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Anatomical and Physical Properties of Cultivated Two- and Four-year-old *Bambusa vulgaris*

(Sifat-sifat Anatomi dan Fizikal *Bambusa vulgaris* yang Ditanam pada Umur Dua dan Empat Tahun)

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ABSTRACT

Cultivated Bambusa vulgaris *of two and four-year old were harvested and studied for their anatomy and physical properties. The anatomy properties between the two age-group of bamboo were observed to have some degrees of variation. This showed that the bamboo anatomy structure has strong correlation with age. The frequency of vascular bundles was greater at the bottom and top portion than in the middle portion of both age-groups. There was no difference in vessel diameter between the two and four-year old culms at the middle of the culms wall thickness. The cell's wall thickness of both parenchyma and fibre were greater in the 4 year-old than in the 2 year-old culms. In the physical aspect, basic density was found to be higher in the 4 year-old culms than in the 2 year-old by 5 to 8%, and increases from lower to upper internodes showing that there is a maturing process going on between the two age-group relative to the tissue type that they possess.*

Keywords: Anatomy and physical properties; Bambusa vulgaris*; cultivated bambo; two age-group culms*

ABSTRAK

Kulma dua kumpulan umur, dua dan empat tahun, Bambusa vulgaris *yang ditanam telah dituai dan dikaji ciri-ciri fizikal dan anatominya. Sifat-sifat anatomi menunjukkan wujudnya perbezaan antara kedua-dua kumpulan umur buluh ini. Ini menunjukkan struktur anatomi berkait rapat dengan umur buluh. Frekuensi berkas vaskular lebih banyak terdapat pada bahagian pangkal dan pucuk daripada bahagian tengah bagi kedua-dua umur buluh. Tidak terdapat perbezaan daripada segi saiz diameter liang bagi kedua-dua umur di bahagian tengah ketebalan buluh. Ketebalan dinding bagi kedua sel parenkima dan serat lebih besar pada buluh 4 tahun berbanding dengan buluh 2 tahun. Daripada aspek fizikal, nilai ketumpatan asas didapati lebih tinggi pada buluh berumur 4 tahun dibandingkan buluh 2 tahun dengan kelebihan antara 5 hingga 8%, dan meningkat daripada bahagian bawah ke bahagian atas ruas yang menunjukkan berlakunya proses kematangan antara kedua-dua kumpulan umur buluh relatif terhadap jenis-jenis tisu yang dimiliki.*

Kata kunci: Bambusa vulgaris*; buluh tanam; kulma dua kumpulan umur; sifat-sifat anatomi dan fizikal*

INTRODUCTION

Bamboo, being one of the fastest growing plant needs only between 3 and 4 years to mature before they are ready for harvesting and utilization. This makes bamboo the best possible alternative to replace timber in the future. As a result, bamboo has been the focus of research in recent years. Research covering all aspects in silviculture, propagation, processing, properties and utilization of bamboo found growing wild in the forest or cultivated has been intensified. However, study on cultivated bamboo stands has so far mostly confined to silviculture and fertilizers application to enhance growing (Azmy et al. 1997, 2004). Information on the properties such as morphology, characteristics, physical, mechanical and chemical properties for different age-group is rather limited.

The anatomy and physical properties of bamboo culms have been known to have significant effects on their durability and strength (Abd. Latif & Mohd Tamizi 1992; Liese 1985; Razak 1998). Studies on the morphological and anatomical characteristics of managed natural bamboo stands *Gigantochloa scortechinii* conducted by Razak et al. (2007) support this statement. Information generated on these properties can be used to determine the possible proper bamboo utilization. Currently, bamboo used for making traditional products such as handicraft, basketry, and high-value added products of panels, parquets, furniture and construction materials.

