

VARIATIONS OF WOOD ELEMENTS IN MAIN STEM OF *ALBIZIA*
LEBBECK (L.) BENTH. GROWING IN BAGHDAD CITY, IRAQ

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ABSTRACT

As *Albizia lebbbeck* is one of the important species in Iraq and the region, its wood has subjected to investigation through the assessment of differences in its element dimensions and specific gravity under Baghdad conditions. Variations of fiber length, fiber width, cell wall thickness, vessel diameter, and density of wood were examined along the stem and horizontally. Results showed that fiber lengths were within the normal range, but their widths were narrower than common range of hardwoods. There were little increase in fiber length, width, wall thickness as the height position increased. Vessel diameter has been affected contrarily. No significant effects of height on specific gravity could be observed. Radial variability appeared to be height dependence. While heartwood possessed longest fibers at stem uppermost, maximum value of width and wall thickness have existed in the heartwood too but at lowermost of stem. The substantial difference was in specific gravity when heartwood had the superiority upon sapwood.

INTRODUCTION

The genus *Albizia* is a member of the family Fabaceae and subfamily Mimosoideae. It comprised of many species most of them are of an extreme economical and environmental importance in many parts through out the world. It is a pantropical genus that includes at least 470 names (Rico *et al.*, 2008). One of the most important species is *Albizia lebbbeck* (L.) Benth..It is fast growing tree with feathery foliage and spreading crown. It produces a tall and straight pole. It is native to Asia, Africa, Northern Australia and India. It is cultivated in the tropical and subtropical regions of north Africa, the West Indies, South America, and Southeast Asia. Many of its habitats are characterized by extremes of climate, e.g., long, hot, and dry summers and cold winters with mean temperatures ranging from 5 to 46°C. (Mohiuddin, 1994).

Because of its adaptability to a wide range of environments, this species grows well in conditions ranging from humid to semiarid. In India it is planted as a shade tree for plantation crops such as tea and coffee in the humid tropical areas in the southwestern part of the country (Daniel *et al.*1994).. This tree is nitrogen-fixing, and tolerates acidity,alkalinity, heavy and eroded soils, waterlogged soils, and drought. (CTSP, 2004).

The plant is useful in many disease conditions and is known for its anti-inflammatory, anti-histaminic, anti-anaphylactic, anti-asthmatic and anti-microbial etc. activities (Shyاملal *et al.*, 2011).Many others worked on the plant for its medical uses (Kumar *et al.*, 2010; Gupta, *et al.*, 2004, Al-Maliky, 2013) .

Albizia lebbbeck (Woman's tongue) is a recognized fodder tree in India and Australia and it is one of a few tree species with record of leaf with a low content of toxin, tannin and

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phenolic compounds and through its relatively higher content of N, Ca but not P, appears to have potential as supplemented on animal feeding mature pasture grass or crop residues (Kennedy *et al.*, 2002). It can attain a height of 30 m and a diameter of 1m; more often it is 15-20 m tall with a diameter of 50 cm (Lewis and Rico Arce, 2008). Pods are yellowish brown with 6-10 seeds. Mature pods remain on the tree for long period and are available till May-July (Shyamlal, 2011).

Wood characteristics are identical features although some variations are involved depending on environmental variations. Wood element dimensions and specific gravity are the most important among them. Wood of this species is moderate heavy with whitish or yellowish-white of sapwood and brown with dark streak heartwood. Specific gravity is about 640 at 12% MC., Grains; straight to wavy or interlocked; texture is coarse (Nazma, *et al.*, 1981). It is termite resistant, well seasoning, and difficult to saw and machine (Mahony, 1990). It can be used to produce good-quality pulp by mechanical, semi-chemical or chemical processes. Because of its light colour, only a little bleaching is required to achieve good white paper (Lewis and Rico Arce, 2008). They also affirmed that it has also been used for the manufacture of viscose rayon.

The average fiber dimensions and corresponding morphological indices were investigated by (Khider et al, 2011). They found that fiber length, fiber diameter, cell wall thickness, and specific gravity were 0.983mm, 25.6. (μm), 4.96 (μm), and 508 kg/m³ respectively.

Importance of this species is coming from its suitability to most of Iraqi lands, and secondly from multi- uses it possesses. Accordingly, this research has suggested to explore the effect of Baghdad climates and soil on wood elements and their variation vertically and horizontally.

MATERIALS AND METHODS

Two Trees of *Albizia lebbeck* were cut from the garden of Natural History Research Center and Museum, Baghdad. Main stem was divided into 1.5 m -length segments. At the base of each segment a complete disc 5 cm thickness was taken. Four radial strips with a width of 3 cm were cut from each disc. After removing of pith, the strip was divided into 3 parts; inner, middle, and outer blocks. The middle part was rejected, the two other parts were used for determining wood elements dimensions, and specific gravity for heart wood and sap wood. Inner or outer wood blocks of all strips for a specific height was collected together and subdivided into smaller pieces. Some of them were randomly selected for maceration, others were used for specific gravity determination.

