SOME TIMBER CHARACTERISTICS OF *GMELINA ARBOREA* GROWN IN A PLANTATION IN PENINSULAR MALAYSIA

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Received November 1989

ANI SULAIMAN & LIM, S. C. 1989. Some timber characteristics of *Gmelina arborea* grown in a plantation in Peninsular Malaysia. Three trees of 33-y-old *Gmelina arborea* were examined. The timber was pale in colour with straight to slightly interlocked grain. Texture was moderately coarse. The timber was light to medium weight with basic density ranging from 345 to 620 $kg\ m^{-3}$. The timber had indistinct growth rings, and pores with simple perforation and arranged in solitary, radial pairs and radial multiples of up to six pores. The pores were moderately small to extremely large. Parenchyma was mainly paratracheal with vasicentric and confluent type. Generally, density increased from pith to bark and from the butt end to the top of stem.

Key words: *Gmelina arborea* - anatomical features - physical characteristics - density variation

Introduction

Gmelina arborea Roxb. (Verbenaceae) occurs naturally from the lower Himalayas in Pakistan through India, Nepal, Bangladesh, Sri Lanka, Burma, Thailand, Laos, Cambodia, Vietnam and the southern provinces of China (Lamb 1968). It is now widely planted in many countries of the lowland tropical zone because of its ability to survive, coppice and yield seed early in various climatic conditions.

G. arborea, known as yemane in Malaysia, was first introduced into Peninsular Malaysia in 1920 where it was mainly planted in and around Kuala Lumpur. The species has also been planted at the Forest Research Institute Malaysia (FRIM) in Kepong. Since 1928 it has been introduced on a small scale throughout the lowlands in Peninsular Malaysia (Durant 1941). Large scale planting started only in 1954 in the Kuala Kangsar district (Freezaillah *et al.* 1966).

Some physical and mechanical properties of plantation grown *G. arborea* in Peninsular Malaysia have been evaluated earlier (Thomas 1939, Lee 1964, Peh 1964, Lee *et al.* 1974, Lopez 1977, Grewal 1979). However, research on the anatomical features and density variation of locally grown *Gmelina* is still lacking. Desch (1954) and Wong and Khoo (1980) gave only a brief description of the physical and mechanical properties of the timber.

The purpose of the present study is therefore to observe the variation in the various anatomical features as well as the density within and between trees of yemane. The results obtained could be used to appraise wood quality in terms of the suitability of the timber for more important uses and products, normally made from various species or species groups. Wood density or specific gravity in particular, is the simplest and most useful index to the suitability of wood for many important uses. There is a high degree of correlation between density and strength. Variations in density may also affect other properties of wood such as drying, machining, finishing, and gluing.

Materials and methods

Three trees of 33-y-old *G. arborea* were obtained from field 38 within FRIM compound. Information pertaining to silvicultural treatments was not available. The general form, length and girth of the three trees are shown in Table 1. The physical characteristics of the discs are shown in Table 2.

Table 1. Tree description of *Gmelina arborea*

Tree number	Length of clear bole (*m*)	Girth (*m*)		Remarks
		Top end	Butt end	
A	9.8	1.4	2.1	Tree crooked; steep buttress of about 1.2 *m* high
B	12.2	0.9	2.1	Tree slightly crooked
C	16.3	0.9	1.6	Tree slightly crooked; steep buttress of about 0.91 *m* high
Mean	12.8	1.1	1.9	

Discs of about 5 *cm* thickness were obtained for each tree at about 10 (at breast height), 30, 50, 70 and 90% heights of the clear bole. From each disc, wood samples measuring 5 × 5 × 2.5 *cm* were taken at 10, 30, 50, 70 and 90% away from the pith for basic density determination using standard method. As for the anatomical studies, microslides were prepared from samples of about 1 cm^3 taken at the longitudinal positions near the butt, centre and top ends of each tree. Measurements were taken to determine the pore diameter, number of pores per unit area, ray height and width and the number of rays per mm^2. Other microscopic features were observed using an ordinary light microscope.

