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ANATOMICAL PROPERTIES OF FIVE MAJOR WOOD SPECIES GROWN IN JAMBI, SUMATERA

(Sifat anatomi dari lima jenis kayu utama yang tumbuh di Jambi, Sumatera)

Oleh/By :

Y.I. Mandang and Krisdianto

RINGKASAN

*Ciri umum dan anatomi beberapa jenis kayu utama di Jambi, Sumatera, telah dipelajari. Tujuannya adalah untuk mendapatkan ciri-ciri sebagai landasan identifikasi kayunya, kegunaannya yang sesuai serta kemungkinannya untuk dibudidayakan secara luas. Lima jenis kayu utama sudah diamati dan dipertelaakan: balam (*Palaquium gutta *Bail.), bayur (*Pterospermum diversifolium *Bl.), medang (*Litsea *sp.), mahang (*Macaranga pruinosa *Muell. Arg.) dan merkubung (*M. gigantea *Muell. Arg.). Balam dan bayur cocok untuk bahan konstruksi rumah, kayu lapis dan mebel. Balam menghasilkan serat berkualitas sedang, bayur menghasilkan serat berkualitas baik. Oleh karena itu balam dan bayur sangat dianjurkan untuk dibudidayakan secara luas. Mahang dan merkubung terlalu ringan dan lunak untuk bahan konstruksi di mana sifat kekuatan merupakan hal utama. Namun mahang dan merkubung menghasilkan serat berkualitas baik sehingga dapat dianjurkan untuk dibudidayakan sebagai sumber serat. Medang cukup baik untuk bahan konstruksi dan seratnya juga berkualitas sedang. Namun adanya sel minyak dalam jaringan kayu serta kemungkinan pengaruhnya terhadap sifat perekatan dan pengecatan, haruslah diperhatikan sebelum keputusan diambil untuk pembudidayaannya secara luas.*

Kata kunci : *Palaquium, Pterospermum, Litsea, Macaranga,* identifikasi, sifat kayu, pemanfaatan, Jambi, Sumatera

SUMMARY

*General characteristics and anatomical properties of several major wood species in Jambi, Sumatera, have been studied. The purpose is to find out their characters for identification, their appropriate uses and their possibilities to be widely cultivated. Five major wood species have been identified and described: balam (*Palaquium gutta *Bail.), bayur (*Pterospermum diversifolium *Bl.), medang (*Litsea *sp.), mahang (*Macaranga pruinosa *Muell.Arg.) and merkubung (*Macaranga gigantea *Muell.Arg.). Balam and bayur are suitable for house construction, plywood, furniture; and their fibers are fairly good for pulp. Therefore balam and bayur are highly recommended to be widely cultivated. Mahang and merkubung are too light and*

soft for construction purposes where strength properties are of prime importance. However mahang and merkubung fibers are of good quality so they still can be recommended to be widely cultivated for pulp source. Medang is fairly appropriate for construction purposes and having fairly good quality fibers as well. However the occurrence of oil cells inside wood tissue and the possible effect of the exudate on gluability and paintability, have to be considered before decision is made for its cultivation in large quantities.
Key words : *Palaquium, Pterospermum, Litsea, Macaranga*, wood identification, wood properties, wood utilization, Jambi, Sumatera

I. INTRODUCTION

Some parts of natural forest in Indonesia, particularly the logged over areas, are planned to be converted into plantation forest. The aim is to produce a more homogenous and high quality timber for industrial purposes. Some questions however have arisen and therefore shall be first answered before the plan is carried out : 1) how are the residual stands going to be used, and 2) what tree species are going to be planted.

To find out answer to the above two questions, it is necessary to study the major wood species grown in the area, their identity, properties and possible uses. From this study, it is expected to determine the appropriate uses of the residual stands and the suitable tree species that are going to be planted.

The purpose of the present study is to determine the anatomical properties and possible uses of major wood species grown in natural forest in Jambi, Sumatera. Among the several major wood species grown in natural forest in Jambi, there are five species that have been identified : 1) balam (*Palaquium gutta* Bail.), 2) bayur (*Pterospermum diversifolium* Bl.), 3) mahang (*Macaranga pruinosa* Muell.Arg.), 4) medang (*Litsea* sp.) and 5) merkubung (*Macaranga gigantea* Muell.Arg.)

II. MATERIAL AND METHODS

There were five wood species to be examined with respect to their general characteristics and anatomical properties, i.e. balam (*Palaquium gutta* Bail.), bayur (*Pterospermum diversifolium* Bl.), mahang (*Macaranga pruinosa* Muell. Arg.), medang (*Litsea* sp.), and merkubung (*M. gigantea* Muell. Arg.). The overall trees of the five wood species selected as samples were harvested in April 1999 from their growing area situated at Bungo Tebo Forest District in Jambi, Central Sumatera. This growing area is adminitered by PT Inhutani V, a government-owned forest enterprise. Wood samples for anatomical studies were prepared in disks, taken from sampled tree at breast height. Three block sections were each cut from the disk at 5-cm, 10-cm, and 15-cm distances, respectively, from its pith toward its periphery.

The three block sections were each assigned for examination of anatomical features on consecutively cross-sectional (transverse), radial, and tangential surfaces. The block samples for transverse surface feature were at first air-dried and

then soaked in distilled water for one week. After becoming saturated, the samples were transferred into a container containing solution of alcohol-glycerin 1:1 (v/v) and further kept for about one week before sectioning (Fujii, 1989).

The other two block sections allocated for consecutively radial and tangential feature examinations were further softened by boiling under pressure for about 60 minutes in a container called as "presto", a specific cooking pan equipped with a pressure-increasing device. A 25/75 (v/v) solution of glycerin- water, as an additional softening agent, was also used (Chong, 1999). The sections were subsequently stained in two respective stages with haematoxylin as well as safranin. After staining, they were dehydrated, then mounted on glass object with entelan, and ready for examination.

The observed characters with respect to the anatomical features included those listed by IAWA Committee (Wheeler *et al.*, 1989). Some of these features are quantitative data or information. The quantitative information in this case was a representative wrap-up by first performing 10-30 measurements on certain feature of each investigated sample, and then taking average of them. Number of measurements was depending on the variability of the characters referred to. The quantitative features are as follows : A. Vessels : 1) diameter, number of measurements (n)= 10; length, n=10; and vessel frequency per sq. cm, n=10. B. Rays: height, number of measurement (n)=30, frequency per mm, n=10. C. Fibers: length, number of measurements (n)=30, diameter, n= 30, wall thickness, n= 30.

