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DURABILITY PROPERTIES OF RAJUMAS WOOD (*Duabanga moluccana* Blume) BY COLD SOAKING METHODS

Sifat Keterawetan Kayu Rajumas (Duabanga moluccana Blume) Dengan Metode Perendaman Dingin

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ABSTRACT

Rajumas wood is a type of fast-growing wood that is included in durable class IV-V. The availability of local wood is abundant and is commonly used in West Nusa Tenggara (NTB) Province. This wood has a low durability class, so it needs special treatment, namely pickling. This research aims to determine the level of absorption, retention, and penetration of rajumas wood. The samples used were the core and sapwood of Rajumas wood. This research uses a cold soaking method with 1% biocide preservative with a soaking time of 12 hours, 24 hours, and 36 hours. The results showed that the TC sample (core part; soaking time 36 hours) produced the highest absorption and penetration values, 0.2035 g/cm^3 and 0.3575 cm, respectively. Meanwhile, the GC sample produced the highest retention value (sapwood; soaking time 36 hours), namely 0.0090 g/cm^3. These results show that the durability of rajumas wood in the heart and sapwood is relatively high at the absorption level, while the retention level tends to be low.

Keywords: Biocide; Preservation; Cold soaking; Rajumas.

ABSTRAK

Kayu rajumas merupakan salah satu jenis kayu cepat tumbuh (fast growing wood species) yang termasuk dalam kelas awet IV-V. Ketersediaan kayu lokal ini sangat banyak dan umum digunakan di Provinsi Nusa Tenggara Barat (NTB). Kayu ini memiliki kelas awet rendah sehingga perlu dilakukan perlakuan khusus yaitu pengawetan. Penelitian ini bertujuan untuk mengetahui tingkat absorbsi, retensi, dan penetrasi dari kayu rajumas. Sampel yang digunakan berupa bagian teras dan gubal kayu rajumas. Penelitian ini menggunakan metode perendaman dingin dengan bahan pengawet biocide 1 % dengan lama waktu perendaman 12 jam, 24 jam, dan 36 jam. Hasil penelitian menunjukan bahwa sampel TC (bagian teras; lama perendaman 36 jam) menghasilkan nilai absorbsi dan penetrasi tertinggi, masing-masing yaitu 0,2035 g/cm^3 dan 0,3575 cm. Sedangkan nilai retensi tertinggi dihasilkan oleh sampel GC (bagian gubal; lama perendaman 36 jam) yaitu 0,0090 g/cm^3. Hasil ini menunjukan bahwa sifat keterawetan kayu rajumas pada bagian teras dan gubal relatif tinggi pada tingkat absorbsi, sedangkan pada tingkat retensi cenderung rendah.

Kata kunci: Biocide; Keterawetan; Perendaman dingin; Rajumas.

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A. INTRODUCTION

Development in Indonesia is advancing yearly along with population growth, so the need for commercial timber continues to increase. Although various building materials have been developed in the market, wood still plays a vital role in housing and residential construction. Along with the continuous use of natural forest wood, the availability of wood begins to decrease. The price is relatively high and requires other alternatives to substitute natural forest wood, which can use fast-growing wood species, including rajumas wood.

Rajumas wood (*Duabanga moluccana* Blume) is one of the local timber forest products originating from West Nusa Tenggara Province and has the advantage of fast-growing wood species (Wulandari & Suastana 2022). However, Rajumas wood has the disadvantage of low strength and durability (Lestari 2020). Rajumas wood is included in the class IV - V category for wood durability class (Bonita 2015). Good quality wood has a long service life and is resistant to termite and mold attacks (Arsyad 2022). Therefore, one of the efforts to increase the strength and durability of wood is to provide treatment (Arsyad 2022). One alternative is to carry out a wood preservation process that is easy to do through cold soaking. The advantages of using cold soaking techniques include extensive penetration and retention values of preservatives and short preservation time. This preservation process aims to extend the service life of wood to save the use of wood (Pangestuti & Hardomo 2016).

Wood preservation is preventing attacks by destroying organisms by adding preservative solutions to wood (Krisdianto *et al.* 2015). Preserving wood is important because it can increase the life service of the wood (Lebow *et al.* 2015). Increasing the durability of wood with preservatives will cause the wood to be toxic to fungi and insects (Brischke *et al*. 2023). Wood durability is measured by three main measures, namely absorption, penetration, and retention. Absorption is the amount of preservative solution that enters and seeps into the wood. Penetration of preservatives is a measure that describes the depth of preservatives in the wood (Pangestu *et al.* 2020). Preservative retention is a measure that describes the amount-of pure preservatives that can be contained in wood after being preserved (Pangestu *et al.* 2020).

