Journal of Engineering Science and Technology
Vol. 15, No. 1 (2020) 345 - 354

THE PRESERVATION OF DURIAN WOOD USING KECUBUNG FRUITS EXTRACT

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Abstract

Knowledge of the mechanical properties of this type of wood is very important and necessary as a basis for designing the structure of wood materials. Wood is a natural organic material and it can be degraded by organic life forms via bacteria, fungi and insects. Normally, borax-boric acid will be used for wood preservation and it is an inorganic form, which is not environmental-friendly used and for the long term effects, the wood will produce leached. This study aims to determine the results of testing the mechanical properties in the form of tensile strength and compressive strength of durian wood preserved by extract of kecubung fruits, which is in the form of organic material. The wood preservation method used a cold soaking method. Experiments were performed by giving differences in the treatment of preservative concentration (0%, 15%, 20% and 25%). Tensile strength test result using the ANOVA test showed that the F_{count} (11.85) is higher for the preserved wood compare to the natural wood F_{table} (3.24), therefore, the alternative hypothesis was accepted. While the compressive strength test result using the ANOVA test showed that the F_{count} (6.18) for the preserved wood is higher than the natural wood F_{table} (3.24). Therefore, the alternative hypothesis was accepted. This showed that there is a difference in the average mechanical strength of the durian wood (tensile strength and compressive strength) with the treatment of different concentrations of the kecubung fruits extract.

Keywords: Compressive strength, Durian, Kecubung fruits, Tensile strength.

1. Introduction

Wood is a natural material that is not homogeneous. This difference in nature is caused by the stem growth pattern and the environmental conditions of plants, which are often not similar [1]. Preservation process can be interpreted as an activity to extend the durability of wood using both chemical and physical process by increasing its resistance to damage from decay and insect attack, shrinking due to changes in water content [2].

According to Dumanauw [3], wood is a hygroscopic material, meaning that wood has a very close connection with water in the form of liquid or vapour. The wood preservatives, such as arsenic (As), copper (Cu), fluorine (F), chromium (Cr), zinc (Zn) and others, are chemicals that are highly toxic to insect. The durian wood is cultivated in tropical regions around the world, particularly in the Southeast Asian countries of Malaysia, Indonesia and Thailand [4].

The general characteristics of durian wood is a red-brown wood terrace after it is freshly cut and slowly turns into greyish brown colour where this wood is categorised as light hardwoods and suitable use for light construction, flooring, partitioning, panelling, joinery, furniture, spars and masts of boats, veneer, plywood and wooden pallets [5]. The texture is rather coarse and evenly with a straight fibre direction or chime. The wood surface is rather slippery and shiny [6].

Based on the Febrianto et al. [7] finding shows that durian is rated as very poorly resistant to termite and categorised as natural durability class V. The current study on the durian is more focus on the biocomposite materials, durian husk fibre, durian seed starch and paper made from durian rinds [8-15].

Caldeira [16] have reviewed the paper on the impregnation of wood with boron-chemical solutions and the major concerned is about the leached issue if the wood is subjected to the wet environment and the scientist are required to overcome the weakness of using boron in the wood preservation event thought Boron compounds have been used for more than 40 years in Australia and European countries. Leached is harm to the environment especially if the leached moving into the water and leached reached into an impermeable soil with fine particles that provide a large reactive surface.

Thus, greater leaching rates is reported from products or specimens that had a high proportion of exposed surface and were placed in an area of high flow rate of water and become more safe condition if the presence of organic acids in soil or freshwater exposures and inorganic ions in seawater also appear to increase the rate of chromated copper arsenate leaching [17].

Therefore, kecubung plants will be used in this study as an alternative wood preservative instead of using the boron. kecubung plants (*Datura fastnosa L*) or *Datura metel L* or *Datura innoxio Miller*) are included in the family Solanaceae.

This kecubung grows in Indonesia and India, in Indonesia spread in various regions, namely Java, Bali, Sumatra, usually amethyst plants are mountainous. Kecubung (*Datura Metellinn*) is one of the plants that produce natural pesticides, which contain toxins (alkaloids) that are strong enough to be used as pesticide [18].

