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Descriptions of the Wood Anatomy and Safranine Impregnation in *Gmelina arborea* Roxb. from Bangladesh[1]

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ABSTRACT

In this report, we describe the anatomical features of *Gmelina arborea* Roxb. belong to the genera of Verbenaceae native to Bangladesh and safranine penetration depth in radial and longitudinal directions. The wood of this species was characterized mostly by distinct growth ring boundaries, diffuse-porous, simple perforations, alternate non-vestured intervessel pits, and relatively short vessel elements and medium fibers. Thin to thick walled septate fibers with simple to minutely bordered pits are confined to the radial walls. Tyloses are common. They are paratracheal axial parenchyma vascicnetric and confluent. Rays not higher than 1milimeter are found, and larger rays commonly 4 to 5 seriate are dominantly present, as are multiseriate rays composed of a procumbent ray with 1 row of square or upright cells. Acicular crystals are present in ray cells. Another experiment was taken under consideration to observe the liquid penetration depth in longitudinal and radial directions using safranine. It was found that safranine penetrated easily in longitudinal direction and sapwood was more permeable than heartwood.

Key words: Anatomical features, Liquid penetration, Safranine.

INTRODUCTION

Gmelina arborea Roxb. (Verbenaceae) occurs naturally in the region extending from the lower Himalayas in Pakistan, through India, Nepal, Bangladesh, Sri Lanka, Burma, Thailand, Laos, Cambodia, Vietnam and the southern provinces of China (Akachuka and Burley 1979). In the southern region of Yunnan province, which is situated in southwest China, trees grow up to 35m high with trunk up to 100 cm in diameter (Wu 1986). Its ecological range presents temperatures from near zero to 48℃ and rainfalls from 800 to near 5,000 mm (Lamb 1970). Trees of *Gmelina* occur usually very scattered mostly in the mixed deciduous forests associated with teak and is occasionally found in evergreen forests or in drier forest types (Troup 1921).

Gmelina arborea is a popular timber for picture or slate frames, various types of brush backs, brush handles and toys as well as for handles of chisels, files, saws, screw-drivers, sickles, etc. It is also used for manufacturing tea chests and general purpose plywood, blackboards, frame core and cross bands of flushdoor shutters. In instrument industry, *Gmelina* timber is widely employed for the manufacture of drawing boards, plane tables, instrument boxes, thermometer scales and cheaper grade metric scales. It is also used in artificial limbs, carriages and bobbins. The objectives of this paper are to describe the anatomical features of *Gmelina arborea* and safranine impregnation depth both in radial and longitudinal directions. It will help us to understand the permeability for the implication of wood drying and wood preservation.

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MATERIALS AND METHODS

Wood identification

Wood sample of *Gmelina arborea* Roxb. was obtained from wood suppliers in Bangladesh. Microscopic slides and macerations were made according to standard techniques (Baas and Zhang 1986). Radial and tangential surfaces were finished with a microtome and the clean-cut surface was (3 x 2 mm) cut of 1mm thick and samples were mounted on FE-SEM specimen stubs using an electrically conducting paste. Samples were dried under vacuum condition and coated with platinum and palladium by using an ion sputter apparatus. At different resolutions and magnifications, samples were examined at 15kV in a Field Emission Scanning Electron Microscope (FE-SEM). Terminology and the method for determining quantitative features conform to the recommendations from the IAWA Feature List (IAWA Committee 1989).

Sample preparation

Only radial and longitudinal directions were considered. The sample size was maintained 6 cm (length) x 1 cm (width) x 0.5 cm (thickness). Samples were sealed with silicon resin except the observation surface. This was done to prevent the leakage to other surfaces.

Estimation of the moisture content (%)

Wood samples were weighed and oven dried in an oven for 24 hours maintaining the temperature 105 ^{O}C. Moisture content of woodchip was calculated using the following formula:

$$M(\%) = \frac{W_m - W_O}{W_m} \times 100$$

Where M = Moisture content (%), W_m= Weight of green wood (g) and W_O= Oven dry weight (g).

Camscope observation

Safranine penetration behavior was observed by *i*-camscope (SV32).

Preparation of safranine solution (1%)

10 g of safranine was taken in 1 L of volumetric flask and 500 ml 50% ethyl alcohol was added. Distilled water was added to make the volume 1000 ml.

