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Preface

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Preface

The 13th symposium of Indonesian Wood Research Society (IWoRS 2021) conference was held virtually because the pandemic situation in Indonesia had not improved until the day of the conference approached. This conference was held virtually instead of being postponed so that the conference which has been regularly scheduled every year will continue to run while at the same time encouraging the researchers, scientists, government, communities, and industry professionals and students that even though the situation is difficult, we can still work. The conference was held at September, 2nd 2021 by University of Mataram, West Nusa Tenggara, Indonesia.

The conference start at 08.00 WITA (GMT +8) with a plenary session which is divided into 2 sessions and there are 3 keynote speakers for each session. The keynote speakers comprise of experts from 6 different countries, they are Dr. Agus Justinanto (Director General of Sustainable Forest Management, Indonesia), assc. Prof. Dr. David Auty (Northern Arizona University), Prof. Dr. Ryo Funada (President of the Japan Wood Research Society), Prof. Jegatheswaran Ratnasinga (University Putra Malaysia), Prof. Zhongwei Guan, Ph.D. (Executive Director of Advance Materials Research Center), Dr. Wen Shao Chang (The University of Sheffield). The conference then continued with a parallel session at 13:00 WITA (GMT +8). Parallel sessions consist of 6 classes with 3 sessions where each session contains 4-6 speakers. Each presenter has present their paper for 15 minutes which is then followed by a discussion session.

The conference was attended by 107 participants from 8 countries (including Indonesia, Malaysia, Japan, Philippines, China, Australia, Germany, and France). There are 65 oral presenters throughout the symposium, which will cover the scopes of biocomposites, wood characteristics and wood quality improvement, nanotechnology and forest product chemistry, and general forestry. Technology that was used to deliver the conference is zoom meeting. The conference was success and on time thanks to the teamwork by the committee (Department of Forestry, Faculty of Agriculture, University of Mataram) and members of the Indonesian Wood Research Society (IWoRS).

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WQ-18

Wettability and Treatability of Sengon (Paraserianthes falcataria (L.) I.C. Nielsen) wood from NTB

A T Lestari[1*], E Wahyuningsih[1], M Syaputra[1], H Anwar[1], P K Suparyana[2] and F N Ritonga[3]

[1] Department of Agribusiness, Faculty of Agriculture, University of Mataram,

Jl. Pendidikan No.37, Kota Mataram 83115, Indonesia

[2] Department of Agribusiness, Faculty of Agriculture, University of Mataram,

Jl. Pendidikan No.37, Kota Mataram 83115, Indonesia

[3] State Key Laboratory of Tree Genetics and Breeding, Forestry College, Northeast Forestry University,

Harbin 150040,China

Corresponding author : atlestari@unram.ac.id

ABSTRACT

The supply of wood from natural forests is decreasing as a result of the imbalance between harvesting and planting. The lack of wood supply from natural forests has resulted in relatively expensive wood prices. This can be anticipated by using fast-growing wood species. One type of fast-growing wood which is very abundantly available in NTB is sengon wood (Paraserianthes falcataria (L.) I.C. Nielsen). However, sengon wood has low durability so it is easily attacked by wood-destroying organisms. This condition can be overcome by making efforts to prevent wood damage in the form of preservation. One indicator of the success of preservation is the ease with which the liquid wets the wood surface (wettability). The wettability test was carried out by measuring the contact angle between the liquid and the sample surface using the sessile drop method and the wood durability testing was carried out by measuring the retention and penetration of preservatives. The treatability test was carried out by measuring the absorption, retention, and penetration of preservatives. The results showed that the wettability of sengon is high with an equilibrium contact angle (θe) of 16.88 in the radial section and 12.51 in the tangential section. This shows that sengon wood has a good adhesion system for preservation. Treatability of sengon wood showed that the average retention and penetration are 10,21 kg/m3 and 7,33 mm. Based on the results of these measurements, sengon wood has met SNI 03-5010.1-1999 (wood preservation for housing and buildings).

Keywords : NTB, Paraserianthes falcataria, sengon, treatability, wettability.

