Wood Anatomical Features of *Juglans regia* L. from Temperate Climate of Kashmir Himalaya

Bilal Ahmad Wani *[1] and Amina Khan[2]

[1]Centre of Research for Development, University of Kashmir, Srinagar-190006, J & K, India
[2] Nasheman Bagat, Barzulla, Srinagar-190001, J & K, India
***Corresponding author: woodscience.2005@gmail.com**

Abstract
Walnut wood an important natural resource is used in high class and decorative joinery for furniture and tableware, and also in decorative construction work such as in Mosques, houses, *Khanqaas*, Shrines and other public and private buildings, to which it is eminently suitable due to its strength and durability at the same time relatively little is known about anatomical characteristics of its wood. For this purpose sections were cut in three different planes and also maceration was done in order to know about wood anatomical features viz. fiber length, fiber diameter, fiber wall thickness, vessel element length and vessel element diameter, growth ring.
Keywords: *Juglans regia*, walnut, fiber, wood, anatomy.

Introduction

Walnuts are large, monoecious trees with wide, dense crowns that can reach heights of 15–35 m. Older trees may have trunk diameters upwards of 1.5–2.5 m (Shalit, 1951). Young trees have slightly furrowed, light-grey bark, while older trees have bark that is darker-grey and strongly furrowed. The leaves are alternate, 19–54 cm long and 15–40 cm wide, imparipinnate with 3–5 pairs of leaflets. The leaflets are typically dark-green, ovate, coriaceous and glabrous, with entire margins. The male flowers are arranged in catkins, with each flower comprising 8–40 stamens. The female flowers occur in groups of 1–3 on the ends of young branches. The fruit is drupe-like and spherical, with a green, dehiscent pericarp (husk), which releases the nut when mature. Theendocarp, or "shell", is light brown and hard. The kernel is covered with a thin, yellow to brown papery layer (pellicle). Western Himalayan especially valley of Kashmir produces high quality walnuts. The Jammu and Kashmir State alone accounts for >98% of India's total production with an average productivity of 2.69 metric tonnes/ha from an area of 83613.80 ha and production of 224595.85 metric tonnes (Sharma, 2012). India export around 5000 metric tonnes walnut kernel of worth US $ 260-300 million annually to France, Germany, Spain, Portugal, Austria, United Kingdom, Kuwait, Bahrain, Dubai and Saudi Arabia. Besides, domestic market of worth of US $ 140-200 million for kernel and in shelled walnuts is also fulfilled by the state (Per. Com. with J and K Walnut Exporters Association in 2012). Also the wood of walnut is hard and strong, stable, lightweight, shock-resistant, flexible. It shrinks and swells less than almost any other wood. It's sweet to work, lovely to smell, delightful to handle, and takes a splendid finish.' (McIntosh, 1995) The wood is mostly used in high class and decorative joinery for furniture and tableware and also for Mosques, Shrines, *Khanqaas*, and other public and private buildings. Wood anatomy an important branch of wood science; which is suitable for predicting the varied utility of woods for different purposes, the present work is an attempt to elucidate wood anatomical patterns in *Juglans*, from temperate climate of Kashmir Himalaya.

Material and Methods

Source of Material: The present study was carried out on hardwood trees of *Juglans regia* L. with deciduous type of habit, belonging to the family *Juglandaceae* from natural provenances of Kashmir Himalaya for their anatomical characteristics.

Samples of approximately 1 cu cm in size were taken at breast height (1.3 m) and were softened by boiling in water for 10-15 minutes. Cross, radial and tangential sections of 15–20 µm thick were prepared by using Reichert microtome, as well as sharp razor for studying various wood anatomical microscopial features. These features were identified as per International Association of Wood Anatomists (IAWA) list of microscopic features for hardwood identification (Wheeler *et al.,* 1989).

Maceration: Maceration was done as per Jeffery's method (Johansen, 1940) for all the sample studies. In this method, small slivers of wood were taken from the samples collected and put into the test tube and then filled with 10% chromium trioxide and 10% nitric acid and left for one to several days at room temperature and the process was hastened by heating up to approximately 60^0C for few minutes. After that, the material was thoroughly washed with distilled water till traces of the acid were removed. The mixture was teased/shaken thoroughly to separate the wood elements and stained with 1% Safranin and mounted in glycerine on microscopic slides.

Staining Procedure for Sections: Twenty micron thick; transverse, radial and tangential sections were stained in Heidenhains haematoxylin and safranin for 20 minutes. The stained sections were washed in acetone and xylene of 1:1 ratio for 10 minutes to ensure complete dehydration and subsequently in Xylene. Finally they were mounted in Diphenyl Pthalate Xylene (DPX) mountant to make the permanent slides.