Biocide is one of the preservatives that can protect wood substrates where the use of biocide preservatives in oil palm wood has proven effective in protecting wood from damage and fungal growth in oil palm wood (Erlangga 2007). Fakhri *et al.* (2016) added that preserving palm wood with a concentration of biocide preservatives effectively prevented blue mold (blue stain). Research conducted by Pangestu *et al.* (2020) states that the best treatment of rubber wood preservation tests using biocide produces an absorption value of 116.2 kg/m³, a retention value of 5.2272 kg/m³, and a penetration value of 4.775 kg/m³ which is done in soaking for 36 hours. Apart from wood, biocide preservatives can also increase the resistance of bamboo to destructive organisms in craft products in Karang Sidemen Village (Lestari *et al.* 2020).

Previous research shows the importance of wood durability properties in facilitating wood preservation. Literature studies have shown that research on the durability of rajumas wood has never been conducted. Therefore, it is necessary to research the preservation properties of rajumas wood to determine the level of absorption, penetration, and retention in rajumas wood.

B. METHODS

Wood testing was conducted at the Forest Products Technology Laboratory (THH), Mataram University. The materials used include rajumas wood, biocide preservatives, and water. The tools used include soaking tubs, cups, saws, measuring tapes, rulers, analytical scales, paint, and paint brushes.

The rajumas wood was obtained from Sambik Elen Village, Masbagik District, East Lombok Regency, on October 30, 2024. The timber was 15 years old with a diameter of 30 cm. The logs were divided by position to obtain the heartwood and sapwood. The logs were then cut to 2 cm x 2 cm x 20 cm. The number of samples required was 18, with details for 9 sapwood samples and 9 heartwood samples. Then, it was placed at room temperature until air dry condition and weighed until it was constant. Next, the samples were immersed into the preservative solution that had been made with the recommended concentration of 1%. The preservative used was biocide wood fungicide by cold soaking. The preservative solution was created in 3 tubs for soaking treatments of 12 hours, 24 hours, and 36 hours.

The research was an experimental method. It used a factorial Completely Randomized Design (CRD) with 2 factors, namely wood parts (2 levels) and soaking time (3 levels). The first factor was wood parts, consisting of 2 levels of sapwood (G) and heartwood (T). The second factor was the length of wood soaking using biocide preservatives, composed of 3 levels, according to the research of Pangestu *et al.* (2020). They were 12 hours (A), 24 hours (B), and 36 hours (C), with 3 repetitions, so that the total samples obtained were 18 samples. The parameters observed in this study were absorption, retention, and penetration. The observation data were analyzed by analysis of variance at an absolute level of 5% using Co-stat software. If a significant difference exists, further tests would be carried out using the Honest Real Difference (Tukey) test.

Wood Durability Testing Parameters

The parameters tested in this study were:

1. Absorption

Samples that have passed the immersion period with preservatives are then removed and weighed to determine the weight of the sample after preservation (BS) to calculate the absorption value. To calculate the absorption value, can use the following equation:

$$\text{Absorption} = \frac{BS - BQ}{V}$$

Where, BS is the weight of wood after curing (g), BQ is the weight of wood before preservation (g), and V is wood volume (cm^3).

2. Retention

The preservative retention is calculated by weighing the weight of the wood sample before and after the preservation process. (Suhaendah & Siarudin 2014). To calculate the retention value of the test sample, the following equation can be used:

$$\text{Retention} = \frac{(W2 - W1) \times C}{V}$$

Where, W1 is the weight of the Rajumas wood sample before preservation (g), W2 is the weight of the Rajumas wood sample after preservation (g), V is a volume (m^3), and C is a dose of preservative solution (%)

3. Penetration

According to Pangestu (2020), to measure the penetration depth of the preservative, each sample will be cut in a transverse direction and located in the center after standing for two weeks at room temperature or air dry conditions. To calculate the penetration value, the following equation can be used:

$$\text{Penetration} = \frac{P1 + P2 + P3 + P4}{4}$$

Where, P1 is first penetration 1, P2 is penetration 2, P3 is penetration 3, and P4 is penetration 4

