CHARACTERISTICS AND VOLUME-WEIGHT RELATIONSHIP OF FOUR MALAYSIAN BAMBOOS

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AZMY MOHAMED, WAN RAZALI WAN MOHD & FAUZIDAH AHMAD. 1991. Characteristics and volume-weight relationship of four Malaysian bamboos. Mensurational attributes, such as average number of internodes, internode length, culm wall thickness, circumference of node and internodes, weight of culm, branch and leaf of four Malaysian bamboos were determined. Data were gathered from 26 to 173 culms of four species in Kedah and Perlis. Significant linear relationships between weight and solid volume of the bamboo were observed for all the species studied. Their corresponding regression equations were also determined. *Bambusa blumeana* had the biggest mean culm wall thickness and mean dbh, followed by *Gigantochloa scortechinii. Schizostachyum grande* had the longest mean internode and *S. zollingeri* the thinnest culm wall at the base and apex.

Key words: Malaysian bamboos - characteristics - volume-weight - relationship

Introduction

Bamboo, belonging to the subfamily Bambusoideae, is distributed widely in tropical and sub-tropical regions, and less so in temperate regions. Bamboos are of three classes: clump-forming (sympodial) with peripheral extension from rhizomes (caespitose), single culms scattered (monopodial) over a network of rhizomes (dumetose) (Huberman 1959), and mixed (having both scattered and clump-forming culms); the first two are more important in the world.

Malaysian bamboos are clump-forming and most of them are found in logged-over areas and disturbed forest (Burton 1979, Ng & Mohd Noor 1980). There are 50 cultivated or wild bamboo species in the forest (Wong 1989). Only 12 types of bamboo are exploited for their culms and shoots.

In Malaysia, bamboo by virtue of its availability and versatility, is associated with the traditional and rural lifestyles. It is used as supplementary materials in house construction and in the making of numerous home utility items.Bamboo shoots are gathered, especially from *Gigantochloa levis, G. ligulata* and *Dendrocalamus asper.*

Several industries use bamboo on an organized scale. These mainly use *G. scortechinii,* supplemented by *G. wrayi,* in the manufacture of poultry cages, shade blinds and barbeque sticks, vegetable baskets, incense sticks and tooth picks (Wong 1989, Azmy 1989). Culms of *Schizostachyum zollingeri* are used for vegetable and fish baskets. Internodes of several species of *Schizostachyum* are

used as containers to cook a Malay rice dish called 'lemang' and the broad leaves of *S. grande* are gathered as wrappers for Chinese rice dumplings.

Bamboos vary considerably in size depending on the species, locality and vigour of the clump (Krishnaswamy 1956). Attributes of stem size and wall thickness influence the range of usage (Wong 1982). The strength, straightness, lightness combined with hardness, variation in size, ease with which they can be propagated and the short period taken to mature and be available for harvesting have rendered bamboos of immense use (Sharma 1982).

Research on bamboo is still at its infancy and deals mainly with the propagation, silviculture, management and establishment of natural bamboo stand.

This study attempts to give comprehensive information on the characteristic qualities of four Malaysian commercial bamboos, such as *Bambusa blumeana* (buluh duri), *G. scortechinii* (buluh semantan), *S. grande* (buluh semeliang) and *S. zollingeri* (buluh nipis). In addition, the weight-volume relationships using regression techniques for the different species were also determined.

This information is important in determining the yield and use of the four commercial bamboos.

Materials and methods

The study was conducted in north Peninsular Malaysia where four commercial species were selected: 173 culms of *G. scortechinii* and 56 culms of *S. grande* were taken at Nami, Kedah; 46 culms of *S. zollingeri,* were taken at Wang Kelian, Perlis and 26 culms of *B. blumeana* from Beseri, Perlis. Data were gathered from freshly harvested culms: (1) for each whole culm, the circumferences of the node and the internode were measured from the base upward at an interval of five nodes; (2) the length of each internode was also measured from the base upward and number of internodes was noted for all culms in each species; (3) the culm wall thicknesses of the base and apex were measured with vernier caliper to the nearest tenth of a centimeter. The average culm wall thickness on all four directions and the average dbh were determined.

