Physical Properties of *Paraserianthes falcataria*

Suria Mohamad Akhir and Jamaludin Kasim

ABSTRACT

The study was conducted with the objective to determine basic properties and effects of distance from pith on potential species for the establishment of short-rotation forest plantation in Malaysia. For this purpose, three 8-year-old Paraserianthes falcataria were studied to obtain its specific gravity against 13 year-old Paraserianthes falcataria from previous studies and also to determine moisture content of this tree. Results show significant differences in specific gravity from the three sample trees where there is an increase of specific gravity from near pith to near bark. The specific gravity of P. falcataria was also observed to decrease from bottom to top whilr the mpisture content increase with tree portion. While the green moisture content of Paraserianthes falcataria decreases from near pith to near bark.

Keywords: *Paraserianthes falcataria, moisture content, specific gravity*

Introduction

The scientific name for the Batai tree is *Paraserianthes falcataria (*L.) Nielsen (which belong to the subfamily of Mimosoidae in the family Leguminocea. Wagner et.al. (1999) states, *P. falcataria* is a rapid growing forest plantation species in many other tropical countries. It is widely planted throughout the tropics region especially Indonesia (Wahyudi et al. 2000; Sumiasri et al. 2006; Ogata et al. 2008). Nowadays, through research development P. *falcataria* is a fast famous growing plantation species and has become a potential raw material for wood based product. Some people argue that the fast growing species has some negative effects of wood qualities. However, confirmed with product from previously established industrial plantations indicated that the supply for timber from plantations of *P. falcataria* is increasing which its acceptable quality of wood for panel and plywood industries (Tan, 1983; Anino, 1994; Nemoto, 2002).

Moisture content and specific gravity is a basic property of wood. "The importance of knowing the physical properties of wood is reflected by the end-use of the materials itself" (Jamaludin, 1999). However, the information on wood properties of *P. falcataria* is still limited a number of studies (Ishigurri et. al. 2007; Ishigurri et.al. 2009). Previously (Ishigurri et.al. 2007) point out that this species has significant differences in the basic density and fiber length with distance from the pith and near bark. Moisture content affects the properties of wood and also influences the dimensional stability and these are generally associated with toughness, density, strength, working properties and durability (Panshin and De Zeeuw, 1970; Hamdan and Abd. Latif, 1992). Moisture affects the behavior of wood in a number of very critical ways (Findlay, 1975). The specific gravity of wood is the single most important physical characteristic. Specific gravity has an important influence on the strength of wood which in general terms, the increasing of specific gravity depends on either increasing wall thickness of fiber from pith to bark or increasing percentage of fibers with little change in wall thickness (Panshin and De Zeeuw, 1970). The aim of this present study is to determine the physical properties of *P. falcataria*. The study also aims to determine the effect of distance from pith on the physical properties.

Material and Methods

Field Procedure

Paraserianthes falcataria trees were harvested from Forest Plantation at Dong Hwa Fiberboard, Merbok Kedah. A age of the trees was 8 year old. At the experimental area, breast height diameters of *P. falcataria* were measured for every tree. After the trees were cut down, cross-sectional discs of approximately 5 cm in thickness were taken from each tree at three height levels: bottom (30 cm above ground), middle (50% of clear bole height) and top (80% of clear bole height). Each disc was mark with the tree number and height level. The discs were immediately wrap with aluminum foil and kept in air-tight plastic bags to reduce the loss of moisture.

All the wrap discs were placed in a cold room (about 4^0C) upon arrival at University Teknologi Mara (UiTM) Jengka, Pahang until further processing.

Sampling for Specific Gravity Analysis

Three *P. falcataria* trees were cut for this experiment. Samples taken in disc shape were cut into cubes approximately 2 cm x 2 cm x 2 cm for specific gravity and moisture content. The samples for each disc were divided into three zones namely near bark, middle, and near pith. A total of 12 sample pieces were obtained for each disc.