Bambusa vulgaris, locally known as *buluh minyak* is one of the most popular tropical bamboo species for plantation. This bamboo is easily cultivated and has low mortality rate. Upon maturity, the bamboo will normally possess thick culms wall, and having uniform sizes between the nodes and internodes. The objectives of the study were to determine the changes in the anatomical and

physical properties between young and matured bamboo culms. Two age-group (2 and 4 years-old) of cultivated *Bambusa vulgaris* were chosen for this study to represent the young and the mature culms. The anatomical structures were investigated due to their relationship with strength, preservative absorption, distribution and likely pathways for colonisation by micro-organisms (Razak et al. 2005a; 2005b; 2002). The physical characteristics and properties such as the culms height, number of internodes per culms, internode length, internode diameter, culms wall thickness, girth, moisture content and basic density are considered to be important factors in determining the suitability of bamboo for various application and chemical treatment. Culms of the two different age-group were studied in order to determine changes that occurred especially in the anatomy and physical properties. These properties are important as they influence the treatability of the culms with preservatives, dimensional changes and attack by insects and fungi. Basic density is important because it reflects the amount of cell wall material per unit volume of culms and relates directly to strength properties.

Materials and Methods

Supply of Culms and Sampling

The cultivated two and four-year old *Bambusa vulgaris* bamboo culms used in this study were harvested in the district of Papar, Sabah, Malaysia. The bamboo culms were randomly selected and have diameters ranging from 8 to 10 cm. The culms were cut at about 30 cm above the ground level. Cutting of the culms below that level will affect the growing rate of the other culms in the bamboo clump. They were harvested immediately after the rainy season to minimize the amount of starch content in the bamboo (Liese 1985). Each culms were cut to a length of 12 m leaving out the top parts with branches. Thirty-six culms consisting of 18 of the two-year and another 18 of four-year old were harvested and investigated. These culms were later subdivided into 3 equal lengths of bottom, middle and top portions of 4 m each. Paraffin wax was applied to the cut surfaces of each portion to reduce sap evaporation. Sample blocks for anatomical study were fixed in formalin-acetic acid (90% ethanol of 70% conc., 4% glacial acetic acid, 6% formaldehyde of 37- 48% conc.) immediately after felling and kept in closed bottles. Within a week after harvesting, all the culms sample blocks were taken to Universiti Malaysia Sabah (UMS) for processing, sampling and subsequent studies.

Anatomical Properties

Vascular bundle distribution and Vessel sizes The anatomy studies on vascular bundles, vessel sizes, fibres, parenchyma and cell walls thickness were carried out according to methods outlined by Abd. Latif (1992), Abd. Latif and Mohd Tamizi (1992), and Jane (1933). Observations for anatomical structure were made using a Leitz and a scanning electron microscope. The distributions of vascular bundles were determined by counting the number of vascular bundle on a cross-section per mm^2. Bamboo sample blocks were cut into sections of 10 mm × 10 mm × culms wall thickness, boiled with distilled water for four hours and sliced into 25 μm thick transverse sections by sledge microtome with a 15 degree knife angle. Each section was stained with 4 drops of aqueous safranin-O and 1 drop of alcian blue for 4 minutes on the slide. They were washed with 50% ethanol then dehydrated through alcohol series of 70, 80, 90 and 95%, and 3 changes of absolute ethanol for 1 minute. One drop of euparal essence was placed on top of the section before mounting on microscope slides using euparal and covering with a cover slip. The slides were then clamped with clothes pegs and placed on a warm plate set at 60ºC oven for the euparal to set over a few days. This procedure stained the thicker cell walls red and thinner walls light blue.

Fibre length Sample blocks of 20 mm × 10 mm × culms wall thickness were chipped radially into match stick size splints with a sharp knife. The splints were then put in marked vial. Jeffrey's solution (50:50 mixture of 15% nitric acid and 10% chromic acid) were used to macerate the fibres. A period of 48 hours was allowed to soften the splints (Abd. Latif & Mohd Tamizi 1992; Razak et al. 2007). At the end of the maceration period, the softened splints were careful washed with distilled water. The vials were then half-filled with distilled water and capped securely. A drop of slurry solution was placed on specially etched glass slide bearing three pairs of parallel lines. Drops of safranin-O were introduced to contrast the fibre's images, which were then projected on a screen of a fibre-scope at 71 magnifications. Twenty-five complete and reasonably straight fibres in between the parallel lines of the slide were measured. The measurements were done using a flexible millimeter scale in a systematic manner to avoid duplication (Hart & Swindle 1967).

Fibre and Parenchyma diameters, lumen diameter and cell wall thickness Slides prepared earlier were used and the measurement of the fibre and parenchyma diameters, lumen diameters and cell wall thicknesses were made from them.