Maceration was carried out according to Franklin (1945). Wood element dimensions were studied using light microscope fitted with a calibrated ocular micrometer. The calibration was achieved by mounting the stage micrometer on the stage of the microscope and aligning its zero-mark with that of the ocular. Fiber length, fiber width, wall thickness, vessel element diameter were measured. Specific gravity was calculated by displacement method on the basis of 12% moisture content.

Data were statistically analyzed as factorial CRD experiment of 2 factors; vertical: 5 levels, horizontal: 2 levels, and 3 replications. For each one of the 30 experimental units 10 samples for specific gravity were used. For any element character 30 measurements were taken to represent a specific experimental unit. Duncan multiple range test has used for testing significant differences between levels.

RESULT AND DISCUSSION

Fiber dimensions of *A. lebbeck* wood gave an indication that the wood of trees growing in Iraq has some different properties from that of same species growing under other conditions. Mean of fiber length was 0.8930 mm (Table 1), it is not far from that obtained by Khider *et al* (2011), but much less than that of Nasroon and Al-Shahrani (1998) which was abnormal length.

Table 1: Dimensions of wood elements and specific gravity as affected by height on main stem.

Height (m)	Fiber Length (mm)	Fiber Width (μm)	Wall Thickness (μm)	Vessel Diameter (μm)	Specific Gravity
0.5	0.8538 (b)	9.64 (ab)	3.34 (ab)	180.38 (a)	711.1 (a)
2.0	0.8375 (b)	9.11 (b)	2.99 (b)	165.13 (ab)	711.3 (a)
3.5	0.8757 (b)	9.52 (ab)	3.33 (ab)	149.25 (b)	720.5 (a)
5.0	0.9041 (ab)	10.08 (ab)	3.61 (a)	164.13 (ab)	695.6 (a)
7.5	0.9940 (a)	10.44 (a)	3.85 (a)	148.63 (b)	713.1 (a)
Mean	0.8930	9.76	3.42	161.51	710.3

Note: Values having same letter are not statistically different at $p \leq 0.05$.

Fiber length at lower position of stem (0.5, 2.0 m) was about 5% less than average, while that at upper elevation (7.5 m) possessed about 10% excessive length. Some authors found unfixed pattern to the effect of height on fiber length (Bhat *et al.*, 1989; Idu and Ijomah, 1996; Jorge *et al.*, 2000).

The width of fiber appeared less than normal width of hard wood fibers. Dry conditions especially in harsh summer conditions could be the reason. The species is native to tropical and subtropical regions of Asia and Africa (Khider *et al*, 2011), so the semi-arid conditions of Iraq and Saudi Arabia might be not optimum; the reason of obtaining slim fibers. Corresponding trend was observed in case of fiber width and cell wall thickness. The second level (2.0 m) showed lowest value, after which gradual increase with height has obtained.

Fiber wall thickness followed the pattern of fiber diameter. It was maximum at the highest stem position. Mean value (3.42 μm) indicates to thin walled fibers although relatively it comprises 35% from fiber diameter. Such values result in obtaining high runkel ratio which means less suitability for pulp production.

Vessel did not follow the same behavior of fibers. Generally, vessel diameters were smaller than ordinary. Laxmi and Dayal, (1985) found that vessel maximum diameter of this species is 280 μm . In relation to height position, some contrary trend to that of fibers could be observed. Highest stem level (7.5m) possessed thinner vessels by about 22 μm than lowest level. Jiang *et al.* (2003) found that variation in all Poplar vessel dimensions showed no significant relationship with tree height.

Specific gravity showed no significant differences among height levels. Mean value was more than normal densities of Albizias. Narrow lumen with relatively thick wall with no

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doubt leads to have more dense wood. Laxmi and Dayal (1985) found that specific gravity of this species in India was 580 and vessel maximum diameter was 280µm. Slow rate of growth resulting from the effect of climatic conditions might be the reason in wood densification. Morales (1987) demonstrated that specific gravity of the wood showed considerable differences between species within each region and between two regions. Also, he confirmed that trees from the drier region showed a higher average density. Once again, the trend of height position effect on specific gravity is not fixed. Results of Espinoza (2004) showed that no correlation was found between specific gravity and height, while the higher value was noticed by Pande and Singh, 2005 at breast height, thereafter it decline and again increased up. Kamala *et al.* (2000) indicated that average specific gravity increases with height.

Table 2: Fiber dimension of *A. lebbeck* wood as affected by height and radial position.

