiological function of the stem. The base is generally composed of older wood tissue with higher density, thus containing more bound water. Conversely, the tip of the stem consists of relatively younger tissue with larger pores, which releases water more quickly during the drying process, resulting in a lower air-dry moisture content. Differences in moisture content can also be influenced by the sapwood and heartwood, as well as water movement within the stem due to transpiration (Skaar, 1988). According to Simpson & Ten Wolde (1999), the ends dry faster, potentially shrinking before the base. This can lead to drying defects such as end splitting or internal tension. Therefore, moisture content control using appropriate drying methods is necessary to reduce the risk of defects and maintain the overall quality of the wood.

Wood is a hygroscopic material, meaning it absorbs and releases water vapor from its environment until it reaches equilibrium moisture content (EMC) (Skaar, 1988). The change in wood from green moisture content to air-dried moisture content is a form of hygroscopic wood processing; this change can be an indicator of wood's dimensional stability. This change begins with the release of free water from the cell cavities until it is exhausted, leaving only bound water in the cell walls. This condition is called the fiber saturation point, with a moisture content of 25-30%. Then, bound water gradually releases until it reaches equilibrium moisture content, or air-dried moisture content, with a moisture content ranging from 14-20%. This change is likely to lead to dimensional changes. According to Simpson & Ten Wolde (1999), who said that this condition is important because the dimensional stability of the wood will determine the quality of the final product, whether for construction, furniture, or other processed materials. Therefore, understanding the relationship between green water content and air-dry water content is very important because it will determine how the drying treatment process so that the wood's durability and strength can be better addressed. The relationship between green water content and air-dry water content of pulai coppice wood can be seen in Figure 5.

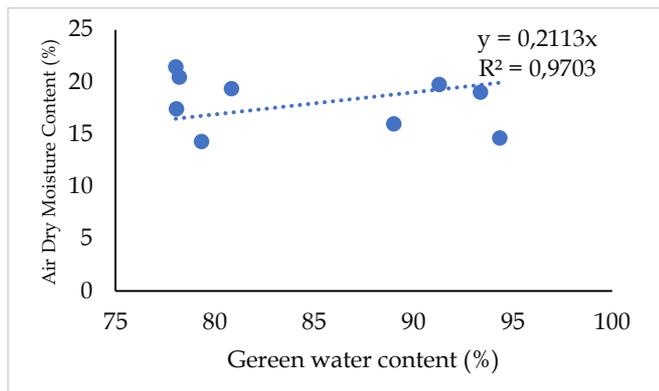


Figure 5. Relationship between green water content and dry water content of Coppice Island wood

Based on Figure 5, the relationship between green water content and air-dry water content of pulai coppice wood shows a positive pattern, with a regression equation of $y = 0.2113x$ and a coefficient of determination of $R^2 = 0.9703$. This R^2 value is considered high, meaning that 97.03% of the variation in air-dry water content can be explained by green water content. The higher the green water content of the wood, the higher the air-dry water content. However, environmental factors, such as temperature and humidity, are more dominant in determining air-dry wood water content than the initial green water content (Simpson & Ten Wolde, 1999; Skaar, 1988).

Green Specific Gravity

Specific gravity is a reliable indicator for assessing wood quality (Augustina et al., 2020). The green specific gravity of pulai coppice wood from the study ranged from 0.17 to 0.36, with an average of 0.28 (Figure 4a). According to Bowyer et al. (2003), knowing the green specific gravity of a wood species is directly related to its utilization. Green specific gravity can be used to estimate the weight of wood in the field, especially after felling, and can then be used to estimate transportation and handling costs. The results of this study indicate that the green specific gravity of pulai coppice wood is lower than that of main stem pulai coppice wood, which is 0.30–0.33 (Martawijaya et al., 2005). Similarly, when compared to the green specific gravity of other light woods such as sengon and jelutung, which range from 0.29–0.32 and 0.32–0.36, respectively. Analysis of variance results indicate that the axial and radial direction factors have a very significant effect (Table 2). The results of the axial green specific gravity test are presented in Table 5, while the radial green specific gravity test is presented in Table 6.

