

COMPARATIVE ANATOMY OF TEAK (*TECTONA GRANDIS*) WOOD GROWN IN DIFFERENT COUNTRIES

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ABSTRACT

Anatomical properties of Teak wood produced in Pakistan on trial basis and that of internationally traded were studied in wood anatomy laboratory at Pakistan Forest Institute, Peshawar to observe variations. Results revealed that Teak wood grown in Indonesia, Burma, India and Pakistan are almost comparable in anatomical properties with minor variations. In Burmese and Indian Teak the fibers were comparatively longer, narrow or thick walled and the wood may be relatively better in strength. The vessels were higher in frequency or larger in size in Indonesian and Burmese Teak for the reason the wood may be comparatively easy to season. The wood rays were lower in frequency or smaller in size in Indonesian and Indian Teak due to that the wood may be somewhat more durable among the studied wood samples.

INTRODUCTION

Teak (*Tectona grandis*) is one of the most well known timbers of the world. Its qualities include attractive color, straight grain, durability, light-weight, desirable strength, easiness in seasoning, working and carving, resistance to termites, fungi, and weathering, etc. The species is native to the Indian-Burmese floristic region and found naturally in India, Burma, Thailand and Lao, and is virtually naturalized in Java, Siam, Cambodia, Cochin China and some of the islands of Indonesian Archipelago (Desch, 1983; Kaosa-ard, 1983; FAO, 1995). It is also grown successfully in certain other countries where climatic conditions are suitable, notably Ceylon, Nigeria and Trinidad (Rendle, 1970). Burma is regarded as the home of Teak and international marketing is known from the 18th century. Of the four countries of natural grown Teak, only Burma and Indonesia continue exports; India and Thailand now import Teak (FAO, 1995). In 1980, Teak was planted on trial basis at Changa Manga, Pakistan (Iqbal, 2007). The trees were harvested after 13 years for the determination of its wood properties.

The current study has been carried out with the objective to collect the anatomical data of Teak wood grown in different prevailing climatic conditions of the world including Pakistan in order to observe variations and evaluate their technological properties.

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MATERIALS AND METHODS

To carry out the research work, the wood samples of local Teak and that from Indonesia, Burma and India were collected from Wood Anatomy Laboratory of Forest Products Research Division. Permanent slides of cross, radial and tangential sections of all the wood samples were prepared by standard laboratory procedures and observe under microscope for various structural features. To measure the fiber length, a small portion of wood from each sample was macerated in Schulze's mixture (20% Nitric acid and Potassium chlorate) to separate the fibers (Anon., 1974). Data were collected for the frequency and dimensional measurements of different wood elements/ structures in each wood sample by the process of micrometry (Anon., 1971) and analyzed for statistical variables for each feature in each sample.

RESULTS AND DISCUSSION

General Characteristics of the wood

The sapwood is white to pale yellowish-brown; heartwood has a characteristic golden-brown color sometimes with irregular dark markings which enhance the decorative value of the wood. The grain is typically straight with very coarse and un-even texture as the wood is ring porous. Further, the wood contains an oleo-resin and has a characteristic smell linked to that of old-leather but without characteristic taste.

Structure of the wood

The growth rings are distinct, conspicuous with the naked eye, undulating, delimited by lighter zone of larger spring wood vessels followed by darker zone of summerwood consisting of smaller vessels and dense fibrous tissue.

The wood is ring porous i.e., the vessels are of two sorts. The springwood vessels are very large, partially or wholly occluded with tyloses, or occasionally with deposits, occur solitary or in radial rows of 2-3 (mostly 2) or two vessels contiguous in tangential plane. Latewood vessels are medium sized to small or very small, solitary or in radial rows of 2-5 (mostly 2), tyloses fairly abundant, often partially, occasionally completely occluded or filled with yellowish or reddish brown gummy deposits.

Parenchyma is paratracheal, paratracheal zonate, and metatracheal. Paratracheal parenchyma relatively sparse confined to vessels or vessel groups, forming 1- several seriate sheath around the vessels. It is confined to early wood vessels forming bands mostly 1-6 seriate. Metatracheal parenchyma is extremely sparse.

The wood rays are medium fine, distinct with the naked eye, closely spaced, frequently contiguous to vessels, lighter than the back ground forming silvery flecks on the radial surface and are heterogeneous.

