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BIOLOGICAL PERFORMANCE OF SOUTH SULAWESI COMMUNITY WOODS AGAINST A WOOD DETERIORATION ORGANISM: MARINE BORER

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ABSTRACT

This research aims to analyze the natural resistance of community woods against marine borer, namely *Diospyros* sp., *Calophyllum inophyllum*, *Dillenia indica*, *Albizia falcataria* (L) Fosberg, and *Vitex cofasssus*. A total of 30 samples with sizes of 5 cm x 5 cm x 30 cm prepared. All samples were arranged using a plastic strap and immersed at a depth of 3 m in the sea for 3 months. At the end of the bioassay, the biological performance of the wood samples was analyzed by obtaining the attack intensity and weight loss of the samples. The results showed that all the samples were attacked by marine borer in various intensity, thereby leading to various weight loss. *D. indica* showed the lowest attack intensity and weight loss compared to the other species. On the contrary, *A. falcataria* (L) Fosberg showed the highest attack intensity and weight loss. Therefore, in conclusion, *D. indica* and *A. falcataria* (L) Fosberg has the highest and lowest natural resistance against marine borer attack, compared to the other wood species. The various types of organisms that attack the samples were *Teredo navalis* (Teredinidae) and *Martesia striata* Linn (Pholadidae).

Keywords: Biological performance; attack intensity; community wood; marine borer; pholadidae.

INTRODUCTION

The potential of community forests in Indonesia is very large, covering 1.271.505.61 ha, with an estimated total of 42.965.519 trees [1]. According to the 2017 forestry statistical data, the total area of community forests in South Sulawesi is 258,854 ha with enormous opportunities and potential in improving their welfare, land quality, and maintaining soil fertility as well as water management [2]. However, the excessive use of wood leads to an increase in forest exploitation and threats to its sustainability. Therefore, pressure on natural forests as the largest supplier of wood is reduced by the use of alternative timbers originating from community forests with relatively lower quality, in terms of natural strength and durability.

The natural durability of wood is due to several factors such as extractive content, age, location of wood usage, as well as the species of deterioration

organisms, such as termites, marine borers and fungi. For this reason, it is necessary to carry out research on the basic nature of wood from community forests, including its resistance to the marine borer. Wood that uses in the marine environment is often exposed to severe deterioration caused by mechanical loads and wood deterioration organisms, namely marine borers [3]. Marine borers cause wood decay, particularly high in tropical countries, and recently become a global problem and causing massive economic loss as well as material losses to the sectors concerned [4]. This tends to create an opportunity for the use of timber from the community as a substitute for natural wood, which is becoming increasingly scarce. Therefore, this study examines the natural resistance properties of *Diospyros* sp., *C. inophyllum*, *D. indica*, *A. falcataria* (L) *Fosberg*, and *V. cofasssus*. These species of wood were selected based on considerations. For example, the cultivation of *C. inophyllum* species recently became a national program for the production of raw material such as biofuel, here the seeds are utilized, and therefore, the wood will be available in large quantities [5]. Furthermore, arang wood (*Diospyros* sp.), was chosen with the consideration that this wood species is a family with ebony which is famous for its strength and durability, so it needs to be investigated does this wood also have the same properties as ebony or not.

MATERIALS AND METHODS

The following were the wood sample used to carry out this study namely: 1) *Diospyros* sp., which grows in rocks in the Selayar Regency, at a diameter of 23.5 cm diameter and ± 40 years. 2) *C. inophyllum* extracted from Barru Regency, which grows in clay soils on the littoral area at a diameter of 33.43 cm and ±50 years. 3.) *D. indica*, at 22.61 cm in diameter and ± 50 years. 4) *A. falcataria* (L) *Fosberg* with ±30 years and 23.25 diameter, and 5) *V. cofasssus* wood from the Palopo area at a diameter of 24.56 cm and ± 50 years.

All wood samples were tested against marine borers at the Barrang Lompo Island as a Marine Station of Hasanuddin University, Makassar.

Sample Preparation

Each tree was cut 0 cm on the ground and taken 50 cm long, with test samples of 2.5 cm x 5 cm x 30 cm, obtained from the heartwood and sapwood in two directions perpendicular to the plane of the piece, as shown in Fig. 1. The sample was prepared 30 pieces and marked based on position in the stem. The test sample comprises of 3 heartwood and sapwoods, respectively. All samples were perforated at both ends in their tangential fields with a wooden drill, then dried in an oven at 60°C for 48 hours and weighed before carrying out bioassay against the marine borer.