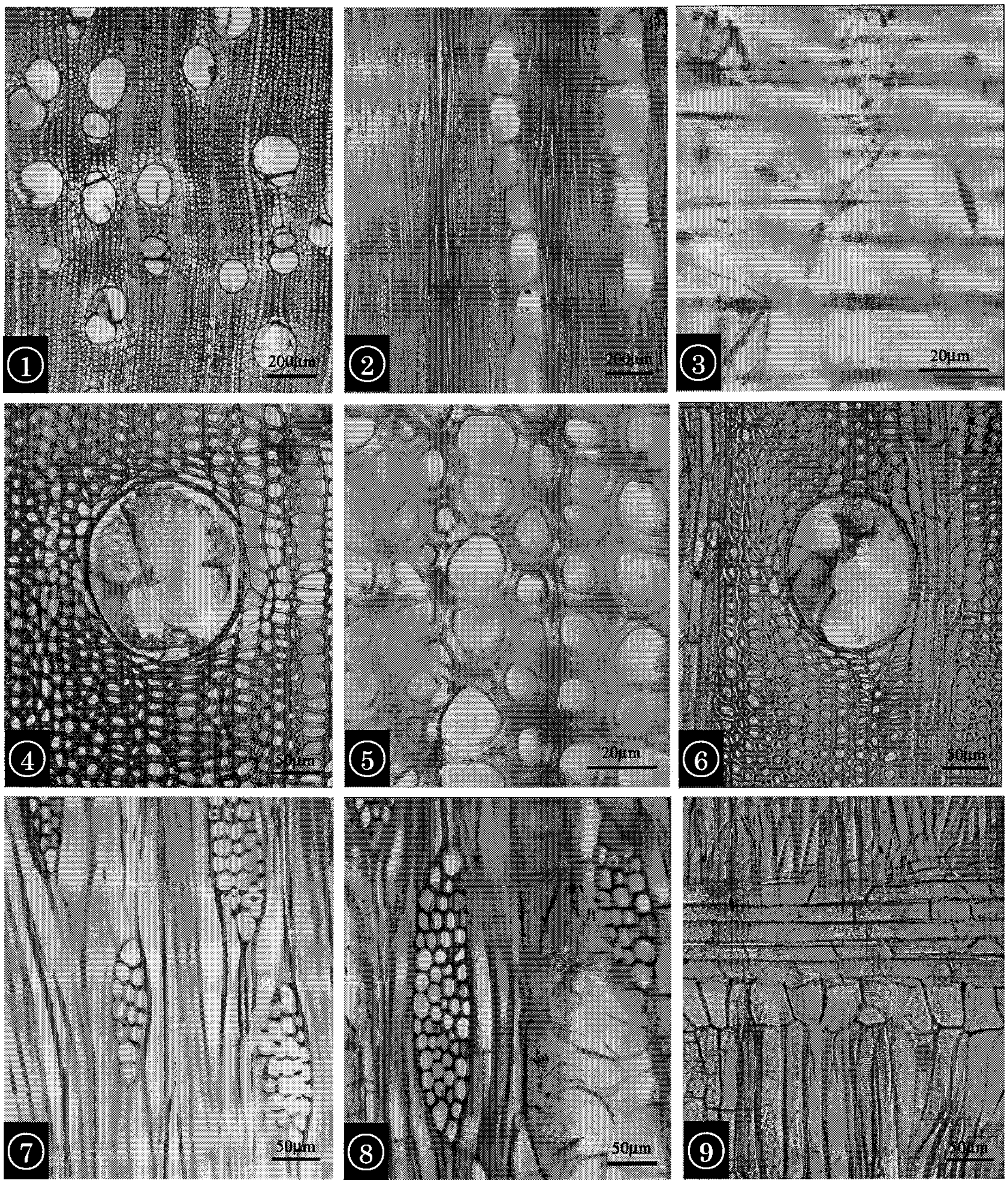
Observation

Samples moisture content were determined before safranine impregnation. While observing the safranine penetration, the room temperature was 24 ℃ and the wind speed was 0m/s. Coated samples were fixed on a Petri dish and safranine was poured on it. With I-Solution software, the safranine impregnation video file was captured for 5 minutes. This 5-minute video file consisted of 300 frames. Specific frames were selected at 1, 2, 3, 4 and 5 minutes by VitrualDub-MPEG2 software.