For each species, culms were cut into four equal sections, that is 0 to 25, 25 to 50, 50 to 75 and 75 to 100% of the whole culm. From each section, the culm wall thickness, fresh weight and solid volume were determined. The branch and leaf weight of each culm were also measured. The solid volume of each equal section was computed using the Tandug and Torres (1985) formula.

The formula is:

$$V = \frac{(A1\text{-}A2) + (a1\text{-}a2)}{2} \times L$$

where V = solid volume of each section of the culm (cm^3); A1 = area of the large end of the section (cm^2); A2 = area of the large end of the hollow portion (cm^2); a1 = area of the small end of the section (cm^2); a2 = area of the small end of the hollow portion (cm^2); L = length of the section (cm).

Total green weight in kilograms was derived by summing up the values obtained for each section.

The branch and leaf weight of each culm were also measured for each species.

Results and discussion

Mensurational attributes

Bambusa blumeana

The 26 culms of *B. blumeana* gathered for the study had total length ranging from 9.8 to 16.5 *m*. This bamboo was observed to have the longest culms. The average internode length was 29.2 *cm*, shortest at both ends (apex and base) and longest in the middle. A normal culm of *B. blumeana* has relatively thick walls all throughout becoming gradually thinner towards the top. The thickest section was located at the base ranging from 7.2 to 36.4 *cm*. It was large at the base and gradually tapered towards the top. The culm weight varied from 19.0 to 40.6 *kg* while the branch leaf weighed between 2.7 to 9.5 *kg*.

The distinguishing feature of *B. blumeana* is that it has large clumps of up to 10 to 45 culms per clump with densely interlaced thickets of very spiny branches at the base, 2 to 3 *m* high. This thicket helps keep the tall culms erect and makes access to the culms exceedingly difficult. Its clump is crowded.

Gigantochloa scortechinii

The 173 culms for the study ranged from 3.9 to 18.6 *m* in total length. The number of internodes varied from 14 to 70 and their length ranged from 0.3 to 67.6 *cm*. This species had culm weight of 2.5 to 33.2 *kg* and branch leaf weight of 1.0 to 9.8 *kg*.

Its culm grows more or less open and not as crowded as *B. blumeana*. This is an important commercial bamboo due to its utility and abundance in the natural forest.

Schizostachyum grande

The 46 sample culms ranged from 2.7 to 10.8 *m* in total length. *S. grande* had the longest internode compared with the other species studied, varying from 53.7 to 85.7 *cm*. The number of internodes ranged from 7 to 21. This species had culm weight of 0.5 to 8.0 *kg* and branch leaf weight of 0.2 to 6.8 *kg*. Its culm tends to bend or droop at its tip and forms an arc shape. Its culms are not tufted and the wall thickness varied from 6.1 to 84.0 *mm* at the base and 1.1 to 4.3 *mm* at its apex.

Table 1. Physical characteristics of four Malaysian bamboos

Species	No. of samples	Culm length (*m*)		No. of internodes (*cm*)		Length of internodes (*cm*)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Bambusa blumeana	26	13.4	1.6	49.0	5.7	29.1	2.6
Gigantochloa scortechinii	173	12.4	2.8	40.9	9.4	10.0	15.9
Schizostachyum grande	56	6.4	1.8	11.9	2.9	66.4	6.5
Schizostachyum zollingeri	46	11.3	3.6	20.2	5.3	63.1	7.9
		Dbh (*cm*)		Culm wall thickness at base (*mm*)		Culm wall thickness at apex (*mm*)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Bambusa blumeana	26	7.8	0.8	21.9	6.5	5.9	1.4
Gigantochloa scortechinii	173	7.3	0.8	17.6	12.0	3.5	0.8
.*Schizostachyum grande*	56	3.6	0.8	10.4	10.2	2.1	0.6
.*Schizostachyum zollingeri*	46	5.8	1.3	8.5	2.1	2.3	0.6
		Circumference of node (*cm*)		Circumference of internode (*cm*)		Weight of culm (*kg*)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Bambusa blumeana	26	29.3	2.6	24.4	2.6	27.6	4.1
Gigantochloa scortechinii	173	23.4	2.8	22.8	2.9	16.6	5.5
Schizostachyum grande	56	11.3	4.1	11.1	4.0	3.2	1.7
Schizostachyum zollingeri	46	17.9	4.6	18.2	4.6	8.6	4.7
		Diameter of half pole (*cm*)		Branch and leaf weight (*kg*)		Volume (cm^3)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Bambusa blumeana	26	12.0	4.8	6.6	1.8	28385.1	2035.8
Gigantochloa scortechinii	173	6.5	1.4	3.4	1.7	20593.3	8314.4
Schizostachyum grande	56	3.4	0.7	3.1	1.9	3176.6	1394.1
Schizostachyum zollingeri	46	5.4	1.0	5.2	2.0	8347.4	4716.2