Physical characteristics and properties Measurements for some basic physical characteristics and properties were done on site where the culms were taken. The culms height, internode length, internode diameter, culms wall thickness and girth were measured from the cut base to the tip. The method used in the physical study was based on Razak et al. (2007), Sulthoni (1989) and ASTM (1974).

Moisture content (MC) Sample blocks representing the 2 age-group (2 and 4 years), 3 height portions (bottom, middle and top) and 6 replicates, consisting of thirty-six bamboo samples were used. All sample blocks were cut from fresh culms were 10 mm × 10 mm × culms wall

thickness. They were weighed and dried in an oven at 105±2°C for 48 h until a constant weight was attained. The sample blocks were then placed 30 min. in a dessicator for cooling-off period before re-weighing.

Basic density Sample for basic density studies were obtained from the middle portion of each internode at the bottom, middle and top culms portions. Each sample blocks were cut to the size of 10 mm × 30 mm × culms wall thickness. Six replicates were used in the study. The sample blocks were oven dried for 48 h at 105±2°C until a constant weight were attained. The sample blocks were then weighed to give the oven dried weight.

The sample blocks were placed in water under vacuum of about 700 mm Hg for 24 h until fully saturated to attain green volume condition. The volume of the fully saturated sample blocks was obtained using the water displacement method. The weight displaced was converted to volume of the sample as a green volume.

RESULTS

ANATOMICAL PROPERTIES

The anatomical properties of *Bambusa vulgaris* of the two age-group and at different height of the culms (Table 1) shows slight increase in the fibre diameter (16.9 to 18.0 μm), fiber length (3.6 to 4.2 mm), fibre cell wall (7.1 to 7.6 μm) and parenchyma diameter (23.7 to 24.8 μm). Decrease in diameter occurred in the vessel (123.0 to 122.5 μm), parenchyma lumen (19.7 to 19.5 μm) and fiber lumen (2.5 to 2.4 μm). The result also shows that there is no change in the vascular bundles distribution (2.6 no./ mm^2) between the 2 year-old and the 4 year-old bamboo culms at bottom, middle and top portions of bamboo.

PHYSICAL PROPERTIES

Physical characteristics The results on the physical characteristics of the cultivated 2 and 4 year-old *Bambusa*

TABLE 1. Anatomical properties of two and four year old *Bambusa vulgaris*

	Height	2 year-old *	4 year-old *
Vascular bundle (VB) frequency (VB no./ mm^2)	Bottom	2.6	2.6
	Middle	2.4	2.5
	Top	2.8	2.7
	Mean	2.6	2.6
Vessel diameter (μm)	Bottom	117.1	110.8
	Middle	133.6	134.6
	Top	118.3	122.2
	Mean	123.0	122.5
Fibre diameter (μm)	Bottom	15.8	16.7
	Middle	18.6	19.8
	Top	16.5	17.6
	Mean	16.9	18.0
Fibre length* (mm)	Bottom	3.7	4.9
	Middle	3.6	4.2
	Top	3.5	3.6
	Mean	3.6	4.2
Fibre cell wall thickness (μm)	Bottom	6.5	7.0
	Middle	7.9	8.5
	Top	6.9	7.4
	Mean	7.1	7.6
Fibre lumen diameter (μm)	Bottom	2.4	2.3
	Middle	2.5	2.4
	Top	2.6	2.5
	Mean	2.5	2.4
Parenchyma diameter (μm)	Bottom	22.4	23.3
	Middle	25.2	26.6
	Top	23.6	24.4
	Mean	23.7	24.8
Parenchyma lumen diameter (μm)	Bottom	19.1	19.1
	Middle	20.5	20.1
	Top	19.6	19.3
	Mean	19.7	19.5

* Means of 6 replicates

vulgaris (Table 1) show that there is not much differences between the height, the number of internodes, internodes length, and culms wall thickness of the 2 and 4 year-old culm. There are however a slight decrease in the internodes length (31.48 to 30.20), internodes diameter (9.4 to 9.1 cm) and girth (29.2 to 28.9 cm) from the 2 to the 4 year-old bamboo culms.