Table 5. Results of the Mean Difference Test (LSD) for Green Specific Gravity of Pulai Coppice Wood in the Axial Direction

Treatment	Base	Middle	Tip
Median	0.23b	0.30ab	0.33a

Means followed by the same letter indicate no significant difference according to the 5% BNT test; BNT ($\alpha = 0.05$) = 0.073.

The results of the BNT test (Table 5) show that the green specific gravity of pulai coppice wood varies along the axial direction. At the 1% level, no significant differences were found, but at the 5% level, the tip (0.33) had a significantly different value than the base (0.23), while the middle (0.30) was not significantly different from either. This pattern indicates a tendency for green specific gravity to increase from the base to the tip of the stem. This condition is likely related to differences in wood anatomy, where the tip tends to have thicker-walled fibers and smaller lumens than the base, which is still dominated by juvenile tissue. Similar results were obtained in studies of axial variations in specific gravity in tropical wood species *Melia* sp. by Nock et al. (2009) and in *Alstonia* sp. by Ofori et al. (2010).

Table 6. Results of the Mean Difference Test (BNT) for Green Specific Gravity of pulai coppice wood along the Radial Direction

Treatment	R1	R2	R3
Median	0.31a	0.17b	0.21ab

Means followed by the same letter indicate no significant difference according to the 1% LSD test; LSD ($\alpha = 0.01$) = 0.11.

The LSD test results at the 1% level (Table 6) show that the near-bark region (R1 = 0.31) was significantly different from the region between the heart and bark (R2 = 0.17), while the near-heart region (R3 = 0.21) was not significantly different from either. This pattern is consistent with the radial variation in wood density in tropical trees (Nock et al., 2009; Ofori et al., 2010) and aligns with the wood anatomy of *Alstonia*, which exhibits differences in cellular structure along the stem radius (Mennega, 1989). The average density of pulai coppice wood (main stem) ranges from 270–490 kg/m³ (PROSEA, 2024).

Air-Dry Specific Gravity

Figure 10 above shows the average air-dry specific gravity of pulai coppice wood, which ranges from 0.21 to 0.35, with an average of 0.29. Air-dry specific gravity is generally used to determine wood quality, mechanical strength, durability, and dimensional stability, all of which relate to its utilization. It can be used as an indicator of wood quality for everyday use. This parameter is measured when the wood is air-dried with a moisture content of 12–15%. In other words, the wood

still contains some water and has not yet fully shrunk. In this condition, the specific gravity tends to be higher than the green specific gravity, but lower than the oven-dry specific gravity. The test results for the air-dry specific gravity of coppice wood are lower than the specific gravity of the main stem pulai coppice wood. According to Lemmens et al. (1995), the air-dry specific gravity of this wood ranges from 0.27-0.49 g/cm³ at a moisture content of 15%, with other data indicating an average value of around 0.37 g/cm³ at a moisture content of 12% (Oktavia et al., 2020). These data indicate that Pulai coppice wood is classified as a light to medium-weight wood. The results of the analysis of variance (ANOVA) showed that only the axial direction significantly affected the air-dry specific gravity of pulai coppice wood. The results of the mean difference test for the effect of axial direction on air-dry specific gravity are presented in Table 7.

Table 7. Results of the Mean Difference Test (LSD) for the Air-Dry Specific Gravity of Pulai coppice wood in the Axial Direction

Treatment	Base	Middle	Tip
Median	0.22a	0.32b	0.35b

Means followed by the same letter indicate no significant difference according to the 1% LSD test; LSD ($\alpha = 0.01$) = 0.085.

The LSD test results (Table 7) indicate differences in axial specific gravity in pulai coppice wood: the base (0.22) is significantly lower than the middle (0.32) and tip (0.35), while the middle and tip are not significantly different. This pattern indicates that the tip and middle of the stem tend to have a higher air-dry specific gravity than the base. This is thought to be due to anatomically significant differences: the tissue at the base contains more juvenile wood with larger lumens and relatively

thin cell walls, resulting in a lower air-dry specific gravity. Conversely, the tissue at the middle and tip generally has a thicker proportion of cell walls, resulting in a higher air-dry specific gravity (Mennega, 1989; Nock et al., 2009).