The fibers are non-libriform, non-gelatinous and septate with large tapering ends angled in cross section, not aligned in radial row and are thick-walled toward the outer margin of the ring.

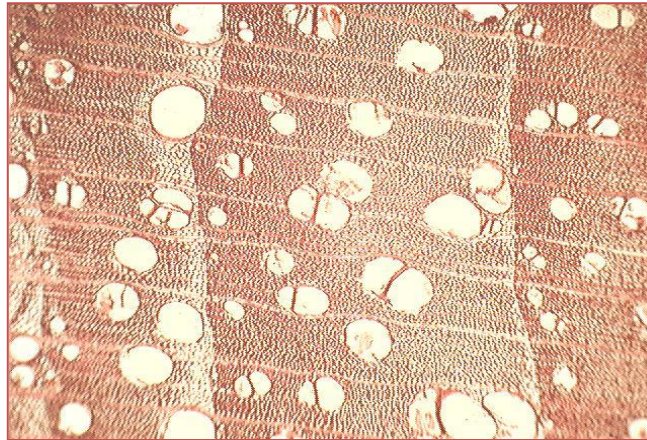


Figure 1. Photomicrograph of the cross section of Teak wood showing the structure

In Pakistani Teak, the vessels were found 4-7/mm² in number. The early wood vessels were ascertained small to large or very large; 107-272 μ in diameter and the latewood vessels were very small to small or medium sized, 49-150 μ in diameter. The frequency of wood rays was observed 8-12/mm² in tangential section and 4-5/mm in cross section. The largest wood rays were measured as 1213 μ (41 cells) in height and 58 μ (4 cells) in width. The fibers were dimensioned as 0.72-1.89 mm long, 20.40-37.70 μ in diameter and the fiber walls were 2.55-5.80 μ in thickness.

In Indian Teak, the frequency of vessels was calculated as 4-5/ mm². The early wood vessels were medium sized to large or very large ranged from 159-272 μ in diameter, the latewood vessels were small to medium-sized or large in diameter ranging from 84-228 μ . The wood rays were detected as 9-13/ mm² in tangential section and 3-4/mm in cross section. The largest wood rays were measured upto 714 μ (34 cells) in height and 53 μ (3 cells) in width. The fibers were observed as 0.91-1.45mm long, 19.13-31.16 μ in diameter and 3.03-5.72 μ in wall-thicknesses.

In Indonesian Teak the vessels frequency was determined as 6-8/mm². The early wood vessels were found very large to extremely large with 219-375 μ in diameter. The latewood vessels were measured as 99-255 μ in diameter i.e. very small to small, medium-sized to large or very large in size. The wood rays were

found as 6-10/mm² in number in case of tangential section whereas; in cross section these were found 3-4/mm. The largest wood rays were 855 μ (36 cells) in height and 76 μ (4 cells) in width. The fibers dimensions were found out as 0.98-1.79 mm in length, 18.05-33.94 μ in diameter and 2.86-4.94 μ in wall-thickness.

In Burmese Teak, the vessels frequency was calculated as 4-6/mm². The early wood vessels were found very large to extremely large ranging from 224-379 μ in diameter whereas the latewood vessels were found small to medium-sized or large with 123-220 μ in diameter. The wood rays were found 5-7/mm² in number in tangential section and 3-4/mm in cross section. The largest wood rays were observed as 1406 μ (64 cells) in height and 61 μ (4 cells) in width. The fibers were measured as 1.17-1.74 mm in length, 20.80-34.92 μ in diameter and 2.61-5.18 μ in wall-thickness.

Comparison of Anatomical data

Based on the average values as shown in Table 1, among the studied Teak wood samples, the maximum number of vessels was found in Indonesian teak followed by that from Pakistan, Burma and India. The largest diameter of early wood vessels was observed in Burmese Teak followed by that from Indonesia, India and Pakistan. However, the largest diameter of late wood vessels was observed in Indian Teak followed by that from Indonesia, Burma and Pakistan.

The lowest frequency of wood rays both in case of cross and tangential sections was found in Indonesian teak whereas, the smallest size (height and width) of wood rays was observed in Indian Teak.

