Fiber and Chemical Characteristics of Branchwoods of Three Meranti Species

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Abstract

The fiber and chemical characteristics of branchwoods of three meranti species namely meranti sangkan, meranti bakau, and meranti bunga kulit hitam from Bukit Batu Peat Swamp Forest, Riau were observed. The aim of this research was to discover the potential utilization of these three meranti species based on their characteristic. The result showed that holocellulose contents of meranti sangkan, meranti bakau, and meranti bunga kulit hitam were 72.97%, 75.28%, and 69.88%, whereas the α-cellulose contents were 43.55%, 51.14%, and 43.25%, respectively. meranti sangkan had the highest lignin content (35.99%) followed by meranti bakau (34.21%) and meranti bunga kulit hitam (32.18%). meranti Bunga kulit Hitam had the highest extractive content (2.24%) followed by meranti sangkan (1.66%) and meranti bakau (1.08). Furthermore, the fiber length of meranti bunga kulit hitam, meranti sangkan, and meranti and meranti Hitam were 1475.45 μm, 1475.45 μm, 1442.62 μm, and 1205.23 μm, respectively. The values of fiber derivative of the three meranti species were slightly differ from class I, except for felting power that was classified in class III. The result also showed that the branchwoods of the three meranti species are suitable for pulp and paper raw material.

Key words: fiber and chemical properties, meranti bakau, meranti sangkan, meranti bunga kulit hitam, peat swamp forest

Introduction

Identification of wood characteristics is very important not only as wood distinguishing features but also to discover potential utilization of wood. Every woods have its own distinctive and unique characteristics which differ from each other. Generally, the features that are often used to identify the types of woods are anatomical and chemical properties. Anatomical properties of wood cover studies of fiber characteristic and its derivative value. It is used to discover the utilization of wood fiber, such as in pulp and paper making whereas the study of chemical characteristics of wood is important to discover the potential utilization of wood based on this chemical characteristic, such as for pulp and paper, carbonized wood and bioethanol.

In this study, three different types of meranti were used which were, collected from Bukit Batu Peat Swamp Forest, Riau. They were meranti sangkan, meranti bakau, and meranti bunga kulit hitam. Since Bukit Batu Peat Swamp Forest is a

biosphere reserve, characteristic analysis can only be done using the branchwood. Bukit Batu Peat Swamp Forest is a natural forest which has high acidity. Therefore, each species was assumed to have different wood properties due to their adaptation in the acidic soil. Each type of wood will be analyzed based on their anatomical properties, both fiber characteristic and the values of fiber derivative and also based on their content of extractives, holocellulose, cellulose, and lignin. This research is expected to give valuable findings in term of unique characteristics of each type of meranti that can be employed to differentiate each other. Furthermore, it will provide information on the potential use of each wood based on its anatomical and chemical properties.

Investigation on chemical and fiber characteristics of these three species is still rare, especially those planted in peatswamp soil hence the information about them is very limited. Forest Research Institute Malaysia has studied the anatomical properties and wood identification of meranti bakau (FRIM 2010). However, study of other characteristics of the wood is still needed. meranti bakau is included in the list of IUCN Red List of Threatened Species 2010 (IUCN 2010). Therefore, this research was conducted to discover the potential utilization of the wood, and it is expected that the information can be used to explore their usage and will help in making an action to propagate the wood for its continous supply sustainability.

Materials and Methods

Branchwoods of meranti sangkan, meranti bakau, and meranti bunga kulit hitam were collected from Bukit Batu Peat Swamp Forest in Riau. Part of the branchwood that was used in this research was the first branch of each wood species, with the diametre of the branchwood is about 7-10 cm. The diametre of the wood that its branch was used approxymately 25 cm. The chemical composition analysis was done in Research and Development Unit for Biomaterials LIPI, while the observation of fiber characteristic was done in Plant Anatomy Laboratory, Forest Products Research and Development Center, Ministry of Forestry of Indonesia.

The branchwood were then milled into powder and then screened with a sieve to get 40-60 mesh particles that would be used in chemical property analysis. Chemical composition of the wood (the relative amount of soluble extractive percentage in alcohol-benzene solvent, holocellulose, α-cellulose, and lignin) were quantitatively analyzed from the powder of wood using Mokushitsu Kagaku Jiken Manual (2000).