Moisture content The means moisture contents (MC) in green conditions of the cultivated *Bambusa vulgaris* decreases from 97.3 to 94.4% at bottom portion, 92.1 to 90.3% at middle portion and 86.4 to 82.5% in 2 and 4 year-old culms, respectively. The differences in MC for the 2 and 4 year-old culms at various internodes are shown in Table 3. Table 4 shows the means moisture content at cross-section along the culm length of *Bambusa vulgaris* in green condition.

Basic density The basic density increases from 2 year to 4 year-old bamboo culms. The increase range from 4.2 to 7.5% (based on 2 year-old culm value). The value of the basic density of 2 and 4 year-old *Bambusa vulgaris* taken from internode 2 to 18 are presented in Table 5. The analysis of variance on the basic density of *Bambusa vulgaris* (Table 6) strengthens this statement.

DISCUSSION

ANATOMY OF *BAMBUSA VULGARIS*

Vascular bundles The vascular bundles of *Bambusa vulgaris* were larger in the inner parts, becoming smaller and denser towards the periphery of the culms wall. Each of the vascular bundles consists of the xylem with one or two smaller protoxylem elements and two large metaxylem vessels and the phloem with thin-walled, unlignified sieve tubes connected to the companion cells. More parenchyma but few fibres and conducting cells were present in the inner part of the culms wall than in the periphery. The frequency of the vascular bundles was greater at both the bottom and top portion of both the 2 and 4 year-old culms than the middle. The 2 year-old culms had a slightly higher frequency of vascular bundles. Figure 1 shows the typical shape of the vascular bundle found in the middle of the bamboo culm wall thickness. The shapes of the vascular bundles changes from the periphery to the inner parts of the bamboo culm wall.

Vessels The vessels were found not to be truly circular but were slightly elliptical in shape with the radial diameter larger than tangential. This is the same for both the 2 and 4 year-old bamboo throughout the culms wall. The diameter

TABLE 2. Mean physical characteristics of cultivated *Bambusa vulgaris*

Characteristics	Bamboo culm age	
	2 years *	4 years *
Culms height (cm)	1469	1452
Number of internodes per culm	36	36
Internode length (cm)		
Bottom	24.53	22.27
Middle	34.11	33.86
Top	35.81	33.93
Mean	31.48	30.2
Internode diameter (cm)		
Bottom	9.30	8.93
Middle	9.89	9.75
Top	9.09	8.59
Mean	9.43	9.09
Girth (cm)		
Bottom	29.53	29.65
Middle	30.42	30.31
Top	27.65	26.74
Mean	29.20	28.90
Culms wall thickness (cm)		
Bottom	1.46	1.54
Middle	0.84	0.93
Top	0.55	0.70
Mean	2.85	3.17

* Means of 6 replicates

TABLE 3. Moisture content (%) along the culm length of *Bambusa vulgaris* at green condition

Internode no.	2 year-old *	4 year-old *	Decreases in moisture content
2	102.3	97.4	5.0 %
4	98.7	93.2	5.0 %
6	95.4	91.4	4.4 %
8	93.3	89.5	4.2 %
10	92.5	87.9	5.2 %
12	91.1	86.7	5.1 %
14	90.5	85.1	6.3 %
16	89.6	83.9	6.8 %
18	86.4	82.5	4.7 %

* Means of 6 replicates

TABLE 4. Moisture content (%) at cross-section along the culm length at green condition

		2 year-old *	4 year-old *
Bottom portion	Outer layer	83.2	79.0
	Middle layer	97.3	94.8
	Inner layer	111.4	109.4
	Mean	97.3	94.4
Middle portion	Outer layer	77.0	76.8
	Middle layer	91.1	89.0
	Inner layer	108.2	105.2
	Mean	92.1	90.3
Top portion	Outer layer	69.8	65.4
	Middle layer	88.2	85.3
	Inner layer	101.2	96.9
	Mean	86.4	82.5

* Means of 6 replicates

TABLE 5. Basic density along the culms height and age

Internode no.	Basic density (kg/m^3)		Increases in basic density (2 to 4 year-old)
	2 year-old	4 year-old	
2	472.6	504.3	6.7 %
4	507.1	545.1	7.5 %
6	521.9	557.7	6.9 %
8	530.7	562.5	6.0 %
10	542.4	565.3	4.2 %
12	549.6	570.0	3.7 %
14	553.6	578.0	4.4 %
16	559.0	585.2	4.7 %
18	565.3	591.8	4.7 %

* based on 2 year-old value.