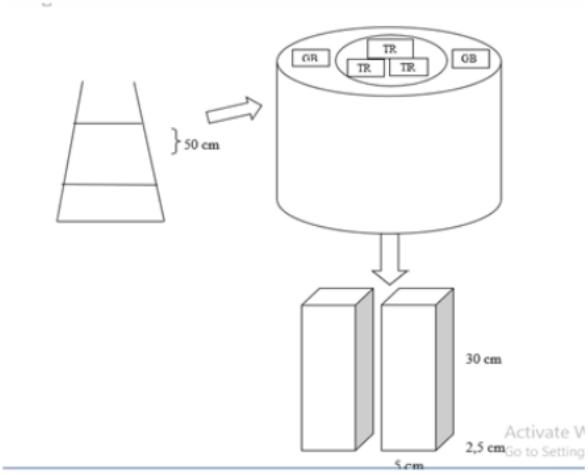


Fig. 1. Samples preparation method

Bioassay against Marine Borer

The bioassay was conducted on Barrang Lompo Island with all test samples woven in plast c straps and separated by a hose, as shown in Fig. 2. Furthermore, they were immersed in the sea in a Horizontal position at a depth of ± 3 m for 3 months. After the immersion process, the samples were removed, and the marine borers species identified by splitting the test sample. The wood was cleaned, dried at 60°C and re-weighed to obtain the final weight. All the samples must be cleaning from the remaining attached organisms to avoid the possibility of heavy additions due to the entry or stickiness of marine borers. In order to obtain the validation value of the natural resistance, there are two kinds of controls prepared in this study, namely, control of wood species that have been known to have natural durability against marine borers and also control of wood species that have low specific gravity which is assumed to have low resistance.

Determination of Attack Intensity of Marine Borers

The attack intensity of marine bores was determined based on the percentage of the samples' weight loss after bioassay attack on marine borer. This was determined using the Standard Nordic Wood Preservation Council (NWPC) No. 1.4.2.2 / 73.

Observation Variable

The weight reduction variable of wood after immersion in the sea is determined using the following formula:

$$WL = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100\% \quad (1)$$

Notes:

Weight Loss (WL) = Weight Loss of samples (g)

Initial weight = Samples weight before bioassay (g)

Final weight = Samples weight after bioassay

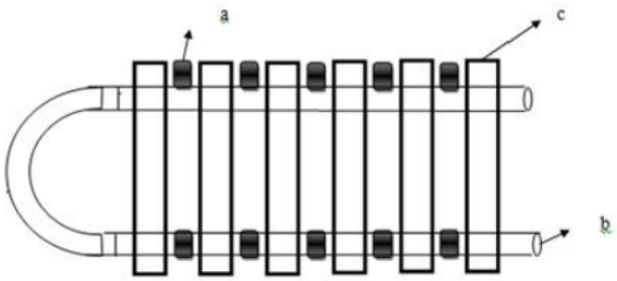


Fig. 2. Samples arrangement to bioassay

Notes:
a. Plastic hose
b. Plastic strap
c. Samples

Table 1. Attack intensity of marine borers

No	Samples condition	Scale	Attack intensity
1	No attack	0	<1%
2	Light attack	1/3	1 – 33%
3	Middle attack	2/3	34 – 66%
4	Heavy attack	1	>67%

RESULTS AND DISCUSSION

Samples Condition before and after Bioassay

The result of this study showed that all samples immersed for 3 months in Barrang Lompo Island were attacked by marine borer. The conditions of the samples before and after bioassay are shown in Figs. 3, 4, 5 and 6.

The marine borer attacked the wood by leaving only small holes on its surface with damages to the inside. The conditions after the split samples are shown in Figs. 7 and 8 due to the fact that when the wood is cleaved, no organism was found. A comparable sample from a similar study was utilized to estimate the species of organism that attacked the wood.

Identified Marine Borer Species

According to Pasang [6] and Abdullah [7], the difficulty in identifying the organisms that attacked the sample, woods with similar marks, were compared [6,7], as shown in Figs. 7 and 8.

Fig. 3. Samples condition before bioassay (a) *V. cofassus* (b) *C. inophyllum* (c) *D. indica* (d) *A. falcataria* (e) *Diospyros* sp.

Fig. 4. Samples condition after one month bioassay (a) *Diospyros* sp., (b) *D. indica* (c) *C. inophyllum* (d) *V. cofassus* and (e) *A. falcataria*

Fig. 5. Samples condition after two months bioassay (a) *A. falcataria* (b) *V. cofassus* (c) *Diospyros* sp. (d) *D. indica* (e) *C. inophyllum*, (f) Shells that stick to the samples