Specific Gravity and Moisture Content

The weight measurements were carried out at green and oven-dry conditions. The specific gravity was determined when cubes were immersed in water until they were fully swollen. These cubes were placed in an oven for 24 hours at 105 ± 2°C until constant weight is obtained. Testing of physical properties were conducted in accordance with TAPPI T2557 cm – 2002: Sampling and preparing wood analysis. The specific gravity and moisture content were calculated with the following formula:

$$\text{Specific gravity} = \frac{\text{Weight of oven dry sample}}{\text{Weight of water displacement}} \quad \ldots\ldots 1$$

$$\text{Moisture content (\%)} = \frac{\text{Air dry weight - Oven dry weight (g)}}{\text{Oven dry weight (g)}} \times 100\% \quad \ldots\ldots 2$$

Results and Discussions

Physical Properties

Table 1 show that the specific gravity of *P. falcataria* increases with distance from pith. The highest value of specific gravity was observed from samples near the bark at the bottom portion (0.31) and the lowest specific gravity was at the top portion near pith sample (0.15). This result was similar with the previous study where the basic density of *P. falcataria* showed value up to 10 cm from near pith and then increased towards the near bark (Ishigurri et.al. 2007). While the green moisture content of *P. falcataria* decreased with distance from the pith, sample near pith at the top portion has higher value of moisture content (502 %) while the sample near the bark at bottom portion show lower moisture content (241 %).

Table 1: Physical Properties of *P. falcataria* According to Tree Portion and Distance

Portion	Distance	SG	MC (%)
Top	NP	0.15	501.51
	Inter	0.23	355.97
	NB	0.25	296.71
	Mean	0.21	384.76
Middle	NP	0.16	458.96
	Inter	0.24	338.36
	NB	0.25	318.81
	Mean	0.22	372.04
Bottom	NP	0.21	372.92
	Inter	0.31	242.89
	NB	0.31	241.37
	Mean	0.28	285.72

Note: NP – Near Pith, Inter- intermediate, NB – Near Bark, SG – Specific Gravity, MC – Moisture Content

Effect of Height Portion

Figure 1and Figure 2 show the effects of specific gravity and moisture content towards tree portion. The specific gravity of *P. falcataria* was observed to decrease from bottom to top while the moisture content increases with tree portion. The correlation analysis Table 2 shows that the decrease in specific gravity has a negative correlation (r = -0.457ns) and the increases in moisture content was significant (r = 0.384*). According to Zziwa, et al, (2006), the specific gravity of the wood varied significantly from species to species and different parts of tree. Fibers are particularly important to determine specific gravity. If the fibers are thick-walled and show small lumina, then the total air space is relatively small and the specific gravity tends to be high (Panshin and De Zeeuw, 1970).

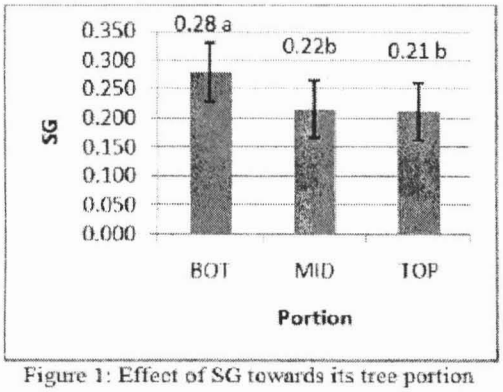

Figure 1: Effect of SG towards its tree portion

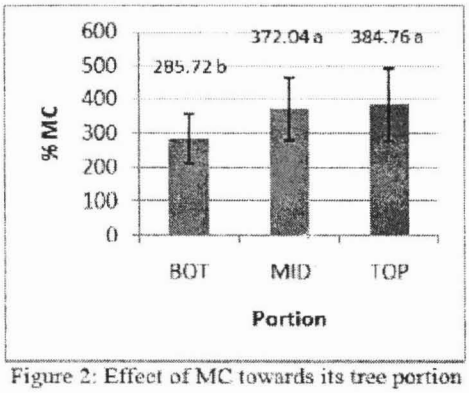

Figure 2: Effect of MC towards its tree portion

Effects of Distance from Pith

Figure 3 and Figure 4 showed that the specific gravity reading were to observed to have increase from near pith to near bark while moisture content decreases from near pith to near bark. The correlations analyses according to distance were given in Table 2. The increase in specific gravity was shown to be significant (r = 0.653**) and for moisture content, its decrease towards near bark was negatively correlated (r = -0.617**). In general terms, the increasing of specific gravity depends on either increasing wall thickness of fiber from pith to bark or increasing percentage of fibers with little change in wall thickness (Panshin and De Zeeuw, 1970). The decrease in moisture content with increasing distance from the near pith is due to the sapwood that is not mature enough to switch to heartwood. Sapwood contains both living and dead cells and functions primarily in the storage of food, also handles transport of water or sap (Anonymous, 1999). The other factors that can influence the moisture content (Haygreen and Bowyer, 1996) are:

a) tree age
b) growth condition
c) genetic
d) types of soil

Table 3 shows a comparison of specific gravity between 8 year old against a 13 year-old *P.*falcataria from the previous studies Ishiguri et.al. (2007) as a controller. The increase in specific gravity is significant in the 8 year old *P. falcataria* while the 13 year old tree shows no significant value. This result shows that this species has higher moisture content and specific gravity for juvenile wood. Juvenile wood is a wood formed in the early stages of growth of a tree stem which is obtained in the center portions of stem cross sections (Haygreen and Bowyer, 1996).

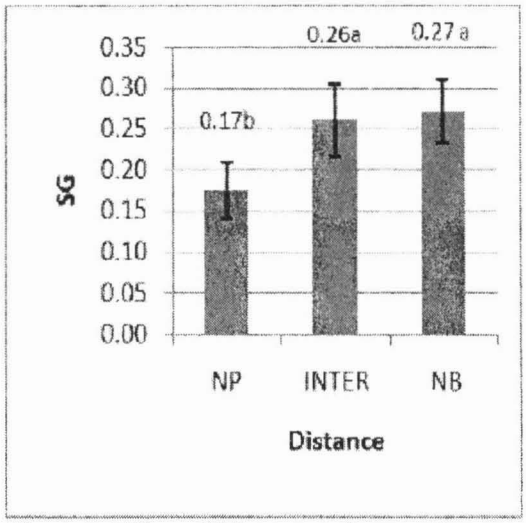

Figure 3: Effect of SG towards its tree distance

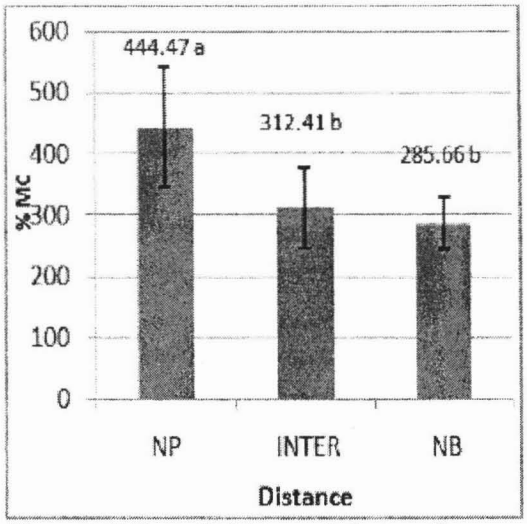

Figure 4: Effect of MC towards its tree distance

Table 2: Correlations analysis of the effects of height portion and distance from pith on the initial moisture content and specific gravity

Source		SG	MC (%)
Portion			
	Pearson Correlation	-0.457**	0.384**
	Sig. (2-tailed)	0.000	0.000
	N	108	108
Distance			
	Pearson Correlation	0.653**	-0.617**
	Sig. (2-tailed)	0.000	0.000
	N	108	108

Note: ** Correlation is significant at the 0.01 level (2 – tailed)

Table 3 shows the comparisons of specific gravity on 8 year-year old *P. falcataria* with a 13-year old tree from a previous study Ishiguri et.al. (2007) in Indonesia. Specific gravity of the 8-year old tree is lower at the near pith area while for near bark it is almost similar. The higher specific gravity of the 13 year old rtree may be due to the accumulation of extractives in the pith thus increasing the weight of the samples.