Height (m)	Fiber Length (mm)		Fiber Width (µm)		Wall Thickness(µm)	
	Heart W.	Sap W.	Heart W.	Sap W.	Heart W.	Sap W.
0.5	0.8665 (b)	0.8410 (b)	10.09 (ab)	9.19 (b)	3.51 (abc)	3.17 (bc)
2.0	0.8240 (b)	0.8510 (b)	9.31 (b)	8.91 (b)	3.12 (bc)	2.88 (c)
3.5	0.8388 (b)	0.9128 (b)	9.13 (b)	9.91 (ab)	3.17 (ab)	3.50 (abc)
5.0	0.8970 (b)	0.9113 (b)	9.70 (ab)	10.46 (a)	3.21 (ab)	4.02 (a)
7.5	1.0650 (a)	0.9230(b)	10.52 (a)	10.36 (ab)	3.88 (ab)	3.82 (ab)
Mean	0.8983	0.8878	9.75	9.77	3.38	3.48

Note: Values having same letter are not statistically different at $p \leq 0.05$.

Difference in mean values of fiber length, fiber width, and wall thickness between heartwood and sapwood were not substantial, mostly not significant. Only heartwood of the uppermost level showed significant increase upon others in regards to fiber length (Tab. 2). The same level showed highest width of fiber and wall thickness but still not far from other means. General trend of relation between these traits and transvers position indicated that these dimensions increase as the distance increases from pith (Zha *et al.*, 2005; Choudhury, *et al.* 2009; Ohshima *et al.*, 2003), while others referred that variations were non-significant except for fiber-diameter (Pande *et al.* (2008) tree of *Leucanealeucocephala*), but Ishiguri, 2009 found that diameter of wood fibers was an almost constant value from pith to bark for the species *Paraserianthes falcataria*.

Radially, vessel diameter showed similar response to that of fiber diameter. Almost comparable mean values were obtained (Tab. 3). Sapwood of highest stem position revealed a maximum diameter. Literatures indicated that trends vary from pith to periphery depending upon the species and anatomical features. Jiang *et al.* (2003) reported in their study on I-214 poplar that vessel tangential diameter showed rapid and then gentle increase from pith to outwards.

Significant effect has observed on specific gravity. Heart wood showed higher specific gravity by about 9% than that of sap wood. The result can be interpretive by the deposition of extractives in such case where little or no horizontal variations in cell diameter and cell wall thicknesses. Heartwood was easily differentiated through its dark color from pale sapwood. The difference between heartwood and sapwood was at maximum in the lowermost level where the stem diameter and horizontal distance between samples were the longest. In *Gmelina arborea*, Espinoza, (2004) found a contrary result when he found that specific gravity increased from pith to bark.

Table 3: Dimension of vessel elements and specific gravity as affected by height and transverse position.

Height (m)	Vessel Diameter (μm)		Specific Gravity	
	Heart Wood	Sap Wood	Heart Wood	Sap Wood
0.5	140.75 (b)	159.50 (ab)	764.0 (a)	662.3 (c)
2.0	172.25 (ab)	156.00 (ab)	725.3 (abc)	666.0 (c)
3.5	166.00 (ab)	132.50 (b)	752.5 (ab)	688.5 (bc)
5.0	163.50 (ab)	166.75 (ab)	727.0 (abc)	695.5 (abc)
7.5	173.50 (ab)	187.25 (a)	745.5 (ab)	676.8 (c)
Mean	163.20	160.40	742.9	677.8

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**تباينات عناصر الخشب في ساق اشجار اللبخ *Albizia lebbeck* (L.)
النامية تحت ظروف مدينة بغداد**

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الخلاصة

نظرا لكون النوع *Albizia lebbeck* من الانواع المهمة في العراق والمنطقة فقد اخضع الى البحث من خلال فحص التغيرات الحاصلة في عناصر الخشب ووزنه النوعي والناجمة عن نموه تحت الظروف الطبيعية لمنطقة بغداد.

تم فحص التباينات في طول اللبف وقطره وسماكة الجدار، وعلى قطر الوعاء والوزن النوعي للخشب. بينت النتائج ان أطوال الالياف لاشجار البحث كانت ضمن المديات الطبيعية في حين كانت أقطارها ضيقة ودون المدى الاعتيادي للاخشاب الصلدة. كانت هناك زيادة طفيفة في طول اللبف وقطره وفي سماكة الجدار مع زيادة الارتفاع في الساق في حين ان قطر الوعاء قد قل لنفس السبب. لم يظهر تأثير معنوي للارتفاع على الوزن النوعي للخشب.

أما الاختلاف القطري فقد ظهر انه مرتبط بعامل الارتفاع. ففي الوقت الذي كانت فيه اطوال الالياف في أقصاها للخشب القلبي عند أعلى الساق، كان القطر الاكبر لالياف الخشب القلبي ايضا ولكن عند أسفل الساق. وقد جاء الاختلاف الاكبر في صفة الوزن النوعي حيث تفوق الخشب القلبي كثيرا على نظيره العصاري.