Schizostachyum zollingeri

It is a type of bamboo which had thin wall ranging from 4.6 to 13.9 *mm* at the base and 1.5 to 3.3 *mm* at the apex. The number of internodes varied from 11 to 32 and its internode length from 46.5 to 79.4 *cm*. Its total length measured from 5.6 to 19.0 *m*.

S. zollingeri had culm weight of 2.0 to 17.7 *kg* and branch leaf weight from 1.6 to 9.5 *kg*. The clump is not tufted and grows straight upwards and droops at its tip. This species can be found in the forest and is cultivated in rural areas.

In general, the culms of these bamboos taper from the base to the top.

However, of the four species studied, it was found that *B. blumeana* and *G. scortechinii* had node circumference of 21.0 to 31.2 *cm*, 10.8 to 32.0 *cm* and internode circumference of from 20.0 to 29.3 *cm* and 10.6 to 28.4 *cm* respectively. It seems that *S. grande* tends to have a smaller culm size range compared with the others in terms of diameter taken at half pole. The internodes in all species were found to be longer in length from the base up to a certain point along the culm and then gradually decreasing to the top.

Weight volume relationship

The relationship between green weight and solid volume of the different species (Table 1) was also determined using regression methods in this study. It was found that *B. blumeana* had the heaviest weight among all, that is from 19.0 to 40.6 *kg* and its volume ranged from 24580.9 to 31907.6 cm^3. This was followed by *G. scortechinii*, *S. zollingeri* and *S. grande*, respectively.

The regression results (Table 2) indicate a highly positive linear relationship between volume and weight of all species. It was found that the highest coefficient of determination (r^2= 93.08%) was obtained for *S. zollingeri*. The fitted regression lines are shown in Figures 1, 2, 3 and 4.

This information could be applied in determining the pulp yield of bamboos for paper manufacture. Bamboo in Malaysia has a potential to be used for this purpose. The inherent long fibres of bamboo can produce papers of high tearing resistance (Escolano & Semana 1970). In the Philippines, *B. blumeana* and *B. vulgaris* (yellow bamboo) have been tried for pulp and paper making (Anonymous 1962, 1984).