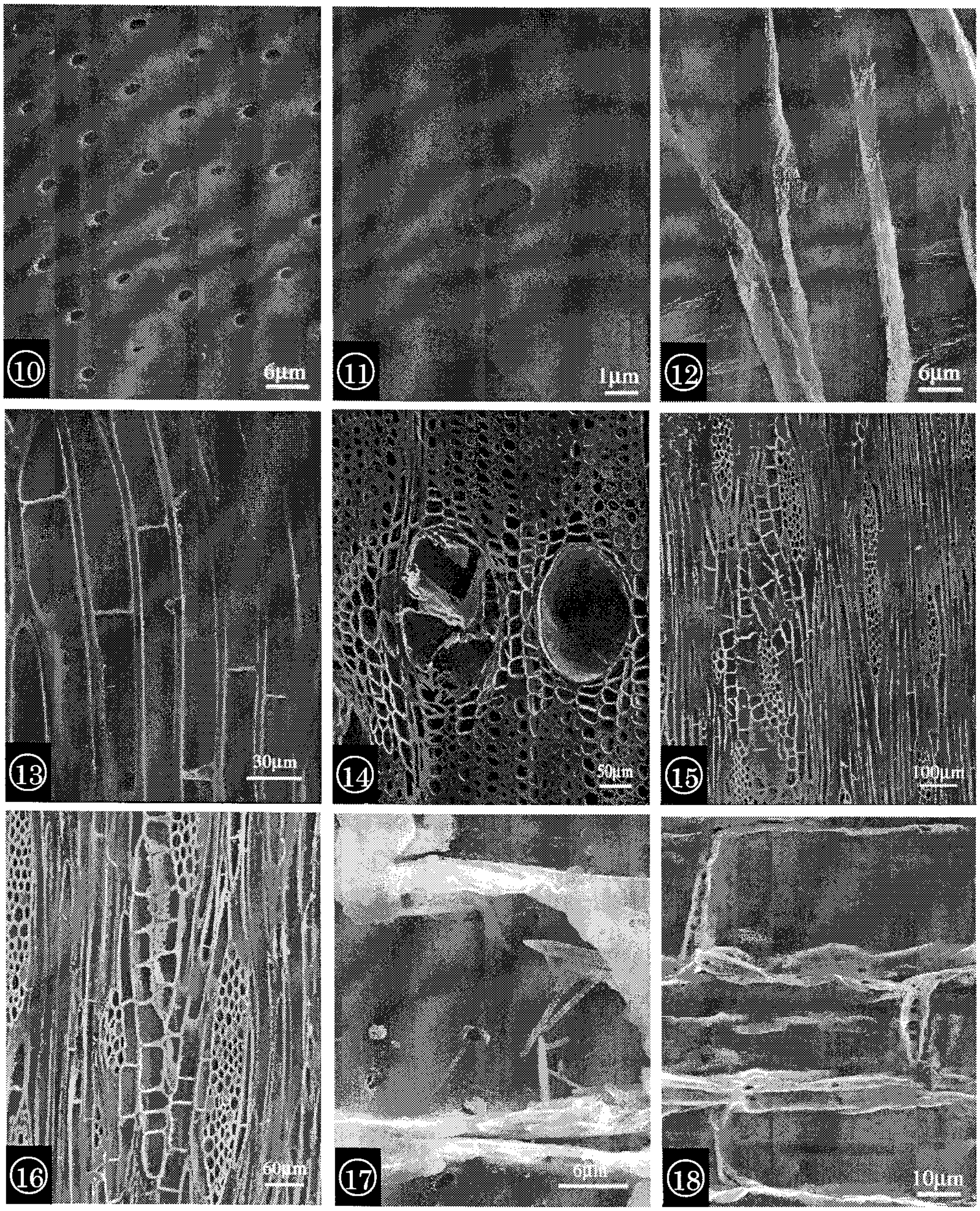
RESULTS AND DISCUSSION

Wood anatomical features

Growth ring boundaries distinct (Fig. 1). Wood diffuse-porous (Fig. 1). Vessels arranged in no specific pattern, in multiples, commonly short (2-3 vessels) radial rows (Fig. 1). Perforation plates simple (Fig. 2). Intervessel pits alternate (Fig. 10), non-vestured (Fig. 11). Shape of alternate pits



Figs. 1-9: Observed by optical microscope. Fig.1. Growth ring boundaries distinct, vessels in short radial multiples, wood diffuse-porous. Fig.2. Simple perforation plate. Fig.3. Vessel-ray parenchyma pit. Fig.4. Tyloses in vessel, axial parenchyma vasicentric. Fig.5. Fibers thin to thick walled. Fig.6. Aixal parenchyma lozenge-aliform. Fig.7. Ray width 1-3 ray cells. Fig.8. Larger rays commonly 4 to 5 seriate. Fig.9. Body ray cells procumbent with one row of upright and/or square marginal cells.