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Wettability and Treatability of Sengon (*Paraserianthes falcataria* (L.) I.C. Nielsen) wood from NTB

A T Lestari[1], **E Wahyuningsih**[1], **M Syaputra**[1], **H Anwar**[1], **P K Suparyana**[2] and **F N Ritonga**[3]

[1] Department of Agribusiness, Faculty of Agriculture, University of Mataram, Jl. Pendidikan No.37, Kota Mataram 83115, Indonesia

[2] Department of Agribusiness, Faculty of Agriculture, University of Mataram, Jl. Pendidikan No.37, Kota Mataram 83115, Indonesia

[3] State Key Laboratory of Tree Genetics and Breeding, Forestry College, Northeast Forestry University, Harbin 150040, China

E-mail: atlestari@unram.ac.id
ORCID ID: 0003-1587-8097

Abstract. The supply of wood from natural forests is decreasing as a result of the imbalance between harvesting and planting. The lack of wood supply from natural forests has resulted in relatively expensive wood prices. This can be anticipated by using fast-growing wood species. One type of fast-growing wood which is very abundantly available in NTB is sengon wood (*Paraserianthes falcataria* (L.) I.C. Nielsen). However, sengon wood has low durability so it is easily attacked by wood-destroying organisms. This condition can be overcome by making efforts to prevent wood damage in the form of preservation. This study aims to determine the wettability and treatability properties of sengon wood. The results of this study are expected to be basic information to improve the quality of sengon wood. The wettability test was carried out by measuring the contact angle between the liquid and the sample surface using the sessile drop method and the wood durability testing was carried out by measuring the retention and penetration of preservatives. The treatability test was carried out by measuring the absorption, retention, and penetration of preservatives. The results showed that the wettability of sengon is high with an equilibrium contact angle (θe) of 16.88 in the radial section and 12.51 in the tangential section. This shows that sengon wood has a good adhesion system for preservation. Treatability of sengon wood showed that the average retention and penetration are 10,21 kg/m^3 and 7,33 mm. Based on the results of these measurements, sengon wood has met SNI 03-5010.1-1999 (wood preservation for housing and buildings).

1. Introduction

The supply of wood from natural forests is decreasing as a result of the imbalance between harvesting and planting [1]. The lack of wood supply from natural forests has resulted in relatively expensive wood prices [2]. The limited of long rotation wood can be overcome by utilizing fast-growing species like sengon wood (*Paraserianthes falcataria* (L.) I.C. Nielsen). Sengon wood is a species that is widely developed in community forests in West Nusa Tenggara (NTB) Province [3]. The price of sengon wood in NTB using methods of stumpage price, market price, and social price also shows that sengon wood can be an alternative to wood from natural forests [4].

Fast-growing wood species are already in demand for use in the light-frame structural, woodworking, and wood composite board industries as the main source of raw material and are becoming leading wood product exports [5]. However, fast-growing wood species has low durability, so it is easily attacked by wood-destroying organisms (e.g. insects, fungi, bacteria, and marine borer) [6]. Since fast-growing wood species are often of inferior quality (e.g. low density, low dimensional stability, low durability, etc.), many modification techniques are used to improve wood properties such as heat treatment [7] and applying a coating layer [8]. One of the most common treatments is the application of preservatives [9].

The success of wood preservation can be influenced by the wettability and treatability of the wood. Wettability is the ability of a material to absorb liquid and provides information on the interaction between the wood surface and the liquid [7, 10, 11]. Wettability is influenced by various factors, such as wood species, wood density, type of liquid, surface roughness, and defects [12-16]. The wettability of wood can be obtained by measuring the contact angle between the liquid and the wood surface. A contact angle less than 90° indicates a high wettability where the liquid wets the surface well. A contact angle greater than 90° indicates low wettability where the liquid does not wet the surface well [17]. Thus, it is known that the higher the contact angle of a liquid, the lower its wettability. The characteristic is related to surface properties and affects the absorbency, adhesion, and finishing attributes of wood [18]. These characteristics are also related to the treatability of the wood. The treatability of wood is influenced by its porous structure wood moisture content, drying technique, preservative formulation, and treatment process [19].

Previous research has shown that fast-growing wood species can be used as a substitute for long-rotation wood by preservation. One indicator of the success of preservation is wettability. This study aims to determine the wettability and treatability properties of sengon wood. The results of this study are expected to be basic information to improve the quality of sengon wood. Wood quality improvement is expected to increase the resistance of wood to destroying organisms, thereby increasing the service life of the wood.