Table 2. The disc characteristics of 33-y-old *Gmelina arborea*

Tree number	% height	Diameter (*cm*)	Sapwood thickness (*cm*)	Condition of heart
A	10	54.5	3.0	Hollow about 17.5 *cm* diameter
	30	44.5	2.3	Slight brittle
	50	46.5	1.9	Slight brittle
	70	39.8	2.8	Slight brittle
	90	38.5	3.0	Brittle about 5 *cm* diameter
B	10	46.5	3.5	
	30	39.0	1.5	
	50	36.5	2.5	-
	70	32.0	3.0	
	90	29.0	1.5	
C	10	47.5	2.8	
	30	36.5	2.5	
	50	36.0	3.0	-
	70	29.0	3.1	
	90	29.0	2.8	

Results and discussion

Physical characteristics

The general form of the trees obtained for the study was mainly crooked with steep buttresses of up to 1.9 *m* high (Table 1). The minimum and maximum lengths of clear bole were 9.8 and 16.3 *m* respectively. The mean girth of the tree at the top end before the first branching was 1.1 *m* and at the butt end 1.9 *m*. An observation on each disc of tree A showed that a large proportion of the disc taken at 10% height contained a hollow heart of about 17.5 *cm* in diameter (Table 2). At 90% height the disc showed the presence of brittle heart of about 5 *cm* diameter.

The timber was pale coloured, ranging from creamy white and light yellow brown and weathered to deeper yellow-brown; the heartwood was not distinct from the sapwood; the grain was straight to slightly interlocked; texture was moderately coarse; and the planed surface was slightly lustrous. The wood was light with an air dry density ranging from 345-620 $kg\ m^{-3}$ averaging 506 $kg\ m^{-3}$.

Anatomical features

Growth rings

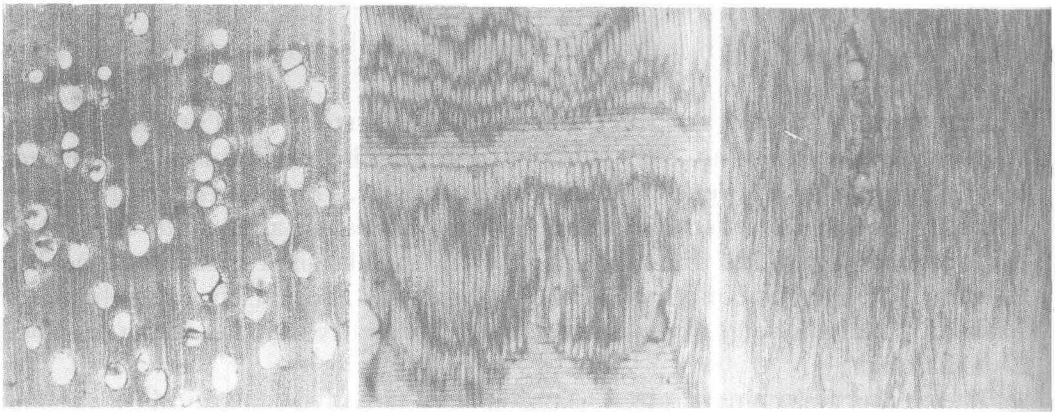
Indistinct in most cases, even though the vessels were slightly larger at the beginning of the growth zone. In some cases, however, the boundary of growth zone was indicated by a definite ring of large vessels, producing a ring porous effect.

Vessels

With simple perforations, arranged mainly in solitary and radial pairs, with radial multiples of up to six pores; pore clusters were common; tyloses were present and deposits absent; sizes ranged from moderately small to extremely large, with pore diameters from 62 to 437μm, (average about 192 μm). Very few to moderately few in number but more commonly very few. Inter-vessel pittings were large and sometimes gash-like.

Axial wood parenchyma

Both apotracheal and paratracheal types were present; apotracheal type was present as diffuse strands whereas the paratracheal type as scanty paratracheal, vasicentric and confluent of 2 to 8 cells wide but commonly 4 or more cells connecting a few pores and at certain intervals forming tangential bands resembling marginal bands.



