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Wood specific gravity of important hardwood tree species of Jhalawar District

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Abstract
The specific gravity (SG) of wood is a measure of the amount of structural material allocated to provide support and strength. In recent years, specific gravity of wood has become the field of ecologists for exploring the universality of plant functional traits and estimation of global carbon stocks and wood quality. The analyzed hardwood species differed greatly with respect to different wood quality parameters. The maximum specific gravity (0.66) was observed in *Acacia nilotica* followed by *Acacia leucophloea* (0.65), *Dalbergia sissoo* (0.62), *Mangifera indica* (0.58) and *Tectona grandis* (0.52) whereas lowest was found in *Ailanthus excelsa* wood with value of 0.44. No effect was seen in location due to locality factors. The main objective of the present study was to estimate the wood specific gravity of six hardwood dominant tree species from the Jhalawar District compared with *Tectona grandis* wood and thus study the potential of wood to be utilized for furniture making and different wood product industries.

Keywords: Hardwood species**,** Specific gravity, Rajasthan

Introduction
Wood is organic, natural raw material with varying physical and mechanical properties making it desirable for variety of construction purposes. Throughout recorded history, the physical and chemical characteristics of wood have proven it as one of the most valuable and useful natural resources for mankind. With the development, civilization and consequent global industrial revolution, timber is one of the most important raw materials for the expansion of industrial activities worldwide. In many parts of the world today, new domestic dwellings are usually built of shoulder wood which can be used as structural and aesthetic materials in both residential and commercial routes. In buildings made of other materials, wood is also found as auxiliary material, especially in roof construction, in the interior doors, their frames, and as the outer cover. Wood is also commonly used as a shuttering material to make molds in which reinforced concrete is poured during construction. Hardwoods are derived from the plant group called angiosperms (two subgroups called monocotyledons and dicotyledons), generally known as broad-leaved trees; their seeds are enclosed in a seed case. Variations in hardwood properties are caused by variations in cellular structure. Hardwood has a more compact structure than softwood which makes it hard and heavy.
Specific gravity of wood is a measure of the amount of structural material a tree species allocates to provide support and strength. Specific gravity varies from species to species depending on the chemical nature and anatomical structure (Zobel and Talbert, 1984) [12]. Specific gravity are very important parameter in selecting wood for numerous uses, such as furniture manufacturing, cabinet manufacturing, construction of frame, bridge, building structures, sporting goods, measuring instruments, musical instruments, particle boards, decorative surfaces, insulating media etc. Some wood properties that are closely related to wood's specific gravity are strength, dimensional stability, ability to retain paint, fiber yield per unit volume, suitability for making particleboard and related wood composite materials and suitability as a raw material for making paper (Bowyer and Smith, 1998) [2]. Wood specific gravity decreases with increasing vessel fraction, vessel area and vessel density affecting the amount of lumen space in wood (Preston *et al.*, 2006) [7]. Wood density, the weight of wood per unit volume, is another measure of the amount of wood material in a tree and the two are often used interchangeably.

Wood density, however, should be reported at certain moisture content, so it is only equal to specific gravity at 0% moisture content. Wood density (specific gravity) is the product of several other traits within a tree including cell diameter, cell wall thickness, and the amount of latewood produced by the tree (Zobel and Talber, 1984) [12]

Rajasthan is India's largest state by area (342,239 square kilometres (132,139 sq mi) or 10.4% of India's total area). One comprising the arid vegetation, falling into the western part of the state, while the other belongs to semi-arid to sub-humid category in the eastern and southern Rajasthan. The vegetation of Rajasthan varies from dry tropical forests to desert thorn scrubs and grasslands following the physiography, temperature and rainfall distribution. As per the Champion & Seth Classification of Forest Types (1968) [3], the forests in Rajasthan belong to two Type groups i.e. Tropical Dry Deciduous and Tropical Thorn Forests which are further divided into 20 Forest Types. Out of the 5 regions of Rajasthan Hadoti is one of the major regions which are flagged by Baran, Bundi, Kota and Jhalawar.

Materials and Methods

Experimental sites - The present investigation was carried out during July 2019 to February 2020 at the Laboratory of the Department of Forest Products and Utilization, College of Horticulture and Forestry, Jhalawar, Agriculture University Kota (Rajasthan). The samples of six hardwood species *viz. Acacia nilotica*, *Dalbergia sissoo*, *Mangifera indica*, *Ailanthus excelsa*, *Acacia leucophloea* and, *Tectona grandis* (control) were collected from three different sites (Plate-1) *viz.* Jhalawar (R_1), Manoharthana (R_2) and Dag (R_3). The recorded data was subjected to ANOVA for statistical analysis.

Samples preparation

The wooden logs of these species collected from above mentioned three market sites were converted into various sample sizes, in accordance with the test specifications. The samples were properly planed and sanded for maintaining the smoothness. The size of the samples prepared for specific gravity of wood conducting test were 20mm x 20mm x 20mm.