Oven-Dry Specific Gravity

The average oven-dry specific gravity value for test-dried pulai coppice wood ranges from 0.25 to 0.37, with an average of 0.31. The oven-dry specific gravity is obtained after the sample is oven-dried at 103 ± 2°C until it reaches a constant weight, resulting in a complete water-free state, or a moisture content of 0%. This condition reflects the number of solids in the wood, essentially devoid of water. Therefore, oven-dry specific gravity is typically used to compare wood properties between species, or for research purposes. Compared to other specific gravities, namely green and air-dry specific gravity, the oven-dry specific gravity of pulai coppice wood is the highest. However, the oven-dry specific gravity of pulai coppice wood is still lower than that of main stem pulai coppice wood. The results of research by Suhirman & Rahayu (2015) found that the average specific gravity of main stem pulai coppice wood from Papua was 0.40, which is also higher than the results of research by Rizki et al. (2022), which stated that the oven-dry specific gravity of main stem pulai coppice wood is 0.31-0.36. The (FAO, 1995) reported a density of pulai coppice wood of 0.36-0.36 g/cm³. The results of the analysis of variance indicate that the axial direction and interaction influence the oven-dry specific gravity of coppice pulai coppice wood (Table 2). The results of the difference test for the average oven-dry specific gravity of coppice pulai coppice wood in the axial direction and interaction are presented in Table 8 below.

Table 8. Results of the Difference Test for Average (LSD) Dry Specific Gravity of pulai coppice wood in the Axial and Radial Directions (Interaction)

Treatment	PR2	PR1	PR3	UR2	TR3	UR1	TR1	TR2	UR3
Median	0.20e	0.26d	0.29c	0.34c	0.29c	0.30b	0.37b	0.36a	0.34a

Means followed by the same letter indicate no significant difference according to the 1% LSD test; LSD ($\alpha = 0.01$) = 0.030. The LSD test results (Table 8) indicate a significant interaction between axial and radial direction factors on the oven-dry specific gravity of pulai coppice wood. In general, there is a tendency for specific gravity values to increase from the base to the tip of the stem, and from the inner radial portion (near the heart) to the outer radial portion (near the bark). The base-inner radial (PR2) combination showed the lowest value (0.20), significantly different from almost all other combinations. Conversely, the tip-outer radial (TR1) combination gave the highest value (0.37), along with

TR2 (0.36) and UR3 (0.34), which are in the upper group. This pattern indicates that variations in oven-dry specific gravity of pulai coppice wood are not solely determined by the axial or radial positions separately, but by their interaction. At the base, specific gravity values are relatively low across all radials, likely related to the dominance of juvenile wood with larger lumens and thinner cell walls. In the middle of the stem, a transition occurs, where the outer radial combination (TR1) shows high values approaching the tip group. Meanwhile, at the tip, almost all radials exhibit high specific gravity, indicating the presence of tissue with a thicker cell wall proportion.

To support understanding of wood quality, we can examine the relationship between specific gravity values. For example, the relationship between green specific gravity and oven-dry specific gravity, or between air-dry specific gravity and oven-dry specific

gravity, can be used to predict wood quality. The relationship between specific gravity and pulai coppice wood is analyzed using linear regression and illustrated by a scatter diagram, as shown in Figure 6.