On certain occasion, the quantitative data are the results of the dimensional measurements of vessel length, fiber length, fiber diameter, and fiber wall thickness. In this regard, the associated woody samples were macerated first; and the maceration was conducted following Schultze method (Sass, 1960), as follows : the sample material was heated slowly and gently at 40-50^{0}C in concentrated nitric acid. A few crystals of potassium chlorate ($KClO_3$), each approximately the size of a matchstick head, were added to the samples-soaked nitric acid; and the heating was continued until the materials was bleached white. It took about 60-120 minute heating to produce an adequately macerated material or a satisfactory separation of woody fibers, for further related dimensional examinations.

Fiber quality of each wood species was evaluated using fiber quality criterion issued by Forest Products Research Institute Bogor (Rachman and Siagian, 1976, Appendix 1).

III. WOOD DESCRIPTION

A. BALAM (*Palaquium gutta* Bail.)

General characteristics

Colour: heartwood color is reddish-brown, clearly demarcated from 4 - 8 cm thick pale brown sapwood.

Figure : flat-sawn board with fine dark brown streak due to the presence of fairly regular layers of denser wood.

Texture: moderately fine and uneven due to radial groupings of the vessels.

Grain: straight to shallowly interlock

Hardness: wood is moderately hard.

Anatomical structure (Figure 1)

Growth ring : distinct, marked by differences in fiber wall thickness and in the spacing of parenchyma bands.

Vessels: diffuse, mostly in radial multiples of 2 - 5 vessels, some are in clusters; diameter up to 220 μ , 170 (± 4) μ on average; length 1100 (± 50) μ; frequency 8 (± 0.6) per sq.mm; perforation plate simple; intervessel pit alternate, polygonal, 5 - 10 μ in diameter; vessel ray pitting of two types, one with distinct borders similar to intervessel pit in shape and size, the other is elongated, horizontal to scalariform pattern; tyloses common; gum like deposit absent.

Parenchyma: in narrow bands, 1 - 2 cells wide, closely spaced forming more or less reticulate patterns with rays; in 6 - 9 cells per strand.

Rays: heterocellular with one to more than four rows of upright cells; sometimes procumbent and upright cells are mixed; 1 - 2 cells wide, up to 1763 μ high, 806 (± 48) μ on average; frequency 7 - 11 per mm, 9 (± 0.4) on average;

Fibers: non -septate, with simple to minutely bordered pits that are common in radial and tangential walls; length 2250 (± 66) μ, diameter 33.4 (± 0.8) μ, wall thickness 5.2 (± 0.2) μ.

Oil and muscilage canals: absent

Mineral inclusion: crystals absent; silica bodies present in ray cells, either in procumbent or in upright cells.

The transverse, radial and tangential surfaces of balam are shown in Figure 1. Fiber dimension, Fiber dimension derived values, Fiber quality evaluation are shown at Table 1, Table 2, and Table 3 respectively.

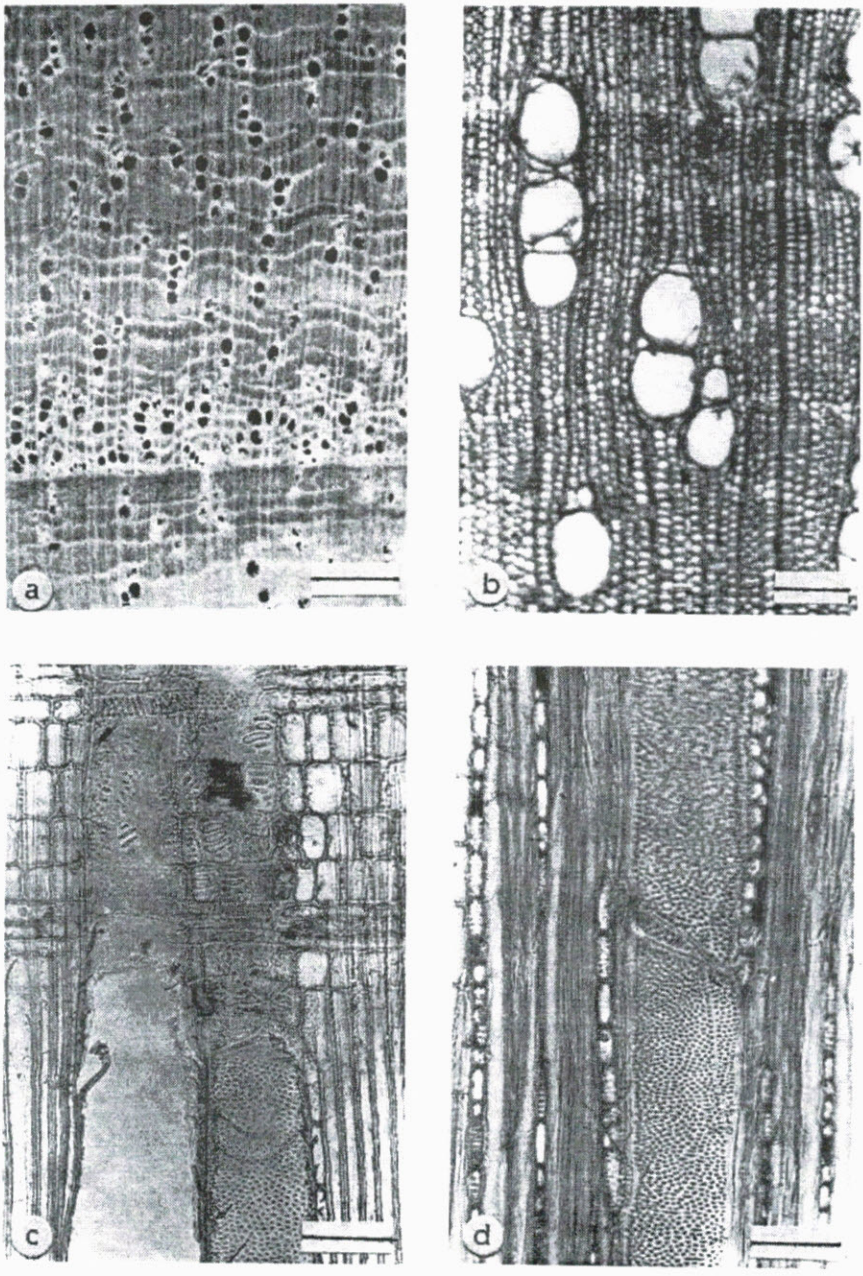

Figure 1(Gambar 1). BALAM (*Palaquium gutta* Bail.)

a. transverse surface, scale bar = 1mm (penampang lintang, palang skala=1 mm)
b. transverse surface, scale bar = 200 μm (penampang lintang, palang skala=200 μm)
c. radial surface, scale bar = 100 μm (penampang radial, palang skala=200 μm)
d. tangential surface, scale bar = 100 μm (penampang tangensial, palang skala=200 μm)

B. BAYUR (*Pterospermum diversifolium* Bl.)

General characteristics

Colour: the heartwood is red-brown, gradually differentiated from 8 to 12 cm thick pinkish to white sapwood.