(a) (b) (c)

Figure 1. Anatomical features of *Gmelina arborea* seen on: a) Cross section showing the vessels. parenchyma, rays and background fibres (× 10); b) Radial section showing the parenchyma, fibres and ray arrangement (× 15); c) Tangential section showing the spindle-shaped rays (× 10)

Rays

Visible to the naked eye without the aid of lens on the cross section; not conspicuous on the radial surface; few in number (about 4 per mm^2; Kribs heterogeneous type III; two to seven seriates but more commonly four seriates; six to 30 cells in height but commonly 15 cells high with an average of 0.31 *mm*; crystals not observed.

Fibres

Thin-walled with large lumen; septate. Ripple marks and Intercellular canals are absent.

Density variation

Variation in the density from pith outwards had been investigated by many researchers. Most of the studies however, are concentrated on softwoods. Panshin and de Zeeuw (1980) observed that specific gravity actually increased or decreased from the pith onwards for various species of hardwoods. Cown (1974) noted that density increased gradually from the pith outwards to the bark at all height levels in radiata pine.

In the present study, the mean specific gravity was found to vary from the minimum of 0.33 in tree A to the maximum of 0.53 in tree B (Table 3). The density generally increased from pith to bark at all height levels in the three trees (Tables 3 & 4). However, at 90% height, there was a slight decrease in specific gravity at a distance 70% away from the pith (Table 4). This cannot be explained yet. In general, the increasing trend in specific gravity from pith to bark observed in this study was consistent. Similar results were also obtained by Esan (1966) (in Wong & Khoo 1980) who found that the density of *G. arborea* increased gradually from pith outwards from 400 to 544 $kg\ m^{-3}$.

Table 3. Mean specific gravity versus distance from the pith

Distance across disc (%)	Tree		
	A	B	C
Pith	0.33	0.44	0.37
10	0.38	0.45	0.41
30	0.42	0.47	0.42
50	0.44	0.50	0.44
70	0.45	0.51	0.46
90	0.44	0.53	0.46

Among hardwoods, both increase and decrease in specific gravity from pith to bark have been found (Panshin & de Zeeuw 1980). In most cases, the low density region found near the pith, were related to the presence of juvenile wood (Zobel & McElwee 1958, Brazier 1976, Baker 1967). In this respect, the three trees contained approximately 25% by volume of juvenile wood as indicated by their lower density below 50% from the pith (Table 3).

Table 4. Variation in mean specific gravity from pith to bark at different height levels

Distance across disc (%)	% height				
	10	30	50	70	90
Pith	0.37	0.39	0.37	0.36	0.41
10	0.40	0.39	0.41	0.41	0.43
30	0.42	0.41	0.45	0.45	0.46
50	0.44	0.45	0.46	0.47	0.48
70	0.44	0.46	0.47	0.48	0.51
90	0.46	0.46	0.50	0.48	0.48

The variations of density in the axial direction from the base of the tree to the top were not consistent for Trees A and B (Table 5). Tree A showed a slight decrease in density of up to 30% height before increasing to 50% height and thereafter remained fairly consistent or increased sharply towards the top. In tree B, there was a gradual increase in specific gravity from the base to the top, except at 70% height where the specific gravity decreased slightly. In the case of tree C, the increase in density was fairly uniform (Table 5). The density generally increased from the base to the top of the tree.

Table 5. Specific gravity versus height

Disc height (%)	Tree		
	A	B	C
10	0.40	0.45	0.41
30	0.39	0.49	0.41
50	0.42	0.50	0.42
70	0.41	0.48	0.43
90	0.50	0.50	0.46

The type of density variations found in trees A and B was actually more common than any other trend. Hardwood timbers like *Fagus sylvatica, Fraxinus pennsylvanica, Nyssa aquata, Liquidambar styraciflua* and *Quercus falcata* have been found to show a non-uniform increase in density from the base to the top of stem (Panshin & de Zeeuw 1980).

Conclusion

From the three trees studied, it was found that there were density variations from pith outwards and in the axial direction. Generally, the density increased from pith to the bark and from the butt end to the top. Juvenile wood was estimated to be about 30% in each tree based on its specific gravity even though the trees had reached 33 years. Special care is necessary in processing this timber as the juvenile wood can give rise to problems in usage such as drying, finishing *et cetera.*

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