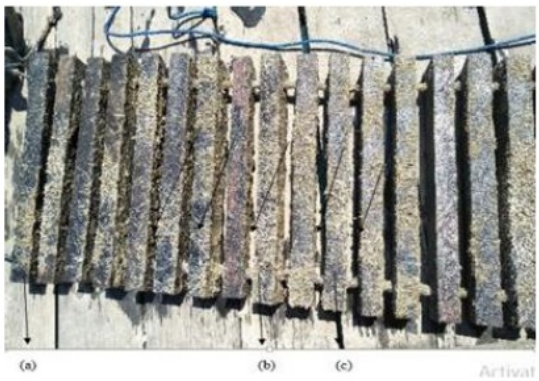


Fig. 6. Samples condition after three months bioassay (a) *Diospyros* sp. (b) *D. indica* (c) *C. inophyllum*

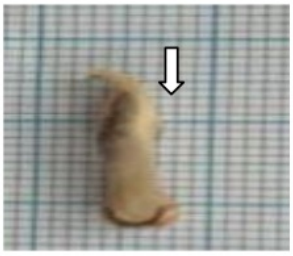
Figs. 7 and 8 show the two types of wood borer organisms that attack the test sample in the research conducted by Pasang [6] and Abdullah [7] with immersion for 3 and 6 months, respectively. The *Diospyros* sp., *C. inophyllum*, *A. falcataria,* and *V. cofassus woods* are attacked by the Teredinidae family of *Teredo navalis*, while the *D. indica* wood is attacked by organisms from the family of Pholadidae namely *Martesia striata* Linne. Species of Teredo are often called shipworms due to their ability to damage yard woods. Young hatched Teredo navalis has a pair of grafts on its edge. Its stingy-like teeth are used to drill wood and become worm-like creatures [8]. The Teredinidae family can cause severe damage to wood, although the wood looks good from the outside, actually inside the wood has been hollowed out [9]. *Martesia striata* Linne is a marine borer organism that is white, brittle, and has a wing-like shape and is a wood deterioration agent which is quite dangerous in the coastal zone and also causes wood damage in the subtidal zone in cooperation with shipworms [10]. There is a radial groove on their bowl with a gap at the rounded end and no grooves [6]. In accordance with the results of research conducted by Atwood and Johnson [11], the number of borers attacking wood in a limited place leads to the creation of numerous linked channels thereby, forming a honeycomb. Teredinidae also has the ability to attack the inside of the wood while the surface is slightly stained.

(a) *A. falcataria*

(b) *Diospyros* sp.

(c) *C. inophyllum*

(d) *V. cofassus*



(e) *Teredo navalis* (Abdullah, 2018) [7]

Fig. 7. ***Teredo navalis*** **is a species of marine borer that attack** ***A. falcataria, Diospyros*** **sp.,** ***C. inophyllum*** **and** ***V. cofassus*** **wood samples**

Weight Loss of Five Wood Species

Fig. 9 shows that the average value of weight loss in the test sample increased from the heartwood to the sapwood. Therefore, all test the samples on the heartwood section have a lower average weight loss, this might be due to the numerous extractive substances contain the wood which may be toxic or repellent to marine organisms attack. Moreover, the wood material properties required for use at marine environment are as follows: high density, strong, high rigidity, high resistance to fungal attack and to marine borers; can be treated, in the case of wood species with low natural durability [3,12], *D. indica* wood showed the lowest percentage of weight loss compared to *Diospyros* sp., *C. inophyllum*, *V. cofassus,* and *A. falcataria*, therefore, it has a higher natural resistance.

Variation in the different natural resistance of wood is due to the differences in extractive content, the levels of silica contained in wood as well as the hardness and density. In general, wood that has resistance against attack wood destroying organisms contains extractive substances which are known to provide protection against these deterioration agents. One of them, obtusaquinone, which is isolated from *Dalbergia retusa*, is effective against marine borers and marine fungi as well as against other wood-deterioration organisms. The silica content in wood is also effective in providing resistance to damage by some sea borers but does not affect the durability of wood on the terrestrial zone [13].

(a) D. indica

(b) *Martesia striata* Linne [6]

Fig. 8. *Martesia striata* Linne is a marine borer species that attack *D. indica* wood samples

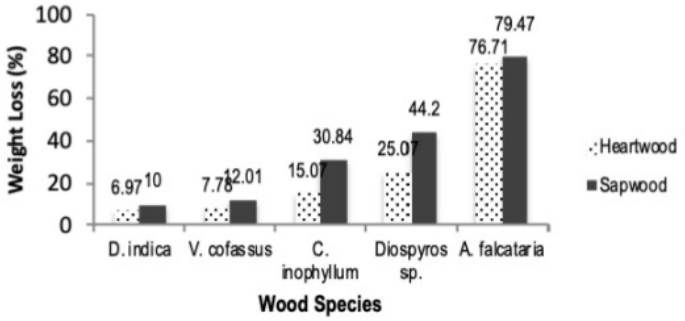


Fig. 9. Weight loss of the wood samples

Hardwood does not mean it is more resistant to attack by wood deterioration organisms [14–17]. It has the lowest weight loss due to a high extractive substance with natural durability in class III and a strong specific gravity of 0.75 in class I-II [17]. Conversely, *A. falcataria* wood is the highest percentage of weight loss value because it is a fast-growing species with a specific gravity of 0.33 and durable class IV-V. Also, it possesses extractive substances which are classified as moderate and resistant to marine borers attack. The *V.* cofassus wood is the main raw material used to construct the phinisi, which is a famous traditional boat from South Sulawesi. This wood has a greater percentage of weight loss compared to *D. indica* with, a higher density, and irresistant to deterioration organisms [18].