Figure: flat sawn board with faint darker streak due to the presence of irregular layers of denser wood.

Texture: moderately coarse.

Grain: straight to shallowly interlocked at portion near the bark.

Hardness: the wood is moderately soft.

Anatomical structure (Figure 2)

Growth ring: boundaries indistinct or distinct, when distinct marked by layers of fibers that seem flattened in radial direction.

Vessels: diffuse, mostly in radial multiples of 2 - 5(- 7), occasionally in clusters; diameter up to 282 μ , mean 211 (± 7) μ; frequency 1 - 7 per sq. mm, 2 - 4 per sq. mm on average; length 314 - 629 μ, 484 (± 14) μ on average; perforation plate simple; intervessel pit alternate, polygonal, 6 - 7 μ in diameter; vessel-ray pit with distinct borders, similar to intervessel pit in shape and size.

Parenchyma: scanty paratracheal to predominantly diffuse in aggregates; in 4 - 6 cells per-strand as seen in radial surface.

Rays: heterocellular, two distinct sizes; small rays 1 - 2 cells wide, up to 1518 μ high, 919 (± 52) μ on average; frequency 7 - 15 per mm, c.11 on average; larger rays 3 - 6 cells wide, up to 2700 μ high; tile cells present.

Fibers: with simple pit, non -septate; length 1181 - 2123 μ, 1705 (± 36) μ on average ; diameter 35.61 (± 1.58) μ; wall thickness 2.32 (± 0.10) μ.

Oil and muscilage canals: absent

Mineral inclusion : prismatic crystals, present in non-chambered axial parenchyma and less frequent in upright ray cells.

The transverse, radial and tangential surfaces of bayur are shown in Figure 2. Fiber dimension, Fiber dimension derived values, Fiber quality evaluations are shown at Table 1, Table 2, and Table 3 respectively.

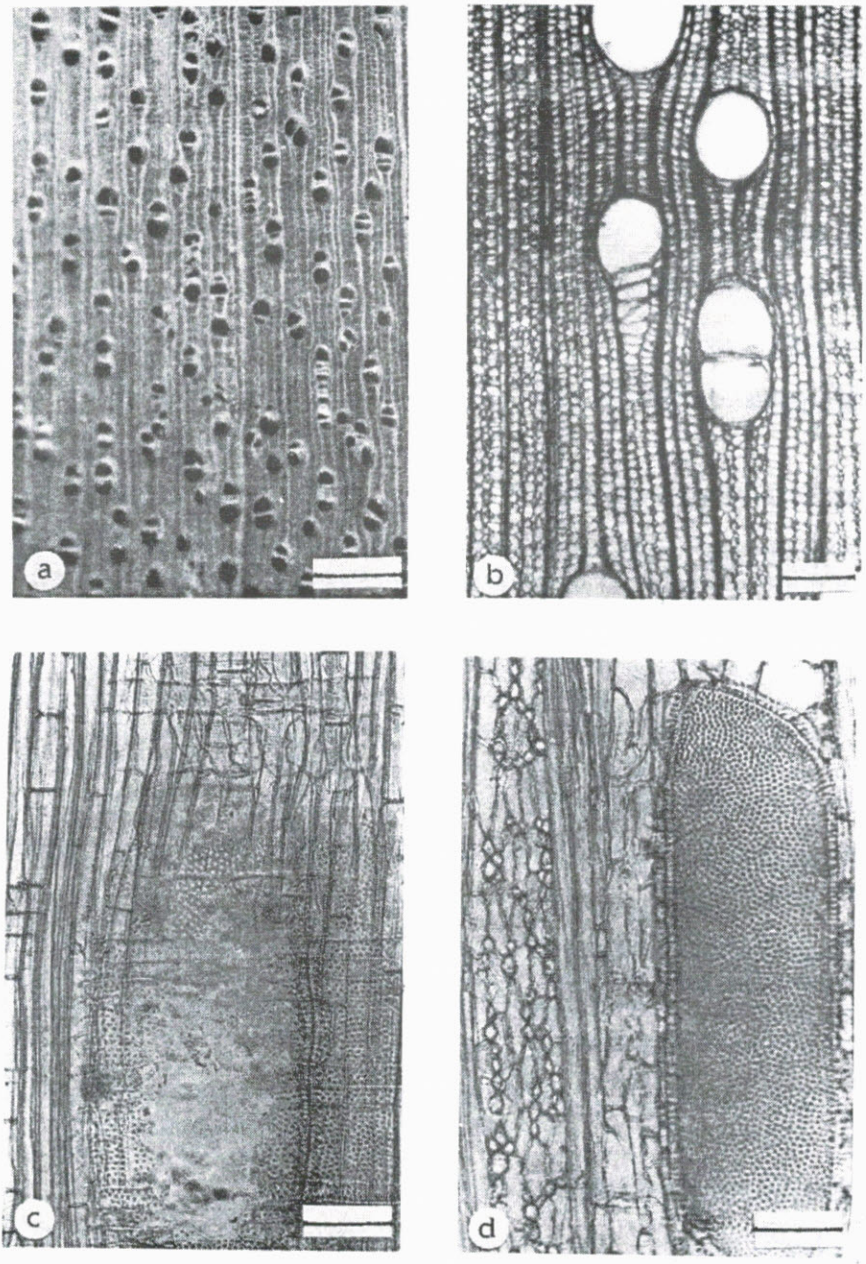

Figure 2(Gambar 2). BAYUR (*Pterospermum diversifolium* Bl.)
a. transverse surface, scale bar = 1mm (penampang lintang, palang skala=1 mm)
b. transverse surface, scale bar = 200 μm (penampang lintang, palang skala=200 μm)
c. radial surface, scale bar = 100 μm (penampang radial, palang skala=200 μm)
d. tangential surface, scale bar = 100 μm (penampang tangensial, palang skala=200 μm)

C. MAHANG (*Macaranga pruinosa* Muell.Arg.)

General characteristics

Colour : the heartwood is grayish brown, not clearly distinguished from sapwood.

Figure : flat sawn board is plain without figure.

Texture: moderately fine and even

Grain : straight.

Hardness : the wood is soft.

Anatomical structure (Figure 3)

Growth ring : boundaries indistinct or distinct, when distinct marked by layers of fibers with thicker wall and which seem flattened at radial direction.

Vessels : diffuse, predominantly solitary, others in radial multiples of 2 - 4 vessels; diameter up to 245 μ , 199 (± 5) μ on average; frequency 1 - 5 per sq. mm, 3-4 per sq. mm on average ;length 1159 (± 45) μ on average; perforation plate simple; intervessel pit alternate, polygonal to rounded in shape, 12 - 17 μ in diameter; vessel ray pit with reduced borders, mostly elliptic shape, some are round or angular; thin walled tyloses sometime present.