TABLE 6. Analysis of variance for basic densities of 2 and 4 years old bamboo

	Sum of square	d.f.	Means square	F-ratio
Age	9609.626	1	9609.636	17.561*
Internode	62317.58	8	7770.257	14.347*

** significant at P<0.01

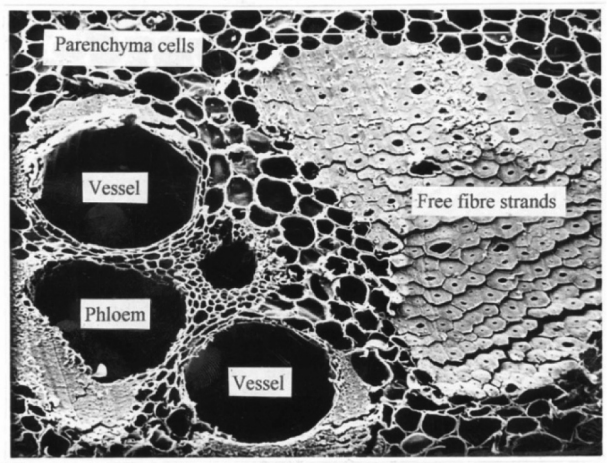

FIGURE 1. The vascular bundle of the *Bambusa vulgaris* in the middle of the culm wall thickness showing the fibre and the parenchyma cells in the four year old *Bambusa vulgaris* (barline = 10 μm)

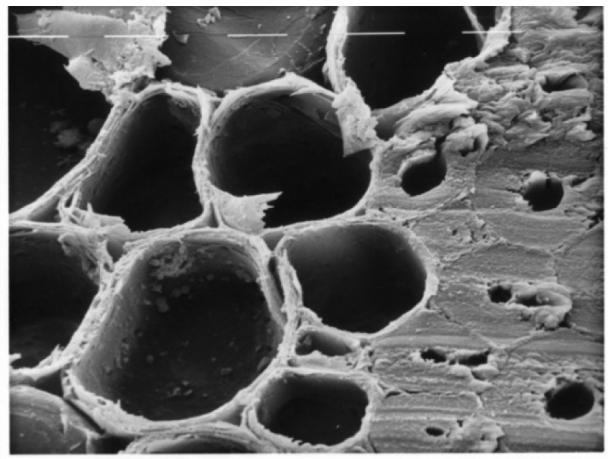

FIGURE 2. The differences in size and thickness between the parenchyma and the fibre cells in the four year old *Bambusa vulgaris* (barline = 10 μm)

of vessels was measured in radial and tangential directions for the vascular bundles across the culms wall.

The vessels progressively increased in diameter from the outer to the inner part. The means diameters were found to be 117.1 μm at the bottom portion, 133.6 μm at middle portion and 118.3 μm at top portion of the 2 year-old culms. For the 4 year-old culms, the means vessel diameter were 110.8 μm at the bottom portion, 134.6 μm

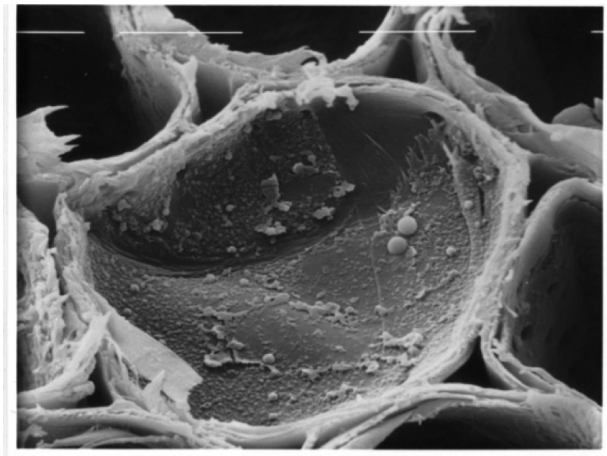

FIGURE 3. Close-up of the parenchyma cells showing starch granules in the four year old *Bambusa vulgaris* (barline = 10 μm)

at middle portion and 122.2 μm at top portion. The size of the vessels between the 2 and 4 year-old culms was not significantly different indicating that it is not affected during maturation.