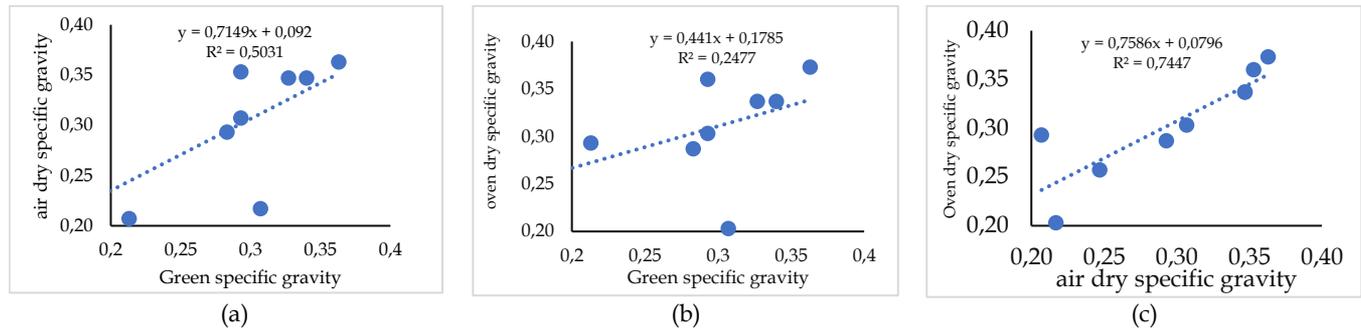


Figure 6. (a) The relationship between green specific gravity and dry air specific gravity; (b) The relationship between green specific gravity and oven dry specific gravity; and (c) The relationship between the air dry specific gravity and the oven dry specific gravity

The correlation analysis shown in Figures 6 shows that there is a varying relationship between the specific gravity measurement conditions of pulai coppice wood. Green specific gravity is positively correlated with air-dry specific gravity ($r = 0.71$; $R^2 = 0.50$; $p < 0.05$), meaning that 50% of the variation in air-dry specific gravity can be explained by green specific gravity. On the other hand, the relationship between green specific gravity and oven-dry specific gravity is relatively weaker and insignificant ($r = 0.50$; $R^2 = 0.25$; $p > 0.05$). The strongest relationship is between air-dry specific gravity and oven-dry specific gravity ($r = 0.85$; $R^2 = 0.73$; $p < 0.01$), this condition indicates that the properties of wood in air-dry specific gravity conditions are good predictors for estimating oven-dry specific gravity. According to Nock et al. (2009); Ofori et al. (2010), measurements under air-dry conditions are more representative for assessing the quality of oven-dried wood than measurements under green conditions.

Utilization Potential

Wood has highly variable properties, both between species, between individuals within the same species, and even between parts of a single trunk, such as differences in position within the trunk, for example, between the base and the tip or between young and mature wood. These variations are influenced by genetic factors, growing conditions, and tree age. Therefore, the physical and mechanical characteristics of wood cannot be generalized based on a single sample (Bowyer et al., 2003; Panshin & Zeeuw, 1980; Tsoumis, 1991).

Research results show that pulai coppice wood (*Alstonia scholaris*) has an air-dry moisture content of 18% and a oven-dry specific gravity of 0.31. This air-dry moisture content indicates that the wood has reached

equilibrium with the surrounding air. According to Skaar (1988) who said that the air-dry moisture content indicates the condition of the wood where the rate of release and absorption of water vapor is relatively stable. In this condition, the physical properties of the wood begin to approach dimensional stability, but there is still the possibility of changes if there are fluctuations in environmental humidity, because wood is hygroscopic. A oven-dry specific gravity of 0.31 indicates that pulai coppice wood is classified as a light wood group (Martawijaya et al., 2005). Specific gravity is closely related to moisture content because the higher the moisture content, the weight of the wood per unit volume also increases, although oven-dry specific gravity remains a standard measure that is free from the influence of humidity (Bowyer et al., 2003). The low specific gravity value in pulai coppice wood is thought to be related to the high proportion of cell cavities and the relatively volatile water content. The relationship between specific gravity and water content in pulai coppice wood shows that the light nature of this wood allows it to quickly adapt to the humidity of the surrounding air. It is important for the use of wood in the field of light construction, crafts, and pulp raw materials, that dimensional stability and fast drying are positive things in the use of wood (Bowyer et al., 2003; Martawijaya et al., 2005). Such conditions can be ensured that this pulai coppice wood is safer for use in indoor conditions (interior) or not directly related to weather changes such as heat and rain. Air-dry moisture content of 18% and specific gravity of 0.31, pulai coppice wood can be categorized as wood with medium stability and low strength but has good prospects for products that do not require high mechanical strength.