Parenchyma : diffuse, scanty paratracheal, and unilateral paratracheal; 7 - 15 cells per strand;

Rays : heterocellular with one to more than four rows of upright cells 1 - 2 (-3) cells wide with uniseriate portions about the same width with multiseriate portions; up to 1695 μ high, 1057 (± 52) μ on average; frequency 8 - 14 per mm, 11 (± 0.5) on average;

Fibers : with simple to minutely bordered pit; length 1364.8 - 2001.2 μ, 1705.9 (± 33) μ on average; diameter 41.97 (± 1.4) μ wall thickness 2.9 (± 0.1) μ.

Oil and muscilage canals : absent

Mineral inclusion : prismatic crystals present in chambered axial parenchyma and in chambered upright ray cells.

The transverse, radial and tangential surfaces of mahang are shown in Figure 3. Fiber dimension, Fiber dimension derived values, Fiber quality evaluations are shown at Table 1, Table 2, and Table 3 respectively.

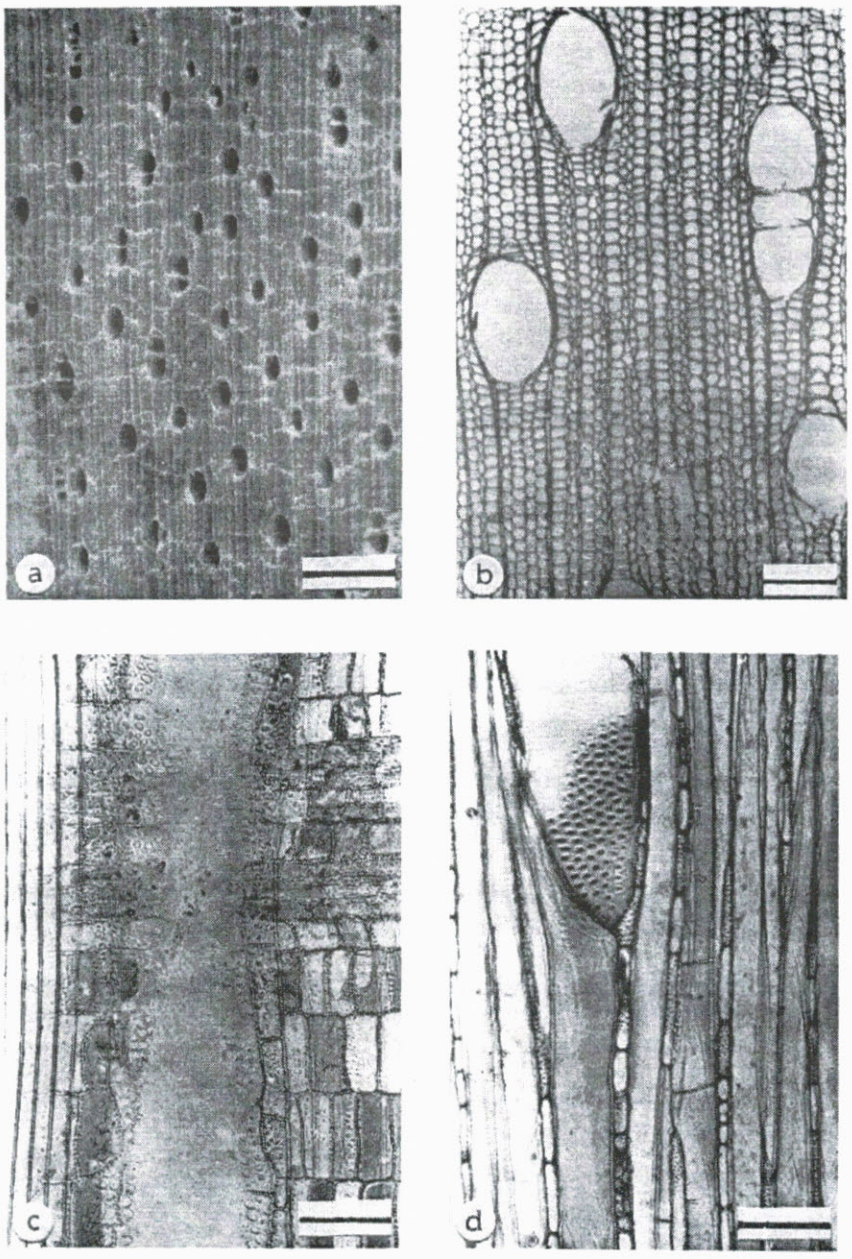

Figure 3 (Gambar 3). MAHANG (*Macaranga pruinosa* Muell.Arg)

a. transverse surface, scale bar = 1mm (penampang lintang, palang skala=1 mm)
b. transverse surface, scale bar = 200 μm (penampang lintang. palang skala=200 μm)
c. radial surface, scale bar = 100 μm (penampang radial, palang skala=200 μm)
d. tangential surface, scale bar = 100 μm (penampang tangensial, palang skala=200 μm)

D. MEDANG (*Litsea* sp.)

General characteristics

Colour : the heartwood colour is yellow with greenish tinge, gradually differentiated from 4 to 5 cm thick pale yellow sapwood.

Figure : flat sawn board with faint darker figure due to the presence of fairly regular layers of denser wood.

Texture : moderately fine and even.

Grain : straight to shallowly interlock.

Hardness : the wood is moderately soft.

Anatomical structure (Figure 4)

Growth ring : distinct, marked by differences in fiber wall thickness; boundaries also distinct, marked by layers of seemingly flattened fibers.

Vessels : c.60 - 70 percent solitary, others in radial multiples of 2 - 4 vessels, occasionally in clusters; diameter up to 190 μ , mean 144 (± 4) μ ; length 615 (± 21) μ; frequency 5 (± 0.7) per sq. mm; perforation plate simple; intervessel pit alternate, rounded to polygonal, 9 - 17 μ ; vessel ray pit simple, some rounded to angular, mostly elongated in horizontal direction forming scalariform pattern; thin walled tyloses present in some vessels; gum-like deposit absent.

Parenchyma : scanty paratracheal to vascicentric, some tend to be aliform and occasionally confluent; in 2 - 8 cells per-strand.

Rays : homocellular to heterocellular with one or two rows of upright cells; 1 - 5 cells wide, up to 829 μ high, 474 (± 27) μ on average; frequency 5 (± 0.4) per-mm.

Fibers : with simple pit, non-septate; length 1557 (± 32) μ, diameter 32.6 (± 1.1) μ; wall thickness 3.48 (± 0.11) μ.

Secretory cells : Oil cells present, associated mostly with axial parenchyma, rarely with upright cells.

Mineral inclusion : prismatic, cubic and styloid crystals present in ray cells, mostly in procumbent cells; silica bodies absent.