Figs. 10-18. Observed by FE-SEM. Fig.10. Intervessel pit alternate. Fig.11. Non-vestured pit. Fig.12. Fiber with simple pit. Fig.13. Septate fibers present Fig.14. Axial parenchyma confluent, also tyloses common. Fig.15. Two-eight cells per parenchyma strand. Fig.16. Over eight cells per parenchyma strand. Fig.17. Acicular crystals in ray parenchyma cell. Fig.18. Macerated ray parenchyma with endwall pit.

not polygonal (Fig. 10). Vessel-ray pits with distinct borders similar to intervessel pits in size and shape throughout the ray cell (Fig. 3). Helical thickenings absent. Tyloses common (Fig. 4 and 14). Vascular or vasicentric tracheids absent. Libriform wood fiber with simple to minutely pits (Fig. 12) and septate (Fig. 13). Fiber pits mainly restricted to radial walls. Fiber walls thin to thick (Fig. 5). Axial parenchyma not banded. Axial parenchyma paratracheal. Paratracheal axial parenchyma vasicentric (Fig. 4) or confluent (Fig. 14). Aliform parenchyma lozenge shape (Fig. 6). Axial parenchyma as strands. Average number of cells per axial parenchyma strand 2-8 cells (Fig. 15). Over 8 cell per parenchyma strand rarely present (Fig. 16). Rays per millimeter 5 (sd= 0.87, range 3-6). Ray width 1 to 3 cells (Fig. 7). Larger rays commonly 4 to 5 seriate and dominantly present (Fig. 8). Aggregate rays absent. Rays of one size. Multiseriate rays composed of procumbent ray with 1 row of square/upright cells (Fig. 9). Storied structure, sheath cells and tile cells absent; no perforated ray cells observed. Intercellular canals absent. Laticifers or tanniniferous tubes absent. Included phloem absent. Other cambial variants absent. Crystals present, needle-like (acicular), located in ray cells (Fig. 17). Crystal-containing ray cells upright and/or square or procumbent. Number of crystals per cell or chamber more than one (Fig. 17). Cystoliths and Silica are not observed in this species.

Wood of this species has commercial importance. The basic specific gravity medium is 0.40-0.75. The color of heartwood is darker than the color of sapwood. The color of heartwood is basically brown or the shade of brown. It has no distinctive odor. The water extract is basically yellow or the shade of yellow. The ethanol extract is basically yellow or the shade of yellow. The froth test and chrome Azurol-S test are negative. The splinter burns to a full white ash.

Safranine penetration observed by Camscope

Moisture content is considered as an important factor for the impregnation of liquid in wood. It depends on different moisture level in wood sample. There is evidence that wood can uptake water above the fiber saturation point while in some wood species, the permeability decreases with increasing moisture content (Comstock 1968; Browning 1963). Also excess moisture can be the physical barrier for the mass flow of liquid (Wirspa and Libby 1950). The moisture content of *Gmelina arborea* was found 8.59%.

Ray cells are joined together to form a capillary structure to make a pathway for the penetration in radial direction. It has been reported that ray parenchyma cells are important channels for radial flow in some species (Behr et al. 1969). The input of safranine input may vary due to the ray parenchyma's diameter, length, endwall pitting and lateral wall pitting.

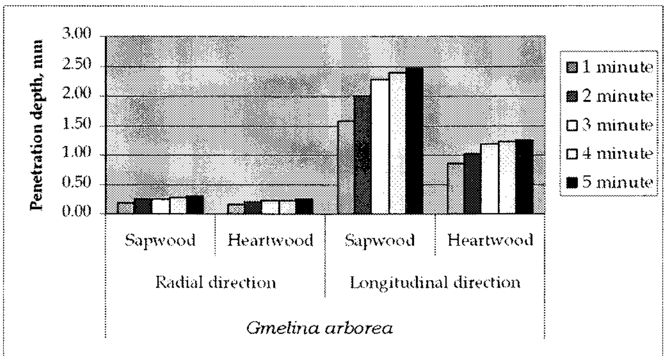


Fig.19. Longitudinal and radial penetration of safranine.