2. Materials and Methods

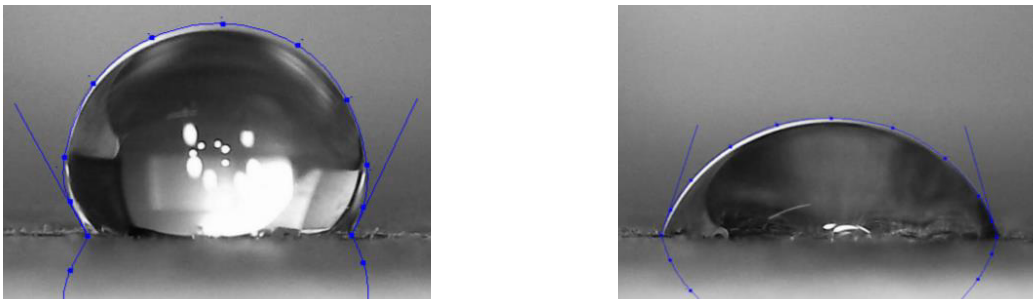
2.1. Wettability measurements

The samples used were radial and tangential section of sengon, made following the ASTM D 358-98 standard which requires the wood used to be free from defects [20]. The defect-free samples were cut into 3 radial section and 3 tangential section in dimension of 20 x 10 x 2 cm (longitudinal x tangential x radial). The samples were then conditioned at a temperature of 21°C until reached the final moisture content of 12-15%. The samples that have the appropriate size and water content were then sanded with sandpaper number 150.

The wettability test was carried out by measuring the contact angles between the water. Water choose to determine the wettabiliy since water-based preservatives are the most widely used preservatives with various types in the world [21]. The contact angles between the water and the surface of the samples by the sessile drop method. The liquid with volume 0.2 ml was dropped using a dropper at 5 different points with a diagonal direction on each sample. The drop shapes on the wood surface were captured by recorded with a digital camera until the liquid seeps on the surface of the wood. Each of the captured video images was cut to an individual image at intervals of 10 seconds for the duration of 180 seconds. The contact angle of each image piece was then measured using Motic Images Plus (MIP) software to obtain an equilibrium contact angle (θe) based on the change in time. The contact angles of each droplet were measured both on the right and left side then the values were averaged (Figure 1).

The value of θe was measured using a segmented regression model with PROC NLIN software from SAS 9.1.3 Portable with the formula y=a+bX+cX2+E where x = time; y = contact angle; a, b and c =

constant; and E = error. The constant change in contact angle (K-value) is calculated using the least-squares method according to the S/G equation using XL-STAT.



(a) (b)

Figure 1. Measurement of the contact angle when water touches (a) and seeps (b) on the wood surface

2.2. Treatability measurements

The treatability samples were made in 10 pieces of sengon beams in dimension of 35 x 5 x 5 cm (longitudinal x tangential x radial) then air-dried in a room (temperature 29 ± 12^{0}C; RH 85 ± 2.2%) for 10 days. All samples were then dried in an oven (60^0 ± 1.5^{0}C) until the moisture content decreased to ± 12%, then the dimensions (width, thickness, length) were measured and the initial weight was weighed. Both ends of each samples (± 2 cm) were immersed in hot paraffin. The samples were then soaked in a preservative for 24 hours at room temperature (cold soaking preservation methods). The preservative used is a combination of biocide insecticide (formulation: Cypermethrine 100 EC) and biocide wood fungicide (formulation: TCMTB) preservatives. These preservatives are used because wood deterioration is generally caused by high species of insects and fungi. After the preservation process, the sample is drained and then its final weight is weighed. Furthermore, the measurement of retention and penetration of preservatives is carried out with the following formula.

$$R = \frac{W1 - W0 \ gr/cm^3}{V} \ldots\ldots\ldots\ldots\ldots\ldots(1) \qquad P = X1 + X2 + X3 + X4 \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where R is Retention of preservatives (gr/cm^3); W1 is Weight of sample after preservation process (gr); W2 is Sample weight before preservation process (gr); V is Volume of sample after preservation process (cm^3); P is Penetration of preservative (mm); and X1 - X4 is Depth of entry of preservative on each side (mm).