The transverse, radial and tangential surfaces of medang are shown in Figure 4. Fiber dimension, Fiber dimension derived values, Fiber quality evaluations are shown at Table 1, Table 2, and Table 3 respectively.

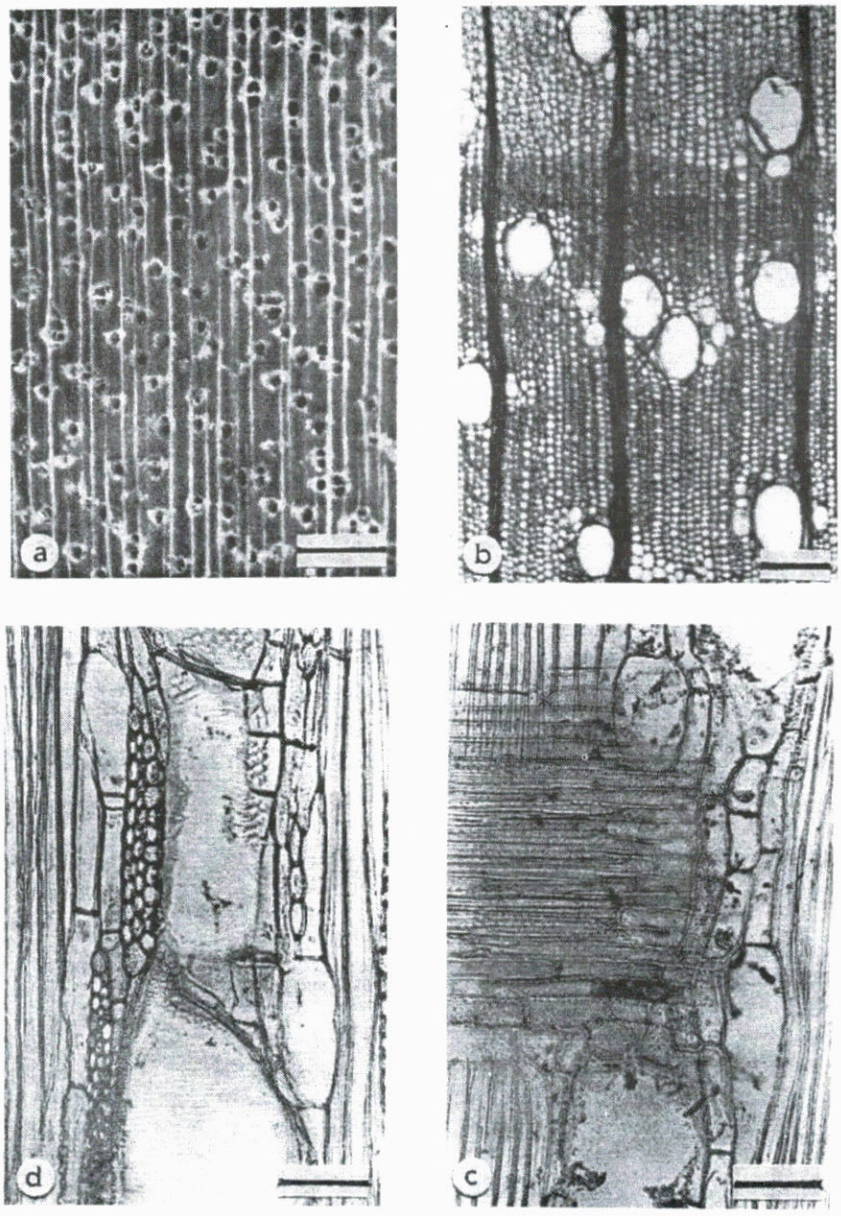

Figure 4 (Gambar 4). MEDANG (*Litsea sp.*)

a. transverse surface, scale bar = 1mm (penampang lintang, palang skala=1 mm)
b. transverse surface, scale bar = 200 μm (penampang lintang, palang skala=200 μm)
c. radial surface, scale bar = 100 μm (penampang radial, palang skala=200 μm)
d. tangential surface, scale bar = 100 μm (penampang tangensial, palang skala=200 μm)

E. MERKUBUNG (*Macaranga gigantea* Muell.Arg.)

General characteristics

Colour : the heartwood is pink when fresh, turning to grayish brown upon exposure, not clearly demarcated from sapwood.

Figure : flat sawn board is plain, without any figure.

Texture : moderately fine and even.

Grain : straight to shallowly interlock.

Hardness : the wood is soft.

Anatomical structure (Figure 5)

Growth ring : boundaries distinct or indistinct, when distinct marked by layers of seemingly flattened fibers with thicker fiber wall.

Vessels : diffuse, c.75 percent solitary, others in radial multiples of 2 - 3 (- 4) vessels, diameter up to 294 μ , 205 (± 5) μ on average; length 1044 (± 45) μ; frequency 2 - 7 per sq.mm, 4 (± 0.4) on average; perforation plate simple; intervessel pit alternate, polygonal, 16 - 20 μ in diameter; vessel ray pit simple, round, angular, to elongated in horizontal to oblique pattern; tyloses present in some vessels.

Parenchyma : vascicentric, aliform to unilateral paratracheal ; in 5 to 12 cells per strand.

Rays : heterocellular with two to more than four rows of upright cells; 1 - 2 cells wide, with uniseriate portions are about the same width as biseriate portions; uniseriate rays composed entirely of upright cells; up to 2519 μ high, 1263 (± 92) μ on average; frequency 12 (± 0.6) per mm.

Fibers : with simple pits, which are common in radial walls; non -septate; length 1698 (± 32) μ, diameter 38.7 (± 1.2) μ; wall thickness 2.8 (± 0.11) μ.

Oil and muscilage canals : absent

Mineral inclusion : absent

The transverse, radial, and tangential surface of merkubung are shown in Figure 5. Fiber dimension, Fiber dimension derived values, Fiber quality evaluations are shown at Table 1, Table 2, and Table 3 respectively.