Fibres The fibres constitute the sclerenchymatous tissue and occur in the internodes as caps of vascular bundles or isolated strands. The fibres are grouped in bundles and sheaths around the vessels. They are long and tapered at both ends. The fibre length from 100 fibres range between 3.5 and 3.7 mm for the 2 year-old culms and 3.6 and 4.9 mm for the 4 year-old culms. Similar observation was also made by Abd. Latif and Tamizi (1992) in their studies on variation in anatomical properties of wild *Bambusa blumeana*, *Bambusa vulgaris* and *Gigantochloa scortechinii* at one and three year old. However, their studies show slightly shorter fibre length in the wild compared to the cultivated *Bambusa vulgaris*.

The fibre cell wall thickness in the 4 year-old culms was generally greater than in the 2 year-old culms. This is consistent with work of Alvin and Murphy (1988) and Murphy and Alvin (1997) on *Sinobambusa tootsik* and *Gigantochloa scortechinii* who found similar thickening of fibre wall during maturation. A similar finding was also observed by Razak et al. (2007) and Abd. Latif (1992) in their work on morphological and anatomical characteristics of managed natural bamboo stands *Gigantochloa scortechinii* and the effect of age and height on three bamboo species on their machining properties.

The outer zone showed the lowest increase in thickness. This is a reflection of the early maturation of this zone compared with the middle and the inner parts of the culms. In the young culms, the tissues of the outer zone are early maturing resulting in the minimal increment of cell wall thickness with further ageing. The middle and inner zones showed much higher increments in fibre wall thickening.

Parenchyma The ground tissue consists of parenchyma cells, which were mostly vertically elongated with short, cube-like inter-spread in between. The former is characterized by thicker walls with a polylamellate structure. They become lignified in the early stages of shoot growth. The shorter cells have a denser cytoplasm, thinner walls and retain cytoplasmics activity for a long time. Figures 2 and 3 show the shape of the parenchyma cells with very much thinner cell walls compared to the fiber cells.

The parenchyma diameter varies from 22.4 μm at the bottom and 23.6 μm at the top portion, having the larger diameter of 25.2 μm at the middle portion of the 2 year-old culms. The diameter increase was slightly smaller in the 4 year-old culms with 23.3 μm at the bottom, 26.6 μm at the middle and 24.4 μm.

The size of the lumen in parenchyma also varies from 19.1 μm at the bottom and 19.6 μm at the top portion, having the larger diameter of 20.5 μm at the middle portion of the 2 year-old culms. The lumen decrease was slightly smaller in the 4 year-old culms with 19.1 μm at the bottom, 20.1 μm at the middle and 19.3 μm at the top. These variations in the diameter of the parenchyma cells and lumens sizes show that there was some maturation occurring, resulting in the cell wall thickening from 2 years to 4-year ages. A similar finding was also noted by Abd. Latif and Mohd Tamizi (1992) in their work on the variation in anatomical properties of wild *Bambusa blumeana*, *Bambusa vulgaris* and *Gigantochloa scortechinii*.

Some parenchyma cells were observed to contain starch. However, the amount was quite small. Starch in the 4 year-old culms was more frequent than in the 2 year-old culms. Liese and Weiner (1997) also made similar observations to this and according to them very young culms (3 month old) do not contain starch. The parenchyma of older culms was filled with starch grains. The low starch content in most of the culms used in this study could be attributed to the time of the harvesting. The starch content in bamboo has been known to vary with seasons, which are higher in the dry than in the rainy season.

PHYSICAL PROPERTIES

Physical characteristics The physical characteristics of *Bambusa vulgaris* show variation depending on the age and height along the culms. The culms generally taper from the middle portion towards the tip with a decrease in diameter, girth and culms wall thickness. As seen from Table 2, the culms diameter decreases by 8.7% from middle to top portion in the 2 year-old culms, and 13.5% in the 4 year-old culms. The same also goes for the culms wall thickness where there is a decreases in thickness by 62.5.0% from bottom to middle portion and 34.5.7% from middle to top portion in the 2 year-old culms. In the 4 year-old culms the decrease in the culms wall thickness from bottom to middle portion is by 39.6%, and from middle to top portion by 24.7%. Similar observations were made by Razak (1998) in the study of the *Gigantochloa scortechinii*.