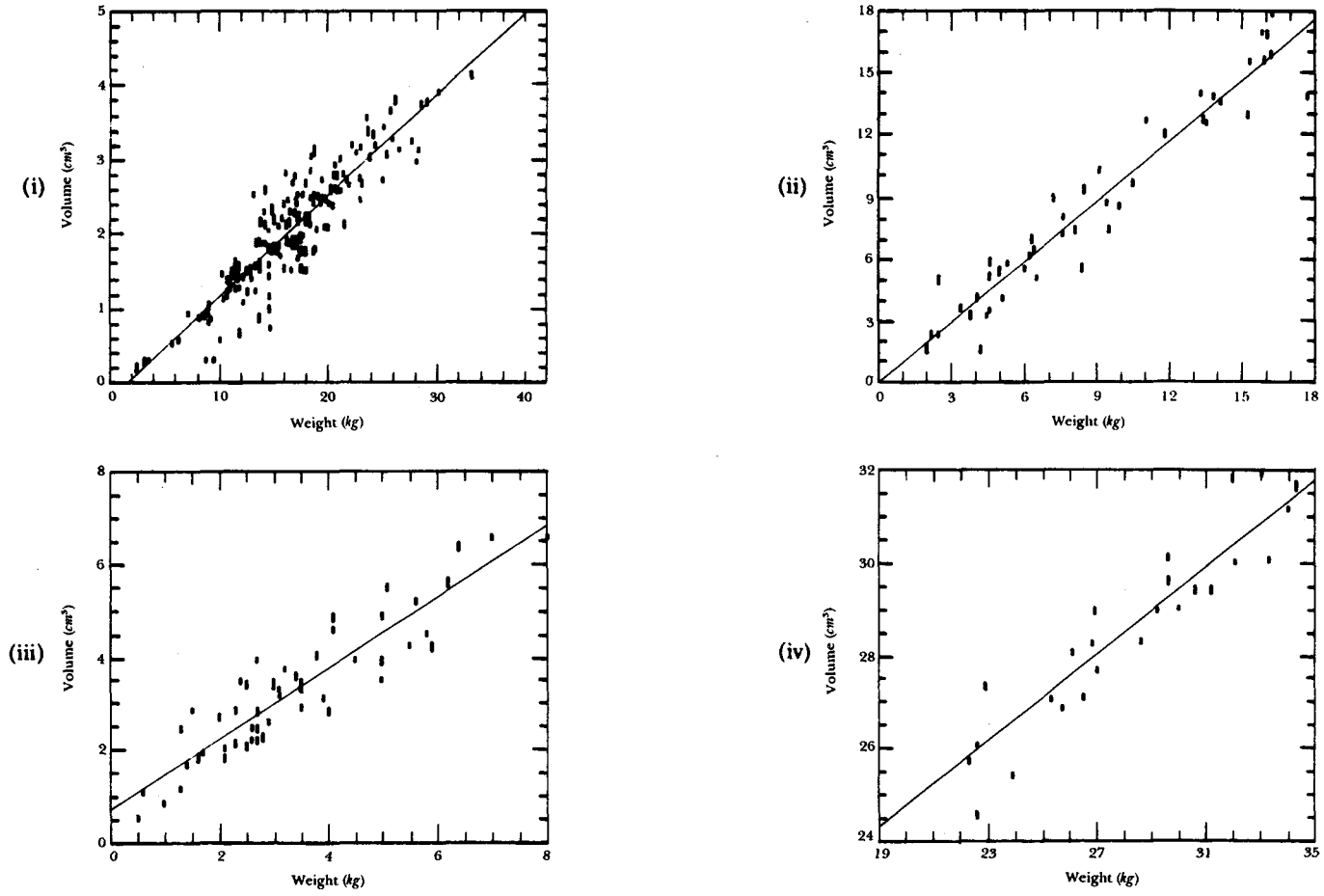
Table 2. Regression equations of the volume on weight of each bamboo species

Species	Equation[a]	r^2 (%)
G. scortechinii	y = - 2086.12 + 1364.44x	81.46
B. blumeana	y = 15469.6 + 466.1177x	86.68
S. grande	y = 726.449 + 759.304x	84.17
S. zollingeri	y = - 53.1224 + 976.808 x	93.08

[a]where: y = volume (cm^3); x = weight (*kg*); r^2 = coefficient of determination

Conclusion

1. Of the four bamboo species studied, *B. blumeana* had the biggest mean culm wall thickness at base and apex, and circumference of internode.
2. *G. scortechinii* was found to be second to *B. blumeana* in terms of mean dbh and the number of internodes.
3. *S. grande* had the longest mean internode length but the lightest culm weight.
4. *S. zollingeri* had the thinnest culm wall at the base compared to other species.



Figures 1 - 4. Fitted regression lines of volume on weight for: 1. *Gigantochloa scortechinii*, 2. *Bambusa blumeana*, 3. *Schizostachyum grande* and 4. *Schizostachyum zollingeri*

Based on the above distinguishing features, *B. blumeana* and *G. scortechinii* are suitable for making chopsticks, barbeque-sticks, toothpicks and other bamboo products. The other two species are suitable for making vegetable and fish baskets.

Significant positive linear relationships between green weight and solid volume of the sample poles were observed for all the species studied.

Knowledge of the given measured characteristics and weight-volume relationship for the four species studied is important in their yield determination and use.

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