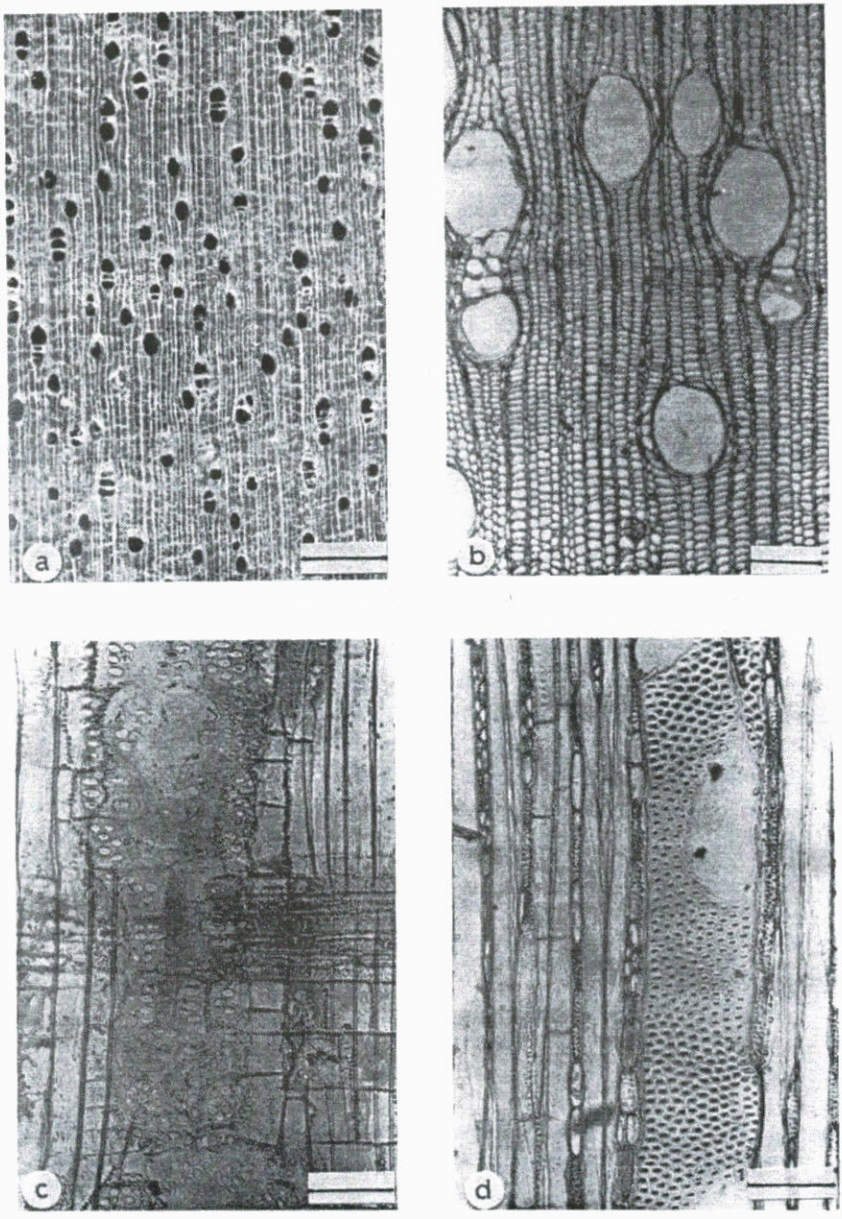

Figure 5 (Gambar 5). MERKUBUNG (*Macaranga gigantea* Muell.Arg.)

a. transverse surface, scale bar = 1mm (penampang lintang, palang skala=1 mm)
b. transverse surface, scale bar = 200 μm (penampang lintang, palang skala=200 μm)
c. radial surface, scale bar = 100 μm (penampang radial, palang skala=200 μm)
d. tangential surface, scale bar = 100 μm (penampang tangensial, palang skala=200 μm)

IV. DISCUSSION

A. Identification

As a matter of fact, general characteristics and anatomical features of the wood under present study have previously been described, among others by Budi (1993) on balam, Madhavan (1998) on bayur, Ho (1995) on medang and Rojo (1998) on mahang and merkubung. The results of the present study (as described in chapter III and figure 1 – 4) correspond mostly with previous descriptions of the genera and therefore confirm their true identity, at least at a generic level.

For identification purposes, it can be summarized that the main features of balam wood are having vessels arranged in long radial multiples combined with closely spaced parenchyma bands. Bayur wood is characterized mainly by having diffuse-in-aggregate's parenchyma, rays of two distinctive sizes and the occurrence of tile cells in ray tissue. Medang is characterized mainly by vascicentric parenchyma and having oil cells associated with axial parenchyma. Mahang and merkubung that belong to the same genus *Macaranga* are characterized mainly by having vessels that are solitary and in short radial multiples, unilateral paratracheal parenchyma which sometimes tends to be seemingly reticulate pattern, and the wood portion is usually light and soft.

The occurrence of prismatic crystals in parenchyma and rays of mahang and their absence in merkubung may be used to segregate these two wood species, but this feature should be confirmed by observing more samples from both species.

All species studied have common tropical characters, mostly with only weakly distinctive growth rings (balam, bayur and medang) marked by layers of wood that slightly differ in density and in fiber wall thickness. Mahang and merkubung have only distinct growth ring at microscopic level, often indistinct to the naked eye. The texture is far from being extreme, laid only from moderately fine to moderately coarse. Wood colour is common, ranging from pale yellow (medang) to reddish brown (balam, bayur, mahang and merkubung), mostly almost plain; only balam which has fairly distinct fine dark brown streak that gives a decorative figure to the wood on radial and tangential surface.

B. Fiber quality

Data on fiber dimensions are presented in Table 1. There are tendencies that fiber length increased with its distance from the wood portion near the pith toward the periphery, even though these tendencies are not consistent in bayur and mahang. This can occur probably because of inadequate number of sample measured. The same phenomenon is also obvious on fiber wall thickness ; there are tendencies that the thickness becomes slightly thicker toward the periphery. Fiber diameters do not vary widely among species and are somewhat stable within species.

Balam has the longest fiber i.e. 2250 microns on average, followed in decreasing order by bayur and mahang, both of which have about the same fiber length i.e. 1705 microns, then by merkubung which has fiber length of 1689 microns. Medang has the shortest fiber, 1556 microns on average. Mahang and merkubung have the

thinnest fiber wall thickness, followed in increasing order by medang then bayur, which have thicker wall. Balam has the thickest fiber wall among the five species studied.

Evaluation on fiber quality is presented in Tables 2 and 3. Even though balam has the longest fiber and therefore may has high felting power, but it has relatively thicker fiber wall that makes it relatively rigid and less flexible. Considering FPRI classification (Rachman and Siagian, 1976 –Appendix 1), balam fiber falls into quality of class II that is only fairly good for pulp manufacture. Similar characteristics are shared by bayur that falls into class II quality. Medang has the shortest fiber and relatively thicker wall so it also falls into class II quality. Mahang and merkubung have the thinnest fiber wall and turn out to be in class quality I, which are very good for pulp. Pulp from this wood species must have high tensile and burst strength. Inferior felting power due to relatively short fibers can be overcome by mixing them with certain amount of long fiber pulp.