The total number of internodes per culms and the length of the internodes also vary. The length of the internodes increases from the basal region to the middle portion of the culms and decreases towards the top. Unlike timber, bamboo does not show any secondary thickening and thus attains its final diameter during the sprouting stage (Liese 1985). With age increment, mature tissue starts to develop and continue to change in density, strength properties.

Selection of sample blocks at the right location along the culms height and age plays an important role in determining a consistent quality of raw material for treatment and utilization purposes. This is mainly because basic density and strength properties vary along the culms height.

Moisture content This study shows that in green condition *Bambusa vulgaris* possesses the highest moisture content which is influenced by age, height and position in the culms wall thickness. The moisture content decreases with age, from bottom portion to top portion, and from inner to outer layer in the culms wall. The 2 year-old culms have means moisture content of 97.3%, 92.1% and 86.4% at bottom, middle and top portion height, respectively. In the 4 year-old culms, the means moisture content was 94.4% at the bottom, 90.3% at the middle and 82.5% top the portions.

Differences in moisture content might be due to anatomical structure and chemical composition between the culms age and location along the culms. The lowest and highest moisture occurred at the periphery and inner layer, respectively, particularly near the bottom portion of the 2 year-old culms. The trend shows that the moisture increases roughly by 30% from periphery to the inner layer and 20% from top to bottom portion. This has a very strong correlation with the anatomical structure, particularly the vascular bundles and parenchyma cell distributed over the culms and also its density.

Considerable differences in the moisture content of freshly felled culms have to be considered when determining the amount of preservative retention possible during treatment process.

Basic density The basic density of the cultivated *Bambusa vulgaris* were found to vary from 472.6 to 565.3 kg/m^3 for

the 2 year-old bamboo culms and 504.3 to 591.8 kg/m^3 for the 4 year-old culms. The basic density of the 4-year culms is consistently higher than in the 2 year old culms and increases from the lower to the upper internodes. There was an increase in basic densities between the two-age group based on the 2 year-old culms, which ranged between 3.7 to 7.5%. This shows that there is a maturation process going from the 2 year to the 4 year-old bamboo culms. Fibre and parenchyma cell walls increases in mean thickness from 2 to 4 year-old culms. This is due to the starch deposition and the lignification process that occurred in the bamboo culms which increases with ages. This is supported by Razak et al. (2007) and Alvin & Murphy (1988) who found that the cell wall increased in thickness along with an increase in lignification between the first and third year of growth in *Gigantochloa scortechinii* and *Sinobamboo tootsik*. These processes contribute significantly to the increase the density in older bamboo. The variation in basic density between different internodes was due to the maturation process that starts from the lower internodes to the upper internodes (Itoh 1990). This was also due to the presence of higher proportion of fibres in the higher internodes. Razak et al. (2007) and Liese (1985) also made similar observations that the higher internodes have higher basic density than the lower portion of the bamboo culms.

Conclusion

The results showed that the four year old culms cultivated *Bambusa vulgaris* possess an overall better properties to that of the two year old. The means fibre and parenchyma cells wall thickness were greater in the 4 year-old compared in the 2 year-old culms. The increase in the cells wall thickness in parenchyma and fibres is a part of the maturing process in the bamboo culms. There was no difference in vessel diameter between the 2 and 4 year-old culms at the middle of the culms wall thickness. There was no significant different in the anatomical properties between cultivated and natural stands *Bambusa vulgaris*. The anatomical structure in bamboo has a very strong correlation with the moisture content. The physical characteristics and properties of *Bambusa vulgaris* vary depending on the age and height along the culms. The culms taper from the middle portion towards the tip with a decrease in diameter, girth and culms wall thickness. The age, height and position in the culms wall thickness influence the present of moisture content in *Bambusa vulgaris*. The basic density was higher in the 4 year-old culms than in the 2 year-old, and increases from lower to upper internodes showing that there was a maturation process going on between the two age-group relative to the two of tissue types.

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