The formation of deposits can subsequently reduce the permeability of heartwood (Kumar and Dobriyal 1993). Besides, the factors attributed to the lowered heartwood treatability include the higher extractive content in heartwood. The vessels are the main avenues in conducting fluids.

Therefore, the size, distribution and condition of the vessels are important factors for treating the hardwood (Wang and DeGroot 1996). The rate and amount conducted by vessels or fiber varies from species to species. Vasicentric tracheids can also function as a communication means for the intervessel fluid transport (Wheeler and Thomas 1981).

CONCLUSIONS

Gmelina arborea was characterized by distinct growth ring boundaries. Wood diffuse porous, simple perforation plates, alternate intervessel pits non-vestured. Vessel-ray pits with distinct borders similar to intervessel pits in size and shape throughout the ray cell. Tyloses common. Vascular or vasicentric tracheids absent. Libriform wood fiber with simple to minutely pits, septate. Fiber pits mainly restricted to radial walls. Axial parenchyma paratracheal and vasicentric or confluent. Lozenge aliform parenchyma present. Average number of cells per axial parenchyma strand 2-8 cells. Over 8 cell parenchyma rarely present. Ray width 1 to 3 cells. Dominant larger rays commonly 4 to 5 seriate. Aggregate rays absent. Multiseriate rays composed of procumbent ray with 1 row of square/upright cells. Needle-like (acicular) crystals located in ray cells. Crystal containing ray cells- upright, square or procumbent. Number of crystals per cell or chamber more than one.

On the other hand, penetration rate of safranine was found highest within 1 minute and gradually decreased with increase of time. Higher penetration depth was observed in longitudinal direction. Sapwood was easily permeable than heartwood.

REFERENCES

Akachuka, A. E. and J. Burley. 1979. Variation of wood anatomy of *Gmelina arborea* Roxb. In Nigerian plantations. IAWA Bull. 4: 94-99.

Baas, P. and X. Zhang. 1986. Wood anatomy of tree and shrubs form China. I. Oleaceae. IAWA Bull. n. s. 4: 141-159.

Behr, A. E., I. B. Sachs, B. F. Kukachka and J. O. Bleur. 1969. Microscopic examination of pressure treated wood. Forest Prod. J. 19: 31-40.

Browning, B. L. 1963. The Chemistry of wood, Interscience Publishers New York.

Comstock, G. L. 1967. Relationship between permeability of green and dry Eastern hemlock. Forest Prod. J. 18(8): 20-23.

IAWA Committee. 1989. IAWA list of microscopic features of hardwood identification. IAWA Bull. n.s. 10(3).

Kumar. S. and P. B. Dobriyal. 1993. Penetration indices of hardwoods: a quantitative approach to define treatability. Wood Fiber Sci. 25(2): 192-197.

Lamb, A. F. A. 1970. *Gmelina arborea*. Fast Growing Timber Trees of the Lowland Tropics - no.1. Commonwealth Forestry Institute, Oxford.

Troup, R. S. 1921. The silviculture of Indian trees, II. The Clarendon Press, Oxford.

Wang, J. Z. and R. DeGroot. 1996. Treatability and durability of heartwood. In: Ritter MA, Duwadi SR, Lee PDH (eds) National conference on wood transportation structures; 1996 October 23-25; Madison, WI. Gen. Tech. Rep. FPL-GTR-94. Madison, WI: USDA, Forest Service, Forest Products Laboratory: 252-260.

Wheeler, E. A. and R. J. Thomas. 1981. Ultrastructure characteristics of mature wood of southern red oak (*Quercus falcata* Michx.) and white oak (*Quercus alba* L.). Wood Fiber Sci. 13(3): 169-81.

Wirspa, V. J. and C. R. Libby. 1950. Penetration of neutral sulphite cooking liquors into yellow birch wood. Tappi. 33(5): 225-231.

Wu, C. Y. 1986. Wild flower of Yunnan III. Tropical. Japan Broadcast Publ. Co., Yunnan People's Publishing House.