Table 3: Comparisons of specific gravity within of *P. falcataria* age (Ishiguri et.al. 2007)

Age	Specific Gravity	
	Near Pith	Near Bark
8	0.17	0.27
13	0.22	0.26

Conclusion

Result shows the specific gravity of *P. falcataria* ranges from 0.15 to 0.31. It increases with distance from pith. While the green moisture content of *P. falcataria* ranges from 280% to 550%. It decreases from near pith to near bark. Further studies should be done especially in relation to the contents of chemicals in the wood as it is closely related to the physical properties of wood. These results suggest *P. falcataria* has a strong potential for use in veneer production, low density wood composite, handicrafts and also artificial limbs.

References

Anino E. (1994). *Commercial Plantation Establishment, Management,and Wood Utilization of Paraserianthes falcataria By PICOP Resources, Inc.* Proceedings of a workshop on Albizia and Paraserianthes species, Bislig, Surigao del Sur, Philippines, Nov. 13–19, Winrock International, 1997, 131–139 pp.

Anonymous. (1999). Wood Handbook - Wood as an Engineering Material. Gen. tech. Rep. FPL-GTR-113. Madison, WI: U.S> Department of Agriculture, Forest Service, Forest products Laboratory. 463 pp.

Haygreen, J.G. & Bowyer, J.L. (1996). Forest Products and Wood Science, third ed. Iowa State University Press, USA, ISBN 0-81382-256-4.

Ishiguri, F., Eizawa, J., Saito, Y., Iizuka, K. Yokota, S., Priadi, D., Sumiasri, N. & Yoshizawa N. (2007). Variation in the Wood Properties of Paraserianthes falcataria Planted In Indonesia.IAWA J. 28: 339–348.

Ishiguri, F., Eizawa, J., Saito, Y., Iizuka, K. Yokota, S., Priadi, D., Sumiasri, N. & Yoshizawa N. (2009). radial variation of anatomical characteristics in paraserianthes falcataria planted in Indonesia .IAWA J. 30: 343–352.

Jamaludin Kasim. (1999). Properties Of Particleboard And Thermoplastic Composite From Bamboo (Gigantochloa scortechinii). PhD Thesis. Universiti Putra Malaysia.

Nemoto A. (2002). Farm tree planting and the wood industry in Indonesia: a study of Falcataria plantations and the Falcataria product market in Java. Policy Trend Report 2002, 42–51 pp.

Panshin, A.J. & De Zeeuw, C. (1970). Textbook of Wood Technology. McGraw-Hill Book Company, New York. 705 pp.

Sumiasri, N., Priadi, D. Yokota. S., & Yoshizawa, N. (2006). Tissue Culture of Fast Growing Tropical Trees in Indonesia: Mangium (Acacia Mangium Willd.) and Sengon (Paraserianthes Falcataria (L) Nielsen). In: Y. Imamura, T. Umezawa & T. Hata (eds.), Sustainable development and utilization of tropical forest resources: 123–130. Research Institute for Sustainable Humanosphere, Kyoto University, Kyoto.

Tan, K.C. (1983). Growth Data from Saba Softwoods Sdn Bhd Plantations of Some Fast Growing Leguminous Trees. Proceedings of a Workshop on Leucaena Research in the Asian Pacific Region, Singapore, 23–26 Nov. 1982, Ottawa, Canada, 155–156 pp.

TAPPI T255 CM. (2002). Sampling and preparing wood analysis. Technical Committee of the Association. 7 pp.

TAPPI T258 OM. (2002). Basic density and moisture content of pulpwood. Technical Committee of the Association. 10 pp.

Wahyudi, I., Okuyama, T., Hadi, Y.S., Yamamoto, H., Yoshida, M. & Watanabe, H. (2000). Relationship between Growth Rate and Growth Stresses in Paraserianthes falcataria Grown in Indonesia. J. Trop. For. Prod. 6: 95–105.

Wagner, W.L., Herbst, D.R., Sohmer, S.H. (1999). Manual Of The Flowering Plants Of Hawai'i, 2 vols. Bishop Museum Special Publication 83. University of Hawai'i and Bishop Press, Honolulu.

SURIA MOHAMAD AKHIR & JAMALUDIN KASIM, Faculty of Applied Sciences, UiTM Pahang.
suriamohdakhir@hotmail.com, jamal@pahang.uitm.edu.my