The maceration specimens were made to observe the dimension and fiber characteristic of each wood. Wood flakes in the size of match stick were put in a tube, which contained hydrogen peroxide (H_2O_2) and acetic anhydride glacial (1:1). The tubes were then heated in a water bath (Tesoro 1989). The quantitative characteristics of microscopic structure were observed for 10-25 times per samples. The parameters of this research were fiber diameter and cell wall thickness. The fiber dimension and fiber length from this research were then used to estimate the value of fiber derivative as the parameter to determine the quality of fiber (Silitonga *et al.* 1972, Marsoem 2005).

Results and Discussion

The result of chemical properties of each different meranti and sengon are shown in Table 1 and 2. The result of fiber characteristics is shown in Table 3.

Table 1 Chemical properties of three different meranti species

Parameters	Meranti sangkan	Meranti bakau	Meranti bunga kulit hitam
Holocellulose (%)	72.97	75.28	69.88
α-cellulose (%)	43.55	51.14	43.25
Lignin (%)	35.99	34.51	32.18
Extractive (%)	1.66	1.08	2.24
Moisture content (%)	5.35	4.78	5.71

Table 2 Chemical characteristic of sengon

Parameters	Stemwood	Branchwood
Holocellulose (%)	77.3	74.7
α cellulose (%)	52.2	42.1
Lignin (%)	21.1	25.7
Extractive (%)	4.3	3.6
Moisture content (%)	5.35	4.78

Source: Marsoem (2005)

Table 3 Fiber characteristic and values of fiber derivative

Species of meranti	Fiber Dimension (µm)				Value of fiber derivative				
	L	d	l	w	Runkel ratio	Felting power	Flexibility ratio	Coef. rigidity	Multshep ratio
Sangkan	1442.62	29.65	25.20	2.22	0.18	48.93	0.85	0.08	2.22
quality					I	III	I	I	I
Bakau	1205.23	26.14	21.65	2.25	0.22	47.85	0.83	0.09	2.25
quality					I	III	I	I	I
Bunga kulit hitam	1475.45	29.87	25.47	2.20	0.17	49.66	0.85	0.07	2.20
quality					I	III	I	I	I

Notes: L = fiber length; d = fiber diameter; l = lumen diameter; w = wall thickness; Runkel ratio = 2w/l; Felting power = L/d; Flexibility ratio = l/d; Coefficient of rigidity = w/d; Multshep ratio = $(d^2 - l^2)/d^2$ x 100%.

Figure of the fiber from meranti sangkan, meranti bakau, and meranti bunga kulit hitam are shown in Figure 1-3.

Figure 1 Fiber and vessel of meranti sangkan (40 x).

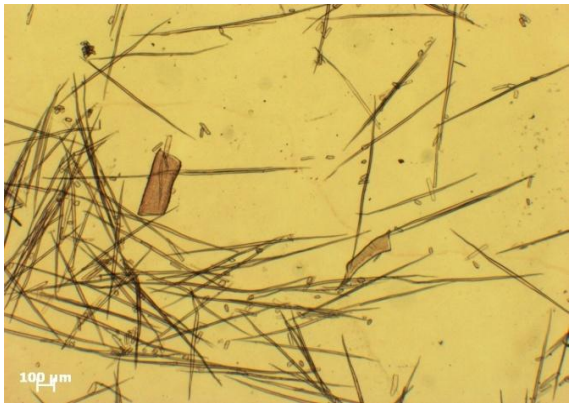

Figure 2 Fiber and vessel of meranti bakau (10x).

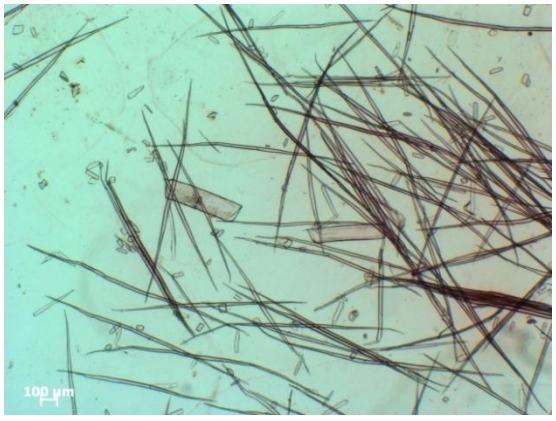

Figure 3 Fiber and vessel of meranti bunga kulit hitam (10x).