Table 1. Fiber dimension
Tabel 1. Dimensi serat

Wood species (*Jenis kayu*)	Location (*Letak*)	Fiber Length (*Panjang serat*)			Fiber diameter (*Diameter serat*)			Lumen diameter (*Diameter lumen*)			Wall thickness (*Tebal dinding*)		
		$\bar{x}$	SD	SE	$\bar{x}$	SD	SE	$\bar{x}$	SD	SE	$\bar{x}$	SD	SE
1.Balam (*Palaquium gutta* Baill.)	A	2276	399		32.3	3.03		23.3	3.46		4.51	0.85	
	B	2285	267		33.4	3.36		22.6	3.30		5.40	0.64	
	C	2189	255		34.6	4.41		23.4	3.37		5.58	1.07	
	$\bar{\bar{x}}$	2250		33	33.4		0.38	23.1		0.35	5.16		0.09
2.Bayur (*Pterospermum diversifolium* Bl.	A	1602	181		38.8	7.24		34.3	6.98		2.21	0.38	
	B	1784	162		33.6	7.62		29.1	7.18		2.24	0.49	
	C	1729	162		34.5	7.59		29.5	7.21		2.50	0.56	
	$\bar{\bar{x}}$	1705		18	35.6		0.79	30.9		0.75	2.32		0.05
3.Mahang (*Macaranga pruinosa* Muell.Arg.	A	1673	169		42.9	7.23		37.7	7.44		2.58	0.37	
	B	1724	144		43.5	6.60		37.4	6.34		3.03	0.52	
	C	1720	155		39.6	6.80		33.3	6.80		3.12	0.47	
	$\bar{\bar{x}}$	1705		17	41.9		0.73	36.1		0.72	2.91		0.05
4.Medang (*Litsea firma* Hook.f.)	A	1559	153		32.6	5.03		25.9	5.22		3.31	0.53	
	B	1473	122		32.3	4.94		25.4	5.12		3.44	0.61	
	C	1637	175		32.9	5.14		25.6	5.14		3.68	0.46	
	$\bar{\bar{x}}$	1557		16	32.6		0.53	25.6		0.54	3.48		0.06
5.Merkubung (*Macaranga gigantea* Muell.Arg.	A	1629	135		37.9	6.08		32.3	6.07		2.77	0.46	
	B	1701	177		40.9	4.91		35.8	5.22		2.58	0.59	
	C	1764	147		37.3	6.24		31.1	6.12		3.11	0.52	
	$\bar{\bar{x}}$	1698		16	38.7		0.61	33.1		0.61	2.82		0.06

Remarks (*Keterangan*):
1. A : 5 cm from the pith (*5 cm dari empulur*)
   B : 10 cm from the pith (*10 cm dari empulur*)
   C : 15 cm from the pith (*15 cm dari empulur*)
   $\bar{\bar{x}}$: average (*rataan*)
2. SD = Standard Deviation (*Simpangan baku*)
3. SE = Standard Error of the mean (*Simpangan baku rata-rata*)

Table 2. Fiber dimension derived values
Tabel 2. Nilai turunan dimensi serat

Wood species (*Jenis kayu*)	Location* (*Letak*)	Runkel ratio [1]	Felting power [2]	Flexibility ratio [3]	Coefficient of rigidity [4]	Muhlsteph ratio [5]
1.Balam (*Palaquium gutta* Baill.)	A	0.40	99.38	0.72	0.14	0.48
	B	0.49	102.43	0.67	0.16	0.54
	C	0.48	94.75	0.68	0.16	0.54
	$\bar{x}$	0.46	98.85	0.69	0.15	0.52
2.Bayur (*Pterospermum diversifolium* Bl.)	A	0.29	59.18	0.78	0.11	0.39
	B	0.30	75.25	0.77	0.11	0.40
	C	0.36	83.12	0.74	0.13	0.45
	$\bar{x}$	0.32	72.52	0.76	0.12	0.41
3.Mahang (*Macaranga pruinosa* Muell.Arg.)	A	0.18	51.84	0.85	0.07	0.28
	B	0.15	48.83	0.87	0.06	0.24
	C	0.21	58.79	0.83	0.09	0.31
	$\bar{x}$	0.18	53.15	0.85	0.07	0.28
4.Medang (*Litsea firma* Hook.f.)	A	0.22	55.48	0.82	0.09	0.32
	B	0.31	66.20	0.77	0.12	0.41
	C	0.33	79.83	0.75	0.12	0.43
	$\bar{x}$	0.29	67.17	0.78	0.11	0.39
5.Merkubung (*Macaranga gigantea* Muell.Arg.)	A	0.14	45.52	0.88	0.06	0.23
	B	0.17	47.15	0.86	0.07	0.26
	C	0.19	53.28	0.84	0.08	0.30
	$\bar{x}$	0.17	48.65	0.86	0.07	0.26

Remarks :

1) Runkel ratio (*Perbandingan Runkel*) = $\frac{2w}{l}$

2) Felting power (*Daya tenun*) = $\frac{L}{d}$

3) Flexibility ratio(*Perbandingan fleksibilitas*) = $\frac{l}{d}$

4) Coefficient of rigidity (*Koefisien kekakuan*) = $\frac{w}{d}$

5) Muhlsteph ratio (*Perbandingan Muhlsteph*) = $\frac{d^2 - l^2}{d^2} \times 100\%$

L = fiber length (*Panjang serat*)

d = fiber diameter (*diameter serat*)

l = lumen diameter (*diameter lumen*)

w = wall thickness *(tebal dinding)*

*) Refer to Table 1 (*lihat Tabel* 1)

Table 3. Fiber Quality Evaluation *
Tabel 3. Penilaian kualitas serat

Wood species (Jenis kayu)	Location	Fiber length	Runkel ratio	Felting power	Muhlsteph ratio	Flexibility ratio	Coefficient of rigidity	Total	Quality Class
Balam (*Palaquium gutta* Baill.)	A	100	50	100	50	50	50	400	II
	B	100	50	100	50	50	25	375	II
	C	100	50	100	50	50	25	375	II
	$\bar{\chi}$	**100**	**50**	**100**	**50**	**50**	**25**	**375**	**II**
Bayur (*Pterospermum diversifolium* Bl.)	A	50	50	50	50	50	50	300	II
	B	50	50	50	50	50	50	300	II
	C	50	50	50	50	50	50	300	II
	$\bar{\chi}$	**50**	**50**	**50**	**50**	**50**	**50**	**300**	**II**
Mahang (*Macaranga pruinosa* Muell.Arg.)	A	50	100	50	100	100	100	500	I
	B	50	100	25	100	100	100	475	I
	C	50	100	50	50	100	100	450	I
	$\bar{\chi}$	**50**	**100**	**50**	**100**	**100**	**100**	**500**	**I**
Medang (*Litsea firma* Hook.f.)	A	50	100	50	50	100	100	450	I
	B	50	50	50	50	50	50	300	II
	C	50	50	50	50	50	50	300	II
	$\bar{\chi}$	**50**	**50**	**50**	**50**	**50**	**50**	**300**	**II**
Merkubung (*Macaranga gigantea* Muell.Arg.)	A	50	100	25	100	100	100	475	I
	B	50	100	25	100	100	100	475	I
	C	50	100	50	50	100	100	450	I
	$\bar{\chi}$	**50**	**100**	**50**	**50**	**100**	**100**	**450**	**I**