C. RESULTS AND DISCUSSION

The results of the rajumas wood absorption test can be seen in Figure 1. The graph in Figure 1 shows the trend of increasing absorption values along with the length of soaking. The test results show that the average absorption results range from 0.1012 to 0.2035 g/cm^3. The TC sample produces the highest value of 0.2035 g/cm^3, and the lowest in the GA sample is 0.1021 g/cm^3. The results in Figure 1 also show that wood with 36 hours of soaking has better and higher absorption than others. The difference in soaking time of rajumas wood can cause differences in the absorption of preservatives. Pangestu *et al.* (2020) stated that the longer the wood is soaked in preservatives, the more preservatives will be absorbed by the wood fibers, thus increasing protection against fungal attacks and other decomposing organisms.

The diversity of absorption values of rajumas wood was analyzed by ANOVA and presented in Table 1. Based on Table 1, it can be seen that the length of soaking has a real effect on the absorption parameter where the results of f count > f table, then the Tukey test must be carried out.

Table 1. ANOVA of Rajumas wood absorbance

Source of Diversity	Free Degree	Sum of Squares	Center Square	F. Count	F Table	Description
Treatment	5	0,02824	0,005648	24,43121	3,105875	Significant
Error	12	0,003	0,000231			

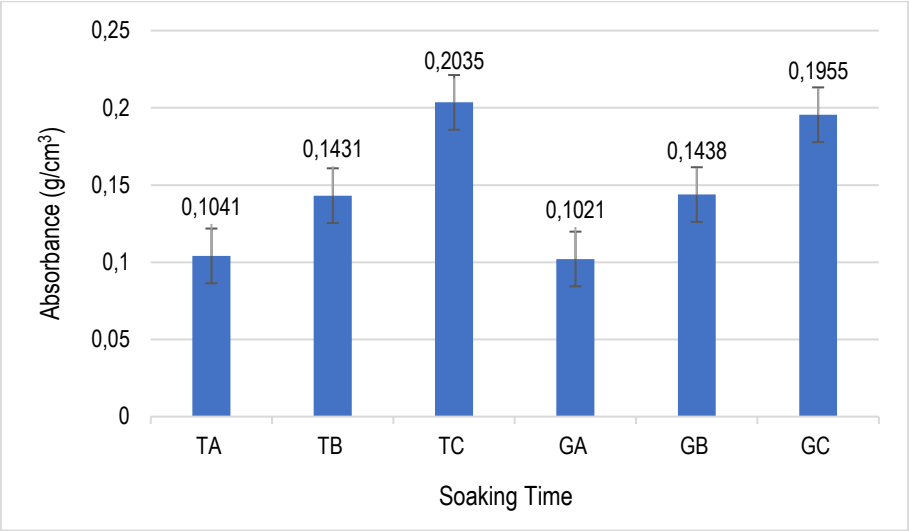

Figure 1. Absorption values of Rajumas wood at various soaking time intervals. Notes: TA= 12-hour soaking heartwood, TB= 24-hour soaking heartwood, TC= 36-hour soaking heartwood, GA= 12-hour soaking sapwood, GB= 24-hour soaking sapwood, GC= 36-hour soaking sapwood.

The results of the Tukey test of the absorption value can be seen in Table 2. It shows that the average absorption results range from 0.1021-0.2035 g/cm^3. The average absorption value in the TC sample produces the highest value of 0.2035 g/cm^3, and the lowest in the GA sample is 0.1021 g/cm^3. The difference in absorption values in heartwood and sapwood is thought to be caused by the presence of extractive substances, density, and wood density (Haroen and Dimyati 2006).

Table 2. The mean of absorption and its Tukey test 5%

Treatment	Absorption (g/cm^3)
TA (12-hour heartwood)	0.1041^{a}
TB (24-hour heartwood)	0.1431^{ab}
TC (36-hour heartwood)	0.2035^{b}
GA (12-hour sapwood)	0.1021^{a}
GB (24-hour sapwood)	0.1438^{ab}
GC (36-hour sapwood)	0.1955^{ab}
Tukey	**0.8931**

Source: Primary Data (2024)

The results also showed that the longer the soaking, the higher the wood absorption in both heartwood and sapwood. This can be caused by the longer the soaking, the easier and deeper the preservatives enter the wood (Sadir & Mirawati 2024). The high absorption in wood can be caused by several factors, including the type of wood, the direction of the wood grain, and the soaking time (Sumaryanto *et al.* 2013).