3. Results and Discussions

3.1. Wettability measurements

Wettability is a change in the contact angle that occurs with a change in time [22]. The wettability of wood is affected by the contact angle between the wood surface and the liquid. The liquid on the wood will spread and penetrate the wood until it is constant (θe). The value of θe is used to calculate the rate of change of constant contact angle (*K*-value). The smaller the value of θe of wood, the better its wettability. The average value of θe in 3 radial and 3 tangential sections is shown in Figure 2. The average value of θe produced by the radial section is higher than the tangential section. The average value of θe generated in the radial section is 18.70, 16,43, and 15.52, respectively. Meanwhile, the average value of θe produced in the tangential section is 12.36°, 12.78°, and 12.39°, respectively. The smaller the value of contact angle indicates the easier the material is wetted and vice versa [23]. The wettability of wood can be seen from the change of the

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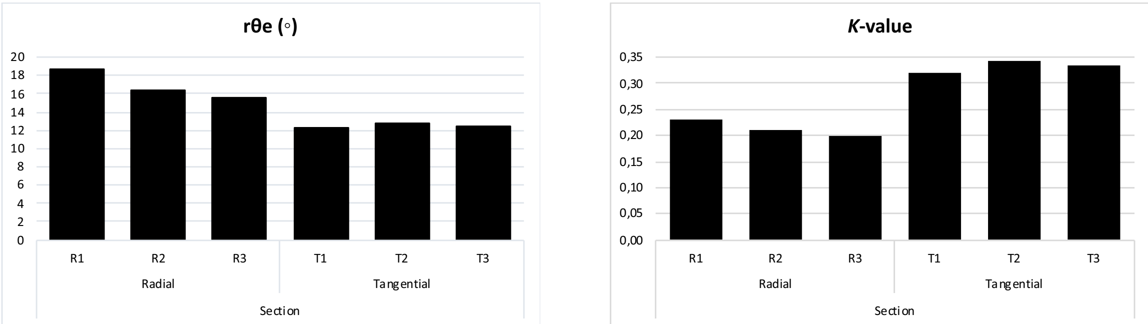
constant contact angle (*K*-value). The average *K*-values (Figure 2) generated on the radial sections are 0.23, 0.21, and 0.20, respectively, while the average *K*-values generated on the tangential sections are 0.32, 0.34, and 0.33, respectively. The higher the *K*-value, the better the wettability, meaning that it is easier for the liquid to spread on the surface of the wood substrate and penetrate faster into the wood [20, 24].



(a) (b)

Figure 2. The average value of *θe* (a) and the average of *K*-value (b) of sengon wood

The results of the *K*-value measurement on sengon wood show that the tangential section has a higher wettability than the radial section. This is thought to be influenced by a lower contact angle on the tangential section caused the liqud spread and penetrated easier in its surface. However, these results indicate that there is no significant difference between the cross-sectional of wood in sengon wood. Liquids have the same wettability trend between radial and tangential cross-sectional patterns [8, 16, 25]. The adhesion on wood can be influenced by the surface texture and the direction of the fiber [23-28].

3.2. Treatability measurements

The treatability of sengon wood with a combination of biocide insecticide and biocide wood fungicide preservatives were shown in Table 1. The results showed that the average retention and penetration in sengon wood is 11,03 kg/m^3 and 7,33 mm respectively. The penetration and retention values of sengon wood produced in this study were quite high, so it can be concluded that sengon wood is easy to preserve. This is presumably due to the low density of the sengon wood, which is 0.35-0.49 [29]. The low density of sengon wood can be explained by the high percentage of juvenile wood and high lumen diameter [30]. This is what is thought to cause preservatives to easily seep into the wood. Based on the results of these measurements, sengon wood has met SNI 03-5010.1-1999 (wood preservation for housing and buildings).

Tabel 1. The treatability of sengon wood with a combination of biocide insecticide and wood fungicide

Sample	**Retention (Kg/m^3)**	**Penetration (mm)**	**Sample**	**Retention (Kg/m^3)**	**Penetration (mm)**
1	11,24	7,42	7	10,85	6,95
2	10,89	8,03	8	10,79	6,9
3	10,82	7,15	9	11,74	7,25
4	11,89	6,87	10	11,77	7,31
5	10,36	7,59	*Average*	*11,03*	*7,33*
6	9,93	7,82			

4. Conclusions

The wettability of sengon is high with θe of 16.88 in the radial section and 12.51 in the tangential section. This shows that sengon wood has a good adhesion system for preservation. The results indicate that there is no significant difference between the cross-sectional of wood in sengon wood. Treatability of sengon wood showed that the average retention and penetration in sengon wood is 11,03 kg/m^3 and 7,33 mm respectively. Based on the results of these measurements, sengon wood has met SNI 03-5010.1-1999 (wood preservation for housing and buildings) and can be used in wood working and biocomposite industries as the raw material such as Glued Laminated Wood (glulam), Laminated Veneer Lumber (LVL), etc.

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