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Mechanical Properties of Modification 5 Commercial Wood in NTB with Japanese Traditional Method – Yakisugi

Andi Tri Lestari[1*], Endah Wahyuningsih[2], Maiser Syaputra[3], Fauzan Fahrussiam[4]
University of Mataram
Corresponding Author: Andi Tri Lestari atlestari@unram.ac.id

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ABSTRACT

Wood has hygroscopic properties so that the dimensional balance is unstable and favored by destructive organisms. In addition, wood exposed outdoors will easily undergo photodegradation by UV rays. One of the methods to improve the quality of wood is the Yakisugi method. This method is a traditional Japanese method that is environmentally friendly, more efficient, and economical. The application of the Yakisugi method can improve the quality of fast-growing wood that has low quality. This study was conducted to evaluate the mechanical properties of Yakisugi method on 5 commercial wood in NTB. The results of this research indicates the best charring time of yakisugi method is only 40 seconds charring, while the worst is 60 seconds charring and it is decrease the mechanical properties of all types of wood

INTRODUCTION

Solid wood is a material that is still in great demand as a material for making wood products and various architectural design products because of its characteristics that have easy to work with and unique patterns in each type. Demand for furniture and woodworking industry products has increased and predicted to continue to increase every year (Indonesian Ministry of Industry, 2021; Lin *et al.* 2019). Wood as a quality raw material is not only seen from its strength but also from its appearance (color) and machining characteristics (Zhong *et al.,* 2013). The difficulty of meeting these criteria causes the selection of raw materials to be based on availability and cost factors alone.

One of the methods that has been popular in improving wood quality is the heat treatment process. Heat treatment on wood will increase dimensional stability resulting from wood surfaces becoming more hydrophobic or water-dislike (Widyorini et al 2014, Gerardin *et al* 2007). The results of the study by Sivrikaya *et al* (2015) showed that subtropical wood (pine, ash, rope, spruce, and iroko) that received heat treatment produced several organic compounds that were able to prevent the growth of brown and white rot fungi. Pratiwi *et al* (2019) and Martha (2021) found that short-rotation teak wood has higher dimensional stability, termite resistance, and adhesion to finishing materials after heating at a temperature of 220^{o}C. In addition, the heat modification process takes a long time, reaching 24 hours, so the cost of modification is higher (Buksans et al, 2021).

Another form of heat modification on wood surfaces that is currently popular again is a finishing method from Japan called the Yakisugi method or in the west better known as Shou Sugi Ban (Kymalainen et al, 2020). The Yakisugi method is traditionally done by tying three boards together to form an elongated triangle and then charring from the bottom surface until black charcoal is formed on the wood surface evenly (Ebner, 2021). The Yakisugi method is more environmentally friendly, efficient and simple because it does not require additional chemicals. This method also produces a natural wood pattern, more beautiful and resistant to fungal and termite attacks, and is able to increase fire resistance in building construction (Kymalainen et al, 2017; Ebner et al, 2021; Hasburgh et al, 2021; Machova et al, 2021; and Buskans et al, 2021).

The commercial application of the Yakisugi method is only dominated by temprate types such as pine, spruce, fir, cypress, hemlock, white oak, and black walnut (Hasburgh et al 2021). Therefore, it is important to conduct research on tropical wood modification with the Yakisugi method to evaluate the mechanical properties of destructive organisms. The development of Yakisugi's method in improving the quality of tropical wood will be the right choice because the process is environmentally friendly, more efficient and produces beautiful wood quality that is natural and resistant to destructive organisms.

METHODS

This research was carried out at the Forest Product Technology Laboratorium, Forestry Study Program, Faculty of Agriculture, University of Mataram which was carried out in November 2023. The tools used consisted of 1 set of charring tools in the form of pressurized torches, wire brushes, sandpaper, cameras, rubber gloves and masks. The material used was coconut oil and the object of the study consisted of 5 types of tropical wood, namely rajumas (*Duabanga moluccana* Bl.), mindi (*Melia azedarach* Linn.), bajur (*Pterospermum javanicum* Jungh.), jati putih (*Gmelina arborea* Roxb.), and kemiri (*Aleurites moluccana* (L.) Willd.). The sample is made with dimensions 40 × 2.5 × 2.5 cm.