* Calculated from the data in Tables 1 and 2 based on FPRI Classification (Rachman and Siagian, 1976). Refer to Appendix 1 *(Dihitung atas dasar data di Tabel 1 dan 2, sesuai dengan klasifikasi LPHH (Rachman dan Siagian, 1976). Lihat Lampiran 1)*

C. Possible utilization

Balam that is also known as nyatoh, is in general suitable for house construction, but its most important uses today is for fine furniture, decorative veneers and doors, flooring, partitions and musical instruments (Soerianegara, 1994). The result of present study on general characteristics supports the previously mentioned information with an additional finding that balam fibers are fairly good for pulp. It may be less profitable to use balam from mature trees for pulp, but as long as small diameter trees as obtained from thinning are concerned, it is reasonable to process them into pulp.

Bayur is also well known as a good material source of timber for house construction, plywood, match splinters, wood wool board, and its pulp is suitable for pulp manufacture (Boer, 1998). The first author (Mandang, 1996) finds, this species suitable for pencil slats. The pencils made of this wood species can easily be peeled with pencil sharpener specially the one designed for children's usage. The result of the present study, particularly on the fiber dimension, proved that bayur fibers could rate in class II quality that is fairly good for pulp.

Mahang and merkubung have been used for light framing, interior trims, moldings, shingles, packing cases, match splinters and wooden shoes. Both species also yield high quality pulp, particleboard, wood wool board, plywood and good fuelled (Lim, 1999). The result of the present study supports the above information.

The wood is light, easy to work, and the quality of its fibers rated into class quality I, very good for pulp making.

Medang is suitable for interior finish, paneling, furniture, cabinet work, board, rotary veneer and plywood, packing cases. To some extent, this specimen has been used for medium-heavy construction, poles, post, plank, canoes, tool handles, agricultural implements, carving, sculpturing and pattern making (Soerianegara, 1995). The result of the present study supports most of the above information, but in some cases it may not be as suitable as what has been thought. Medang has oil cells inside the wood tissue that certainly spread over their contents while the wood is being worked. Depending on the amount of oil, it may influence some wood properties such as gluability and paintability. Its wood portion produces fibers with fairly good quality, so when it is not good enough for other purposes, it is still good for pulp making.

V. CONCLUSION AND RECOMMENDATION

1. Balam (*Palaquium gutta* Bail.), bayur (*Pterospermum diversifolium* Bl.), medang (*Litsea* sp.), mahang (*Macaranga pruinosa* Muell.Arg.) and merkubung (*Macaranga gigantea* Muell.Arg.) are among the major wood species grown in Jambi, Sumatera. Study on their general characteristics and anatomical properties have confirmed their true identity at genera's level.

2. Balam and bayur have been commonly used for house construction, plywood and furniture. Bayur has recently proved to be suitable also for pencil slats. The present study on their fiber dimension revealed that balam and bayur produce fairly good quality fibers. These two wood species are therefore recommended to be widely cultivated.

3. Mahang and merkubung are known to be suitable for light framing, handicraft and particleboard. The present study on their fiber dimension revealed that mahang and merkubung produce good quality fibers as well, so they are recommended to be widely cultivated in supporting the raw material needs for pulp and paper industry.

4. Medang has been commonly used for construction, interior finish, furniture and many other purposes. It also produces fairly good quality fibers for pulp. However this species contains oil cells and the oil may influence some wood properties , such as gluability and paintability. So in this case, action should be taken to overcome these undesirable properties before decisions are made for its cultivation.

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Appendix 1. Indonesian wood fiber criteria for pulp and paper raw material*
Lampiran 1. Kriteria serat kayu Indonesia untuk bahan baku pulp dan kertas

	Class (*Kelas*) I		Class (*Kelas*) II		Class(*Kelas*) III	
	Requirement (*syarat*)	Value (*nilai*)	Requirement (*syarat*)	Value (*nilai*)	Requirement (*syarat*)	Value (*nilai*)
Length (*panjang*), micron	>2 000	100	1000-2000	50	<1000	25
Runkel ratio (*Perbandingan Runkel*)	<0.25	100	0.25-0.50	50	0.50-1.00	25
Felting power (*Daya tenun*)	>90	100	50-90	50	<50	25
Muhlsteph ratio (*Perbandingan Muhlsteph*)	<30	100	30-60	50	60-80	25
Flexibility ratio (*Perbandingan fleksibilitas*)	>0.80	100	0.50-0.80	50	<0.50	25
Coefficient of rigidity (*Koefisien kekakuan*)	<0.10	100	0.10-0.15	50	>0.15	25
Interval (*selang*)	450-600		225-449		<225	

* Source: Rachman and Siagian, 1976

PETUNJUK BAGI PENULIS

BAHASA : Naskah ditulis dalam bahasa Indonesia dengan ringkasan dalam bahasa Inggris atau dalam bahasa Inggris dengan ringkasan dalam bahasa Indonesia.

FORMAT : Naskah diketik di atas kertas kuarto putih pada suatu permukaan dengan 2 spasi. Pada semua tepi kertas disisakan ruang kosong minimal 3,5 cm.

JUDUL : Judul dibuat tidak lebih dari 2 baris dan harus mencerminkan isi tulisan. Nama penulis dicantumkan di bawah judul.

RINGKASAN : Ringkasan dibuat tidak lebih dari 200 kata berupa intisari permasalahan secara menyeluruh, dan bersifat informatif mengenai hasil yang dicapai.

KATA KUNCI : Kata kunci dicantumkan di bawah ringkasan

TABEL : Judul Tabel dan keterangan yang diperlukan ditulis dalam bahasa Indonesia dan Inggris dengan jelas dan singkat. Tabel harus diberi nomor. Penggunaan tanda koma (,) dan titik (.) pada angka di dalam tabel masing-masing menunjukkan nilai pecahan/ desimal dan kebulatan seribu.

GAMBAR GARIS : Grafik dan ilustrasi lain yang berupa gambar garis harus kontras dan dibuat dengan tinta hitam. Setiap gambar garis harus diberi nomor, judul dan keterangan yang jelas dalam bahasa Indonesia dan Inggris.

FOTO : Foto harus mempunyai ketajaman yang baik, diberi judul dan keterangan seperti pada gambar.

DAFTAR PUSTAKA : Daftar pustaka yang dirujuk harus disusun menurut abjad nama pengarang dengan mencantumkan tahun penerbitan, seperti teladan berikut.

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