The results of the research on albizia wood preservation through cold-soaking technique using *Enbor Sp*, the preservative on the mechanical properties showed that the wood moisture content of albizia wood and specific gravity is influenced by the treatment of preservation (the concentration of preservative 0%, 3%, 6% and 9% with a cold soaking for 120 hours). In general, the wood moisture content of preserved albizia wood has decreased, while the specific gravity of albizia wood has increased absorption, retention, termite mortality, and a decrease in mass loss and degree of damage to the test sample [19].

Preservation of albizia wood used cold and hot soaking method with kecubung fruit extract against the attack of dry wood termites. The results showed that the mortality index equals to 70.44% - 87.11% (good), loss of test sample weight was 83.486 mg - 165.269 mg, and the degree of damage of 14.50 - 28.714% (high). The results of the analysis of variance showed that the preservative concentration and soaking time did not interact significantly.

The high concentration of preservative and soaking time resulted in an increase in absorption, retention, termite mortality, and a decrease in mass loss and degree of damage to the test sample [20]. There is no significant difference in tensile strength for the investigated species; kedondong, keruing and bintangor.

This investigation confirmed that these species are in the same strength group [21]. The objective of this research is to investigate the use of natural resources, kecubung fruits extract that are easily obtained in Semarang as the preservative for the durian wood and to measure the mechanical properties in the form of tensile strength and compressive strength of durian wood.

2. Materials and Methods

2.1. Materials preparation

This study used durian wood from the Gunung Pati area of Semarang. Based on SNI 3129-2011 the "wood-sampling method and general requirements for physical and mechanical tests", the sampling process for specimens were taken one-third from the durian tree [22]. The water moisture content testing was based on the SNI 03-6850-2002 standard method for testing the measurement of wood water moisture content and wood materials [23].

The tensile test was carried out by referring to the SNI 03-3399-1994 standard for testing tensile strength [24]. The testing for the compressive strength parallel to the fibre direction is based on the SNI 03-3958-1995 standard [25]. The size of the test specimen for mechanical tensile testing (L = 25 mm, T = 25 mm, P = 460 mm) as shown in Fig. 1 while the compressive testing size (L = 50 mm, T = 50 mm, P = 200 mm) as illustrated in Fig. 2.

The treatment of wood by preservation is done by using the cold soaking method. The preservative used is from the amethyst fruit extract. The extract was made by drying the kecubung fruit, which is then mashed into a powdery form as showed in Fig. 3. The concentration of preservatives used in the preservation is 0%, 15%, 20%, and 25%. The water moisture content testing, tensile and compressive strength test were repeated 5 times. The tensile strength test was performed by using the Digital Pull Test Machine and the compressive test was done by using the Digital Compression Machine as presented in Fig. 4.

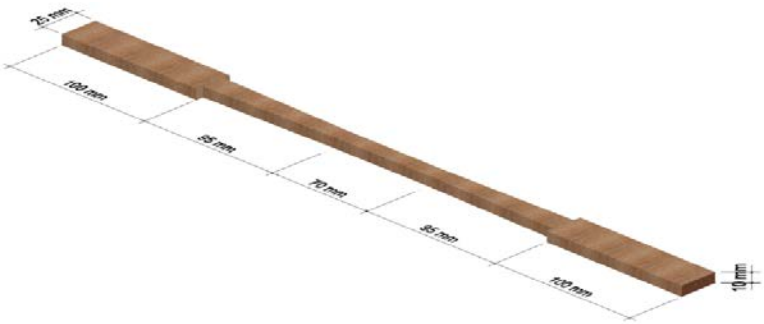

Fig. 1. Size of the specimen tensile strength test.

Fig. 2. Size of specimen compressive test.

Fig. 3. Powder of kecubung fruits.

Fig. 4. Preservation and testing preparation.

2.2. Data analysis

All data obtained from the test results were analysed by using the analysis of variance (ANOVA) to determine the differences in mechanical test values (compressive or tensile strength test) with differences in treatment of preservative concentration of 0%, 15%, 20%, and 25% [20].

The tensile strength test information:

ft: The tensile strength (MPa)

P: maximum load (N)

b: the width of the specimens (mm)

h: height of the specimens (mm)

The compressive strength test information:

fc: compressive strength test (MPa)

P: maximum test load (N)

b: the width of the specimens (mm)

h: height of the specimens (mm)

3. Result and Discussion

3.1. Water moisture content

The water content test result of durian wood is shown in Table 1. The average water content of durian wood was 16.52% (0%), 15.99% (15%), 12.84 (20%) and 9.01% (20%). The result from the research on the water content of the durian wood showed that there is a tendency that the greater the percentage of preservatives will lead to lower water content.