The longest fibers were found in Burmese teak followed by that produced in Pakistan, Indonesia and India whereas maximum fiber wall-thickness was observed in Indian Teak followed by that grown in Burma, Indonesia and Pakistan. Further, the narrowest fiber diameter and lumen width was also found in Indian Teak.

CONCLUSION

Based on the results it can be concluded that Teak wood produced in Pakistan, India, Indonesia and Burma are almost comparable to each other however, the Burmese and Indian teak may be comparatively better in strength due to longer, narrower or thick-walled fibers, the Indonesian and Burmese Teak may be relatively easy to season due to higher frequency or larger size of vessels whereas the Indonesian and Indian teak may be somewhat more durable due to lower frequency or smaller size of wood rays among the studied Teak wood samples.

Table 1 here

REFERENCES

- Anon., 1971. Examination of Timber. Teaching Aid No.7. Timber Research and Development Association, Hunghenden Valley, High Wycombe, Bucks.
- Anon., 1974. The Preparation of Wood for Microscopic Examination. TIL52, Building Research Advisory Service; Building Research Station Garston, Watford WD27JR.
- Desch, H. E. and J. M. Dinwoodie, 1983. Timber its Structure, Properties and Utilization, 6th Edition. The Macmillan Press Ltd. London and Basingstoke. P-150.
- Food and Agriculture Organization, 1995. Teak for the Future - Proceedings of the Second Regional Seminar on Teak. TEAKNET Publication: No. 1.
- Iqbal, M., R. Gul and H. Tanvir, 2007. A Note on Properties and Utilization of *Tectona grandis* (Linn.f.) grown at Changa Manga. PJF. vol.57 (1), 2007.
- Kaosa-ard A. 1983. Teak improvement program annual report, No.15±16. Teak Improvement Centre (TIC), Bangkok, Thailand.
- Rendle, B.J. 1970. World Timber, Vol.3 Asia, Australia and New Zealand. Published by Ernest Benn Limited, University of Toronto Press, P-90.

Table 1. Frequency and dimensional measurements of various wood elements/structures in Teak wood grown in different Countries

(Statistical analysis)

Origin	Anatomical Features													
	No. of Vessels/ mm ²		Diameter of vessels(μ)		No. of rays in tangential Section/ mm ²	No. of rays in cross section/ mm	Height of rays		Width of rays		Fiber length (mm)	Fiber diameter (μ)	Fiber wall-thickness (μ)	Fiber lumen width (μ)
Pakistan	Avg.	6.06	209.39	100.03	10.34	4.91	642.14	23.20	42.19	2.87	1.33	29.83	3.72	22.39
	S.D±	0.79	38.35	26.43	1.01	-	254.17	9.66	10.19	0.64	0.28	4.63	1.05	-
	C.V%	13.10	18.31	26.43	9.85	-	39.58	41.65	24.16	22.53	21.07	15.52	28.18	-
India	Avg.	4.50	217.98	151.76	11.39	3.53	426.70	20.92	33.02	3.22	1.21	23.59	4.54	14.51
	S.D±	0.46	25.85	36.56	1.06	-	149.11	7.15	9.91	0.40	0.13	3.10	0.73	-
	C.V%	10.29	11.86	24.09	9.34	-	34.94	34.20	29.86	12.54	11.03	13.14	16.07	-
Indonesia	Avg.	6.97	298.70	148.78	7.92	3.25	522.72	22.38	59.67	3.22	1.32	24.97	3.92	17.13
	S.D±	0.55	40.67	33.08	0.96	-	149.43	6.81	9.75	0.49	0.16	4.08	0.64	-
	C.V%	7.93	13.61	22.23	12.15	-	28.58	30.46	15.67	15.37	12.11	16.34	16.47	-
Burma	Avg.	5.14	316.46	117.17	5.97	3.81	884.20	38.46	50.01	3.22	1.45	28.55	3.99	20.57
	S.D±	0.52	34.21	24.70	0.60	-	280.24	13.77	6.47	0.47	0.11	3.62	0.62	-
	C.V%	10.25	10.81	13.94	10.12	-	31.69	35.82	12.93	12.86	8.20	12.70	15.52	-

Avg=Average value

SD=Standard deviation

C.V=Coefficient of variation