The rajumas wood retention test results showed an increasing trend in retention values along with the length of soaking (Figure 2). The average retention results ranged from 0.0030-0.0090 g/cm^3. The GC sample produced the highest value of 0.0090 g/cm^3 and the lowest in the GA sample, 0.0030 g/cm^3. The longer the wood is soaked, the more preservatives can be absorbed, increasing retention (Pangestu 2020). The retention test results in this study are lower than the research of Muslim *et al.* (2022), who preserved bayur wood with the cold soaking method using neem leaf extract preservatives and obtained an average retention value of 0.009 g/cm. Based on these results, it can be concluded that to get the best retention value, the sapwood of rajumas can be used with a soaking time of 36 hours.

The diversity of retention value of rajumas wood was analyzed by ANOVA and presented in Table 3. Based on Table 3, it can be seen that the length of soaking has a real effect on the absorption parameter where the results of f count> f table, then the Tukey test must be carried out.

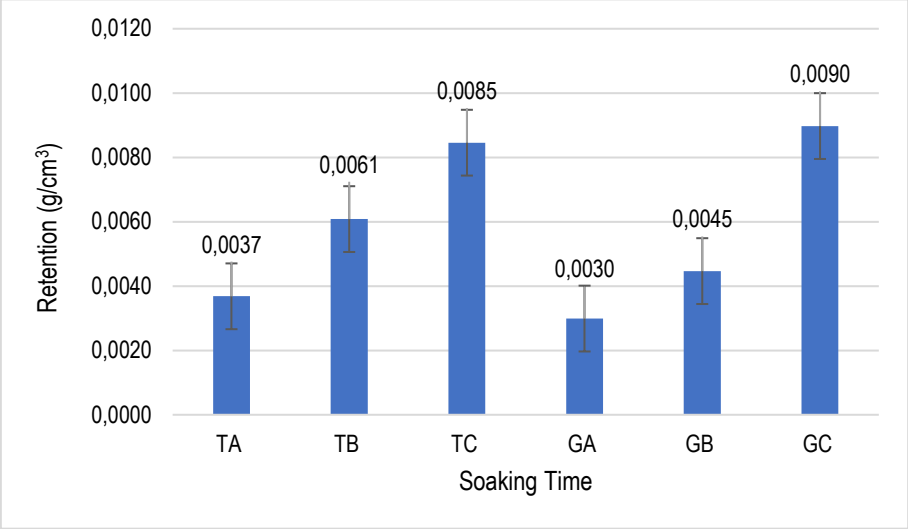

Figure 2. Retention value of Rajumas wood at various soaking time intervals. Notes: TA= 12-hour soaking heartwood, TB= 24-hour soaking heartwood, TC= 36-hour soaking heartwood, GA= 12-hour soaking sapwood, GB= 24-hour soaking sapwood, GC= 36-hour soaking sapwood).

Table 3. ANOVA of Rajumas wood retention

Source of Diversity	Free Degree	Sum of Squares	Center Square	F. Count	F Table	Description
Treatment	5	9.41073E-05	1.88215E-05	58.5423	3.105875	Significant
Error	12	0.0000039	3.21502E-07			

The results of the Tukey test on the absorption value can be seen in Table 4. Table 4 shows that the average retention results ranged from 0.0030-0.0090 g/cm^3. Based on Table 4, the average value of the most significant retention in the treatment of 36-hour soaking in the sapwood rajumas or GC is 0.0090 g/cm^3, while the lowest is in the treatment of 12-hour soaking in the sapwood rajumas or GA is 0.0030 g/cm^3. Sapwood is the outer part of a younger tree trunk, where wood cells tend to contain more water and have less lignin and cellulose content, making it easier to retain preservatives. This is in line with Sumaryanto (2013), who also preserved sapwood with the cold soak method, which states that the longer the preservative soaking affects wood retention.