Table 1. Water content of durian wood.

No. of code	Concentrations of preservatives (%)	Average Water content (%)
A	0	16.52
B	15	15.99
C	20	12.84
D	25	9.01

3.2. Specific gravity of the durian wood

The specific gravity is the ratio of wood density to the water density at the same volume. The results of the specific gravity of durian wood can be seen in Table 2. The results of this test showed that the average specific gravity of the durian wood, which was 0.551 (0%), 0.559 (15%), 0.571(20%) and 0.578 (25%).

The result is shown in Fig. 4 an inverse relationship between the Wood water content (preservative concentration of 0%, 15%, 20% and 5%) and its specific gravity; higher water content of wood will lead to lower specific gravity, or vice versa. Furthermore, there is a tendency that the specific gravity of wood will affect the treatment of wood bending structures.

There is an inverse relationship between water content and specific gravity. The greater the moisture content of the wood will lead to lower specific gravity and explains that the greater the concentration of preservatives will lead to a greater specific gravity as shown in Fig. 5. For the durian wood, without preservatives (0%), the average water content was 16.52%. The specific gravity was 0.551 g/cm at 15% concentration, the average water content was 15.99% with specific gravity of 0.559 g/cm^3 at a concentration of 20%, the average water content was 12.84% with a specific gravity of 0.571 g/cm^3 and at a concentration of 25%, the average water content was 9.01% with a specific gravity of 0.578 g/cm^3.

Table 2. Specific gravity of durian wood.

No. of code	Concentrations of preservatives (%)	Average Specific gravity (g/cm^3)
A	0	0.551
B	15	0.559
C	20	0.571
D	25	0.578

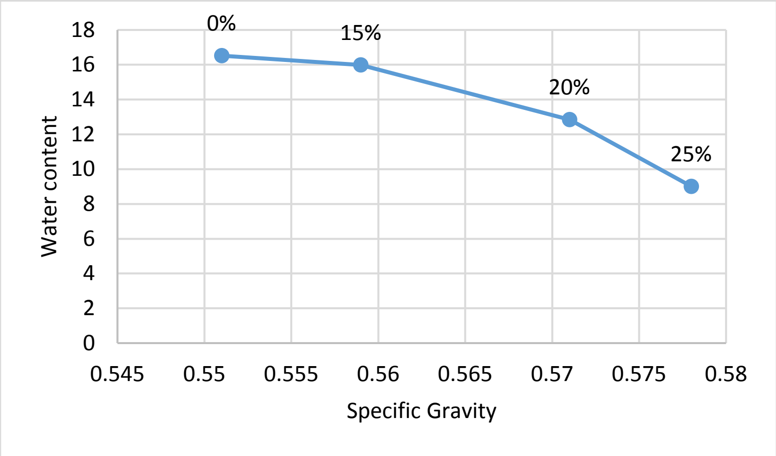

Fig. 5. Relationship between water content and specific gravity of durian wood timber.

3.3. Analysis of tensile strength of durian wood

Table 3 shows that the average tensile strength of durian wood is 58.65 MPa (0%), 74.68 MPa (15%), 76.64 MPa (20%) and 91.69 (25%). The result of the tensile strength at concentrations of 0%, 15%, 20% and 25% indicates that there is a tendency for the greater the percentage of preservatives will lead to a higher tensile strength. This result is also supported by the result of the analysis of the mean difference test using the ANOVA analysis.

Table 4 shows the one-way ANOVA on the effect of various concentrations of preservatives. The results showed that all the response variables have a significant level where the significant value is ($p \leq 0.05$).

The ANOVA analysis using α: 5% showed that the F_{count} was 11,863. Meanwhile, the F_{table} was 3.24. The result of the ANOVA test showed that the F_{count} is higher than the F_{table}, ($F_{count} > F_{table}$/11.85 > 3.24). There is a difference in the average tensile strength of durian wood with the treatment of different concentrations of kecubung fruits extract preservative (0%, 15%, 20% and 25%).

Table 3. Tensile strength testing of the durian wood.