Before charring, the test sample was air-dried until it reached a moisture content below 14%. The authoring process uses a pressurized flame through the tip of the torch with a distance of ±15-20 mm to the surface of the test sample. The duration of the charring treatment is 0 second (control), 20 seconds, is 40 seconds, and 60 seconds. Test samples that have gone through the authoring process are then cleaned using a wire brush and sandpaper until the texture of the wood is visible. The mechanical properties tested are the values of modulus of elasticity (MoE) and modulus of rupture (MoR). The test was carried out according to the ASTM D 143-05 (1996) standard and determined through a bending test using the INSTRON 3369 engine at a single point.

RESULTS AND DISCUSSION

The yakisugi method could decrease in MoE value (Figure 1). The highest value of MoE were obtained by Rajumas, Mindi, and Kemiri wood at 40 seconds of charring and the highest reductions were seen in MoE of Mindi, Bajur and Kemiri wood at 60 seconds of charring. It means that 40 seconds of charring is better treatment for yakisugi and 60 seconds of charring is the worst.

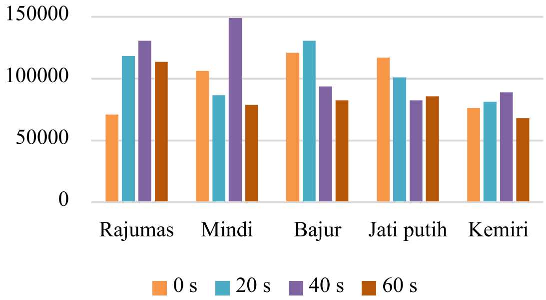

Figure 1. MoE values based on Wood Type and Charring Time ((kgf/cm²)

Figure 2 shows that the MoR value produces the same trend as the MoE value where charring treatment that is too long has an unfavorable effect. Figure 2 indicates that 40 seconds of charring on Rajumas, Mindi and Kemiri wood. Furthermore, the data in Figure 2 indicates that the MoR value at 40 seconds of charring is higher than the MoR value at 60 seconds of charring for all types of wood.

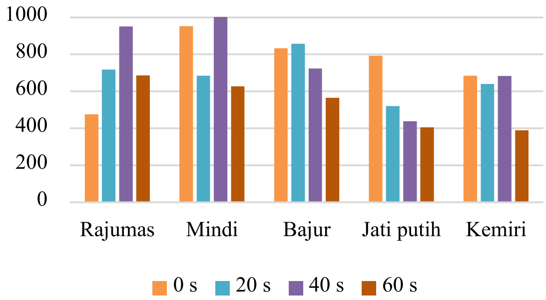

Figure 2. MoR values based on Wood Type and Charring Time ((kgf/cm²)

Based on the results, it can be concluded that the best charring time of yakisugi method is only 40 seconds, because charring 60 seconds will actually reduce the mechanical properties of all types of wood. The disadvantage of heat treatment is the deterioration of the mechanical properties of the wood as the temperature increases and the duration of heating (Martha et al 2021, Korkut and Hiziroglu 2009). This is because during the heating process, the hemicellulose content experiences high degradation and the crystallization process of the cellulose amorphous part which results in the wood becoming brittle so that the mechanical properties tend to decrease (Esteves and Pereira, 2008; LeVan et al. 1990). Other studies have also found that decreased MoE and MoR values in wood are related to hemicellulose loss in modified wood which involved in water exchange processes while preserving the wood's structure and it is vital to carefully control the temperature and restrict oxygen levels (Ebner et al, 2023).

Conclusion

The finishing process of 5 types of commercial wood in NTB using the yakisugi method with variations in charring time shows the best charring time of yakisugi method is only 40 seconds, while the worst is charring 60 seconds and decrease the mechanical properties of all types of wood. However, more detailed studies are needed to find the appropriate temperature and time for the charring process.

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