Table 4. The mean of retention and its Tukey test 5%

Treatment	Retention (g/cm^3)
TA (12-hour heartwood)	0.0037^{ab}
TB (24-hour heartwood)	0.0061^{c}
TC (36-hour heartwood)	0.0085^{d}
GA (12-hour sapwood)	0.0030^{a}
GB (24-hour sapwood)	0.0045^{b}
GC (36-hour sapwood)	0.0090^{d}
Tukey	**0.0346**

Source: Primary Data (2024)

The results of the preservative penetration test on rajumas wood continued to increase along with the length of immersion (Figure 3). This study showed that the average penetration results ranged from 0.175-0.3575 cm, with the most significant average penetration value in the TC sample, 0.3575 cm, and the GC sample, 0.3367 cm. The lowest is in GA, which is 0.1750 cm. The data shows that the preservation of sapwood and heartwood wood is different, especially regarding the penetration process of preservatives. Sapwood generally has better preservative penetration ability but is more quickly damaged if not treated. In comparison, the heartwood is the core part of the tree trunk, which is denser and more durable (Sumaryanto *et al.* 2013) because heartwood has tighter cells and thicker cell walls, so this structure makes the pores of heartwood smaller and less than sapwood. This condition allows preservatives to be more easily retained in

the heartwood cells. Sapwood has larger cells and thinner cell walls. The pores of sapwood are larger and more numerous, so during the drying process, the preservative evaporates more quickly and escapes from the wood. Due to these factors, the penetration results did not show significant penetration into the wood (Darwis *et al.* 2005).

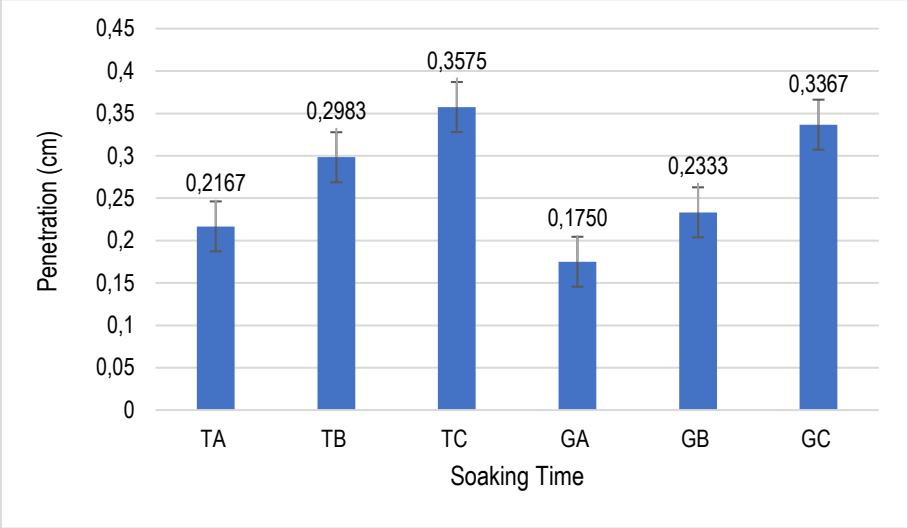

Figure 3. Penetration values of Rajumas wood at various soaking time intervals. Notes: TA= 12-hour soaking heartwood, TB= 24-hour soaking heartwood, TC= 36-hour soaking heartwood, GA= 12-hour soaking sapwood, GB= 24-hour soaking sapwood, GC= 36-hour soaking sapwood.

Data from the analysis of the diversity of rajumas wood penetration can be seen in Table 5. The data shows that the effect of soaking time on penetration parameters has no real effect where the results of the f count are not much different from the f table, so there is no need to do a Tukey test.

Table 5. ANOVA of Rajumas wood penetration

Source of Diversity	Free Degree	Sum of Squares	Center Square	F. Count	F Table	Description
Treatment	5	0.078349	0.01567	4.591413	3.105875	Significant
Error	12	0.0409542	0.003413			

The penetration results in this study are lower than the penetration value in the research of Muslim *et al.* (2022), who preserved bayur wood with the cold soaking method using neem leaf extract preservatives, obtaining values ranging from 2.771-3.037 cm with an average value, 2.901 cm. The difference in penetration value can be influenced by tree species, moisture content, and the preservation process (Vhanotank 2022). The drying factor is also one of the causes of the high and low penetration values obtained by wood (Ikhsani *et al.* 2014).

D. CONCLUSION

It can be concluded from the study that, in general, the TC sample (heartwood part; 36 hours soaking time) produces the best preservation properties with an absorption value of 0.2035 g/cm^3, retention of 0.0085 g/cm^3, and penetration of 0.3575 cm. This is because the longer the sample soaking, the better and more profound the absorption of preservatives into the wood.

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