Table 1 shows that holocellulose and α-cellulose contents in meranti bakau was higher than that of meranti sangkan and meranti bunga kulit hitam. Holocellulose is a term for the entire carbohydrate fraction of wood, i.e. cellulose plus hemicelluloses (Fengel & Wegener 1995, Biermann 1996). Holocellulose is a carbohydrate fraction which is produced by wood delignification (Fengel & Wegener 1995). Holocellulose is very important for making pulp and paper as it can increase the yield and the strength of the pulp. Based on table 1, it can be seen that meranti bakau has higher holocellulose than the others. It means that meranti bakau is more likely to have more pulp yield and higher strength if it is to be used as pulp and paper raw material.

α-cellulose is a fraction of wood or pulp isolated by caustic extraction procedure. Generally it is considered to be pure cellulose (Biermann 1996). Cellulose is also a polysaccharide, indicating that it contains many sugar units. Pure cellulose can be rather easily hydrolyzed to glucose under controlled (acidic) conditions (Smook 1994). Table 1 shows that meranti bakau has higher α-cellulose content (51%). Therefore, there is a good chance to utilize this type of wood to make pulp and paper, as well as bioethanol product. In these two kind of wood products, α cellulose is an important material to make pulp and bioethanol.

Lignin content in meranti bunga kulit hitam was lower than that of meranti bakau and meranti sangkan. Lignin is the adhesive or binder in wood that holds the fibers together (Biermann 1996). In case of pulp and paper making or bioethanol production, isolation of lignin become an important factor. Lignin can reduce paper strength because it could be a barrier for

hydrogen bonding in the fiber formation. In the sacharification, lignin could be an inhibitor in the hydrolysis process. Hence, any wood that has low lignin content and high α-cellulose content would be a good potential to be utilized as raw material for pulp and paper making and bioethanol production.

Generally, chemical characteristic of branchwood and stemwood is different. The holocellulose and cellulose content from the stemwood is higher and its lignin content is lower than that of branchwood. Table 2 shows the difference of chemical characteristics of stem and branch of sengon wood. It shows the difference composition of juvenille and mature wood in the branchwood than stemwood. Branchwood may has higher content of juvenile than in the stemwood. Juvenile wood has less cellulose, more hemicellulose and lignin compared to mature wood. There is a gradual increase in cellulose content and a gradual decrease in hemicellulose in the mature wood while the lignin content decreases more rapidly as the cell mature (Rowell 2005). Other factor that may cause difference in chemical characteristic of wood is reaction wood. The wood cells that are formed when softwoods and hardwoods are tilted or bent out of vertical are called reaction wood since these cells are reacting to stressful condition (Rowell 2005). Branchwood is usually foremed out of vertical that might the difference in chemical characteristic of wood such as the lignin content of this part of the tree will differ from that of the stemwood.

Table 3 shows the fiber characteristic of meranti sangkan, meranti bakau, and meranti bunga kulit hitam. Fiber length of these three species of meranti was classified as class III. Generally, fiber length of hardwood is shorter than that of softwood thus fiber from these meranti could be considered as length fiber. From the value of fiber derivative, these meranti were almost included in class I which is suitable to be utilized as raw material for pulp and paper making. Branchwood mayhave high content of juvenile wood which makes the wood cells short, have small cell diameter and large microfibil angle (Rowell 2005).

Although analysis was carried out using branchwoods, all meranti species in this research have high content of holocellulose and are included in class I for fiber characteristic. Therefore, there is a good potential to utilize these woods to make various products considering their chemical properties such as pulp, paper and bioethanol, especially using meranti bakau which has higher polysaccharide than the two other meranti species. The chemical characteristic of the stemwood might be quite different from the branchwood. Therefore, a research on stemwood characteristics is needed to provide thorough information about the potential utilization of the three meranti species in this study.

Conclussion

Fiber characteristics which are fiber length and fiber derivative values of meranti sangkan, meranti bakau, and meranti bunga kulit hitam slightly differ from class I fiber to make pulp and paper. Holocellulose, α-cellulose, and soluble extractive in alcohol benzene content of meranti bakau are higher than those of meranti sangkan and meranti bunga kulit hitam while lignin content in meranti bunga kulit hitam is the lowest among them. Since this research used branchwood which is likely to have high content of juvenile and reaction wood, future research using stemwood is needed.

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