Conclusion

The conclusion of this study is that the parameter values of green water content, air-dry water content, green specific gravity, air-dry specific gravity, and oven-dry specific gravity of pulai coppice wood are lower than those of the main stem wood. The axial direction of the stem affects all parameters, the radial direction only affects one parameter, namely green specific gravity. In general, the results of this study show that the axial factor of the stem is the main determinant of the variation in the basic properties of pulai coppice wood. In addition, significant axial and radial interactions on green water content and oven-dry specific gravity indicate that the physical properties of wood are the result of a complex combination of growth direction and tissue anatomical conditions. Pulai coppice wood can be categorized as wood with medium stability and low strength but has good prospects for products that do not require high mechanical strength.

Acknowledgments

Acknowledgments are expressed by the researchers to the team so that researchers can complete research in the form of journal publications.

Author Contributions

Conceptualization; methodology.; validation; formal analysis; investigation; V. D.; resources; data curation; writing—original draft preparation; Y. D. F.; writing review and editing.; visualization: K. K. All authors have read and agreed to the published version of the manuscript.

Funding

No external funding.

Conflicts of Interest

The researchers funded this research independently.

References

- Arinana, & Diba, F. (2009). Kualitas Kayu Pulai (*Alstonia scholaris*) TERDENSIFIKASI (Sifat Fisis, Mekanis dan Keawetan. *Jurnal Ilmu Dan Teknologi Hasil Hutan*, 2(2), 78–88. Retrieved from <https://www.researchgate.net/publication/277988176>.
- Augustina, S., Wahyudi, I., Darmawan, I. W., Malik, J., Basri, E., & Kojima, Y. (2020). Specific Gravity and Dimensional Stability of Boron-Densified Wood on Three Lesser-Used Species from Indonesia. *Journal of the Korean Wood Science and Technology*, 48(4), 458–471. <https://doi.org/10.5658/WOOD.2020.48.4.458>
- Bahanawan, A., Darmawan, T., & Dwianto, W. (2020). Hubungan sifat berat jenis dengan sifat higroskopisitas melalui pendekatan nilai rerata kehilangan air [Relationship between specific gravity and hygroscopicity through average water loss approach. *Jurnal Riset Industri Hasil Hutan*, 12(1), 1. <https://doi.org/10.24111/jrihh.v12i1.5643>
- Bowyer, J. L., Shmulsky, R., & Haygreen, J. G. (2003). *Forest Products and Wood Science: An Introduction*. Iowa State Press.
- FAO. (1995). *Sorghum and Millets in Human Nutrition*. Rome: Food and Agriculture Organization of The United Nations. Retrieved from <https://shorturl.asia/WtVrN>
- Glass, S. V., & Zelinka, S. L. (2010). Moisture relations and physical properties of wood. In *Wood Handbook – Wood as an Engineering Material*. USDA Forest Service, Forest Products Laboratory.
- Lemmens, R. H. M. J., Soerianegara, I., & Wong. (1995). *Plant resources of South-East Asia No (W. C (ed.); Vol. 5, Issue 2)*. Backhuys Publishers. Retrieved from <https://prosea.prota4u.org/view.aspx?id=3346>
- Martawijaya, A., Kartasujana, I., Mandang, Y. I., Prawira, S. A., & Kadir, K. (2005). *Atlas Kayu Indonesia Jilid I*. Bogor: Pusat Penelitian dan Pengembangan Hasil Hutan.
- Meiganati, K. B., Susdiyanti, T., & Suryana, M. F. H. (2023). Karakteristik Fisika Dan Mekanika Kayu Jati Unggul Nusantara Coppice Umur 8 Tahun: Physical and Mechanical Characteristics of Superior Nusantara Copies Teak Wood Age 8 Years. *Jurnal Penelitian Hasil Hutan*, 41(3), 157–164. <https://doi.org/10.55981/jphh.2023.2562>
- Mennega, A. M. W. (1989). Ecological and systematic wood anatomy of *Alstonia* (Apocynaceae. *IAWA Bulletin*, 10(1), 25–37. Retrieved from <https://scispace.com/pdf/ecological-and-systematic-wood-anatomy-of-alstonia-1ip2pe0dar.pdf>
- Nock, C. A., Geihofer, D., Grabner, M., Baker, P. J., Bunyavejchewin, S., & Hietz, P. (2009). Wood density and its radial variation in six canopy tree species differing in shade-tolerance in western Thailand. *Annals of Botany*, 104(2), 297–306. <https://doi.org/10.1093/aob/mcp129>
- Ofori, J., Brentuo, B., & Espinoza, E. (2010). Shrinkage characteristics and density of *Alstonia boonei* De Wild. *Ghana Journal of Forestry*, 26(1), 66–75. Retrieved from https://fornis.net/sites/default/files/documents/shrinkage_characteristics.pdf
- Oktavia, R., Misfadhila, S., & Rivai, H. (2020). Overview of traditional, phytochemical, and pharmacological uses of pulai (*Alstonia scholaris*). *World Journal of Pharmacy and Pharmaceutical*