Attack Intensity

The attack intensity of marine borers is based on the Standard Nordic Wood Preservation Council (NWPC) No. 1.4.2.2 / 73.

The intensity of attacks is measured by splitting the test sample into two parts, with the magnitude expressed in percentage (%). The intensity of attacks on heartwood and sapwood are expressed in percentage (%) as shown in Fig. 10.

In accordance with the percentage of an attack on *C. inophyllum* wood, the intensity in heartwood (17.82%) and the sapwood (17.32%) is medium. The *Diospyros* sp. wood has a heartwood and sapwood of 38.4% and 58.87%, respectively, with severe attack conditions. This is due to extractive substances and moderate cellulose content. Meanwhile, for *D. indica*, the percentage of the smallest average value in heartwood and sapwood is 6.33% and 6.5% with mild attack conditions due to the extractive substances inhibiting the attack. A graph of *V. cofassus* against *A. falcataria* is plotted and used to compare the three types of woods. The graph shows that *D. indica* and *V. cofassus* possess similar conditions to the attack, may because of the extractive substances contained in the wood function as poisons or resist attacks by marine borer organisms. However, A. *falcataria* has a fairly high attack intensity because it is a softwood commonly used in building poles, household furniture, fences, pulp, and paper.

Table 2. Average value of attack intensity

No	Wood species	Attack intensity (%)	Wood condition
1	*D. indica*	12.83	Light attack
2	*V. cofassus*	17.63	Light attack
3	*C. inophyllum*	35.13	Middle attack
4	*Diospyros* sp.	97.27	Heavy attack
5	*A. falcataria*	128.2	Heavy attack

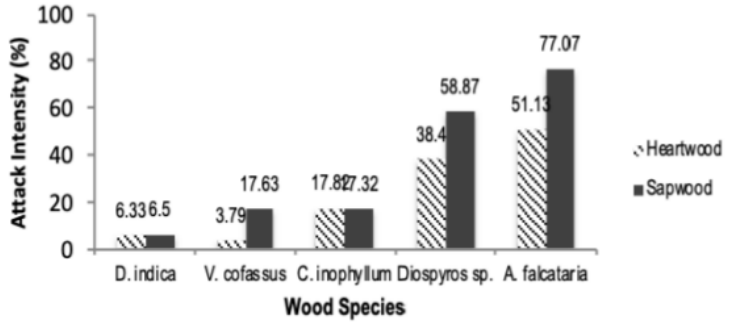


Fig. 10. Percentage of average intensity

The difference in the rate of attack of the test sample against marine borers is due to the different chemical components [19]. Turner et al. [20] stated that wood containing more cellulose, has a higher intensity of marine borers attack, especially from the Teredinidae family. The content in wood that inhibits sea borers attack is silica, with its hardness due to extractive substances [19]. The Pholadidae family make boreholes perpendicular to the surface of the wood with shallow holes and tends to attack as a place of residence.

The salinity level of the seawater also affects the life of marine organisms. At the sample immersion location in Barrang Lompo Islands, the salinity value of seawater and temperature was 32% and 31°C. This salinity value corresponds to the level of tolerance for the viability of marine organisms. Kasry [21] stated that the salinity of 31-33% is suitable for marine life and provides a good condition for the immersion location, of the wood tested in this study. The yearly changes in salinity, temperature, currents, and waves do not show a striking difference. Therefore, the population of borer in the waters tends to develop properly [14].

CONCLUSION

The following conclusions were made to analyze the natural resistance of community woods against marine borer, namely *Diospyros* sp., *Calophyllum inophyllum*, *Dillenia indica*, *Albizia falcataria* (L) Fosberg, and *Vitex cofasssus*.

1. Marine borer organisms that attacked the samples were *Teredo navalis* from the Teredinidae family and *Martesia striata* Linne from the Pholadidae family.
2. The wood species with high natural resistance is *D. indica*.

Based on the attack intensity, *D. indica* and *V. cofassus* were found mildly and moderately attacked, while *Diospyros* sp. and *A. falcataria* wood were found heavily attacked.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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