Specific gravity

Specific gravity of the samples was determined by the maximum moisture content method (Smith, 1954) [10]. The specific gravity was calculated as per the formula given below:

$$\text{Specific gravity} = \frac{1}{\frac{Mm-Mo}{Mo}+\frac{1}{GS}}$$

Where

Mm = Fresh / Green weight of the sample having maximum moisture (g)

Mo = Oven dried constant weight of the sample (g)

GS = Average density of wood substance, a constant, having value 1.53

Result and Discussion

The statistically analyzed data related to specific gravity in wood for all the species and site locations are presented in Table 1. The examination of data depicted significant difference in specific gravity in wood among different species at 5 per cent level of significance. The maximum specific gravity (0.66) was observed in *Acacia nilotica* followed by *Acacia leucophloea* (0.65), *Dalbergia sissoo* (0.62), *Mangifera indica* (0.58) and *Tectona grandis* (0.52) whereas lowest was found in *Ailanthus excelsa* wood with value of 0.44. Among the location, the result found to be non significant and ranged from 0.58 to 0.59. The interactions between species and locations were also found to be non significant and ranging from 0.43 to 0.67. In this present study the variation in specific gravity may be due to various factors, including the variable cellular structure, variation in chemical concentraton, geographic location of trees, soil fertility, rainfall, seasonality, temperature and moisture content which varies by species, d.b.h., age, and stem position. The variation in average specific gravity due to these factors has also been reported by Muller-Landau (2004) [6]. Similar result were also reported by Sheikh *et al.*, (2011) [9] The specific gravity of wood was determined for a total of 34 tree species and found average wood specific gravity was 0.631 (ranging from 0.275 ± 0.01 to 0.845 ± 0.03) for the lower elevation species and 0.727 (ranging from 0.628 ± 0.02 to 0.865 ± 0.02) for the upper elevations. Rani *et al.*, (2017) [18] that's found North Indian Rosewood (*Dalbergia sissoo*) has highest wood density, it can be used for agricultural implements and other works that require high strength wood. Chauhan and Sharma (2016) [4] also studied the specific gravity in *Pinus roxburghii, Bombax ceiba and Celtis australis*, and found that density of wood is said to be influenced by moisture, structure, extractives, and chemical composition.

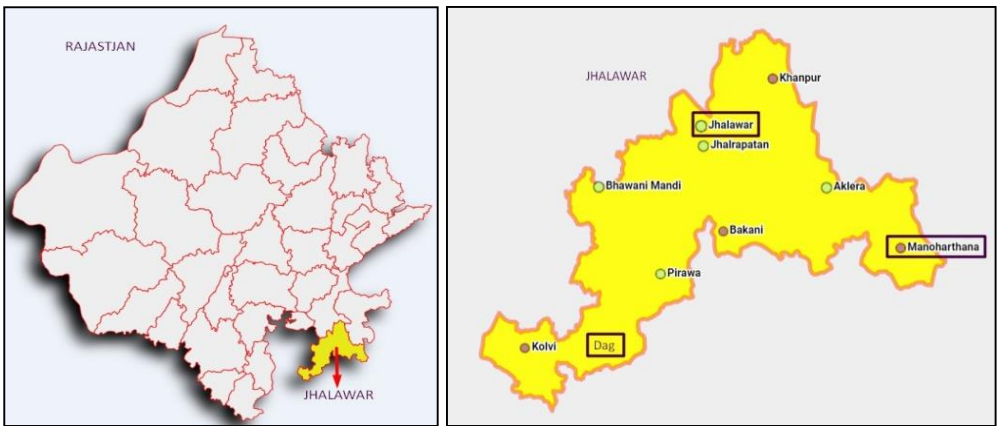

Plate 1: Map of different site locations

Table 1: Variation in Specific gravity of hardwood from different site locations

Species (S)		Locations (L)			Mean
		(R_1) Jhalawar	**(R_2) Manoharthana**	**(R_3) Dag**	
T_1 (*Acacia nilotica*)		0.67	0.66	0.64	0.66
T_2 (*Dalbergia sissoo*)		0.62	0.63	0.62	0.62
T_3 (*Mangifera indica*)		0.58	0.58	0.58	0.58
T_4 (*Ailanthus excelsa*)		0.44	0.45	0.43	0.44
T_5 (*Acacia leucophloea*)		0.66	0.66	0.64	0.65
T_0 (*Tectona grandis*)		0.55	0.54	0.54	0.54
Mean		0.59	0.59	0.58	
Species (CD = 0.05)	0.017				
Site	NS				
Species*Sites	NS				

Conclusion

The study was chiefly embattled on utilization of diverse type of wood for their usage in different application. The *Acacia nilotica* wood showed better performance for good quality timber and can be recommended for use in different application. So far various studies have been carried out in estimation of specific gravity of trees, but not for the south-east Rajasthan. This study will help researchers who are working on choosing good quality timber in wood based industrial sectors and provide information for selection criteria of wood to make a different component of wood implement and tools. Hence, the species could be studied and explored for further tree improvement programme.

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