- Sciences*, 9(8), 334–354. Retrieved from <https://shorturl.asia/9nKzb>
- Panshin, A. J., & Zeeuw, C. (1980). *Textbook of wood technology: Structure, identification, properties, and uses of the commercial woods of the United States and foreign woods* (4th ed.). New York: McGraw-Hill.
- PROSEA. (2024). *Alstonia scholaris* (pulai) species profile. *World Agroforestry*. Retrieved from <https://apps.worldagroforestry.org/treedb2/speciesprofile.php?Spid=201>
- Riana, A., Marwoto, J. K., & Zaini, B. (2025). Peningkatan Kayu Pulai (*Alstonia scholaris*) dengan Metode Densifikasi Waktu Pengukusan. *Jurnal Silva Tropika*, 8(2), 130–140. <https://doi.org/10.22437/jurnalsilvatropika.v8i2.37797>
- Rizki, L. M., Nuriyatin, N., & Saprinurdin. (2022). Analisis kualitas kayu pulai (*Alstonia angustiloba* Miq) sebagai bahan baku pensil pada berbagai posisi batang ditinjau dari berat jenis (BJ) dan dimensi serat. *Journal of Global Forest and Environmental Science*, 2(3), 69–77. Retrieved from <https://ejournal.unib.ac.id/jhutanlingkungan/article/view/25727>
- Salahuddin, M., Tambunan, H., & Wahyudi, I. (1995). 1995. *Pengaruh lama penyimpanan bahan baku kayu terhadap sifat fisis dan mekanis papan partikel kayu karet (Hevea brasiliensis Muell Arg.* IPB University. Retrieved from <http://repository.ipb.ac.id/handle/123456789/148298>.
- Sallenave, R. (1971). *Properties of Tropical Woods*. FAO.
- Simpson, W. T., & Ten Wolde, A. (1999). Physical properties and moisture relations of wood. In R. J. Ross (Ed.), *Wood handbook: Wood as an engineering material*. U.S. Department of Agriculture.
- Skaar, C. (1988). *Wood-Water Relations*. Springer-Verlag.
- Suhirman, & Rahayu, I. (2015). Drying behaviors of two Papuan wood species: *Alstonia scholaris* and *Octomeles sumatrana*. *Journal of the Korean Wood Science and Technology*, 43(5), 635–643. <https://doi.org/10.5658/WOOD.2015.43.5.635>
- Tsoumis, G. (1991). *Science and technology of wood: Structure, properties, utilization*. New York: Van Nostrand Reinhold.
- Vieilledent, G., Fischer, F. J., Chave, J., Guibal, D., Langbour, P., & Gérard, J. (2018). New formula and conversion factor to compute basic wood density of tree species using a global wood technology database. *American Journal of Botany*, 105(10), 1653–1661. <https://doi.org/10.1002/ajb2.1175>
- Zobel, B. J., & van Buijtenen, J. P. (1989). Wood variation and wood properties. In *Wood variation: its causes and control* (pp. 1–32). Springer. https://doi.org/10.1007/978-3-642-74069-5_1