No. code	Concentration of the preservative(%)	Average		
		Area of specimen	Load	Tensile strength (*Ft*)
		(mm^2)	(N)	N/mm^2 (MPa)
A	0	106.76	6225.60	58.65
B	15	105.54	7883.20	74.68
C	20	106.55	8148.00	76.64
D	25	109.27	9968.00	91.69

Table 4. One-way ANOVA on the for effect of various concentrations of preservatives on tensile strength of durian wood.

ANOVA						
Source of variation	*SS*	*Df*	*MS*	*F*	P-value	*F* crit
Between groups	2739.89	3	913.29	11.863	0.00024	3.24
Within groups	1232.12	16	77.01			
Total	3972.02	19				

3.4. Analysis of compressive strength of durian wood

Table 5 presented the average of the bending strength of durian wood is 36.16 MPa, for concentration (0%); 36.69 MPa (15%), 37.42 MPa (20%) and 39.78 (25%). The results of the bending strength test at a concentration of 0%, 15%, 20% and 25% indicate that there is a tendency for the greater the percentage of preservatives will lead to a higher compressive strength. This result is also supported by the result of the analysis of the mean difference test using the ANOVA analysis.

Table 6 illustrated the one-way ANOVA test for the effect of various concentrations of preservatives on the tensile strength of the durian wood. The ANOVA table was used in this study to analyse the significant of data or result. The result showed that all the response variables have a significant level ($p \leq 0.05$).

ANOVA analysis with the α: 5% shows that the F_{count} was 6.18. In addition, the F_{table} is 3.24. The result of the ANOVA test showed that the F_{count} is higher than the F_{table}, ($F_{count} > F_{table}$/6.18 > 3.24), then the alternative hypothesis is accepted.

Thus, there is a difference in the average compressive strength of durian wood with the treatment of differences in concentrations of amethyst fruit extract (0%, 15%, 20% and 25%) in preserving durian wood with the cold soaking method.

Table 5. Compressive strength of durian wood.

Code	Concentration of the preservative	Average		
		Area of specimen (mm^2)	Load (N)	Compressive strength (*Fc*) N/mm^2 (MPa)
A	0%	2615.69	94496.08	36.16
B	15%	2667.72	97856.99	36.69
C	20%	2571.56	98335.08	37.42
D	25%	2598.95	103333.85	39.78

Table 6. One-way ANOVA test for the effect of various concentrations of preservatives on tensile strength of durian wood.

ANOVA						
Source of variation	***SS***	***df***	***MS***	***F***	**P-value**	***F* crit**
Between groups	38.28	3	12.76	6.18	0.0054	3.24
Within groups	33.01	16	2.06			
Total	71.30	19				

4. Conclusion

Based on the result from the analysis of tensile and compressive mechanical tests, it was shown that there were strong differences in the results of mechanical tests on the tensile and compressive tests of the durian wood with differences in the concentration of preservatives. The higher the concentration of Amethyst fruit extract of the preservative will lead to a higher mechanical strength of the wood (tensile and compressive strength). This is because, during the preservation process, the extract of amethyst fruit infiltrated the pores of the wood. The infiltration of preservative on the durian wood causes it to increase its density due to the ability to absorb the preservative depending on the surface area of the cell cavity. The water content in durian wood was replaced by the kecubung fruits extract, which has been dried and crystallized, thus the binding between the wood cells adds to the density of durian wood.

The pores filled with kecubung fruits extract to increase the cross-sectional area of the tensile and compressive strength of the durian wood. It increases the bond between the fibres of the durian wood. The addition of amethyst fruit extract at a concentration of 25% resulted in the most optimal tensile and compressive strengths. The concentration of preservative of the kecubung fruits extract at a concentration of 25% can be absorbed optimally by the pores of the durian wood, which is indicated by the highest value of density at a concentration of 25%. The technology of wood processing through Wood preservation using the kecubung fruits extract on the durian wood is expected to improve the utilization of the durian wood optimally, especially in the field of construction.

Nomenclatures

b	Width of the specimens
Df	Degrees of freedom
F	F count

F crit	F table
fc	Compressive strength test
ft	Tensile strength
h	Height of the specimens
h	High
l	Long
N	Load
P	Maximum load
P	Maximum text load
t	Wide
Greek Symbols	
α	Significance
Abbreviations	
MS	Mean Square
SS	Sum of Squares

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