Photomicrography: Photomicrography involves combination of the principles of microscopy and photography; is a technique of recording microscopic image. By this method, the object was focussed under microscope and the photographs were taken with the help of Olympus Clinical CH20I microscope model CH20 BIMF 200; on the top of which Olympus camera was fitted with photomicrographic attachements.

Wood Element Measurements: The measurements/dimensions of different wood elements viz., vessel elements and rays were made from macerated and transverse section materials, with the help of ocular-stage micrometry. Twenty-five measurements were made from unbroken fibers and vessel elements for lumen diameter, wall thickness, length and width.

Colour: The colour feature was determined when logs were cut across, showing two distinct regions of sapwood and heartwood (Chowdhury and Ghosh, 1958) and (Rao and Junjea, 1971).

Some timbers when cut on the surface have some characteristic smell or odour due to resins, oils or chemical deposits. It may be asset or a liability in its utilization for a given purpose. This feature was determined by exposing fresh wood sample or by adding moisture through breathing already cut wood sample (Wheeler *et al.,* 1989).

Results and Discussion

Juglans regia Linn.

Sapwood greyish-white, broad; heartwood greyish-brown with few or no markings or with darker streaks; the wood varies considerably in intensity of colour and in markings, and beautifully mottled stock can be obtained by selection; rather lustrous, working to smooth surface under tools, without odour or taste, straight grained, medium- and quite even textured.

Wood diffuses porous with medium to large pores. Growth rings distinct, delineated by 1-3 layers of flattened fiber tracheids and one layer of wood parenchyma, narrow to little, 0.3-2.3 mm. Pores few arranged in radial direction, 5-8/mm sq, medium to large, gradually decreasing in size towards the end of the growth rings, tending to be semi-ring porous mostly solitary or in small radial multiples of 2-4. Solitary pores oval or round in outline 50-250 x 50-299 µm, thin walled, 2.5 µm. Vessel element 170-900 µm long; perforation plates exclusively simple; intervessel pits dense, compact and alternate, a little large polygonal in outline, 5-12.5 µm in diameter, with slit like apertures. Helical thickenings not observed. Tyloses abundantly present. Nonperforated tracheal elements

fiber tracheids, consisting ground mass of the wood, square, polygonal or oval in cross section, 10-40 µm in diameter, a little thick walled, 2.5 µm; bordered pits round, 5 µm in diameter. Wood parenchyma apotracheal, diffuse aggregate in narrow discontinuous bands, similar to fiber tracheids in cross section, thin walled, 1.2 µm, crystals not found. Rays homogenous, uniseriate and multiseriate. Uniseriate rays low, 2-11 cells or 50-350 µm tall. Multiseriate rays wide and rather low, 2-7 cells or 20- 81 µm wide, and 210-900 um tall with uniseriate wings of 1-11 cells tall. Procumbent cells small oval or vertically elliptical in tangential section, 15-28, 10-20 x 55 -120 µm. Ray vessel pits dense, alternate, oval a little large, 5-12 µm in diameter (Figure 1, 2, 3 & 4).

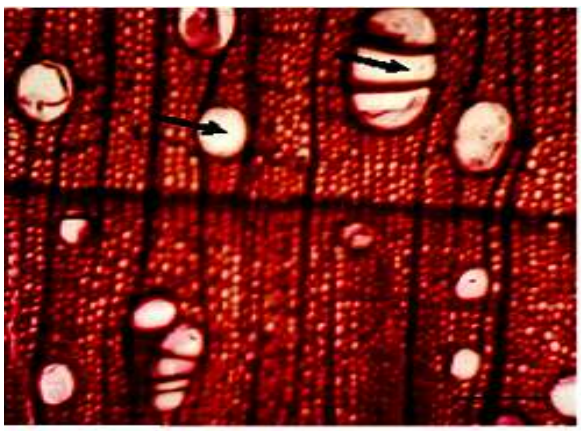

Figure 1

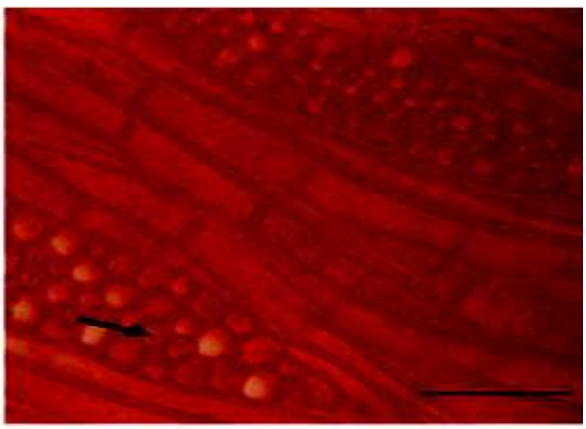

Figure 2

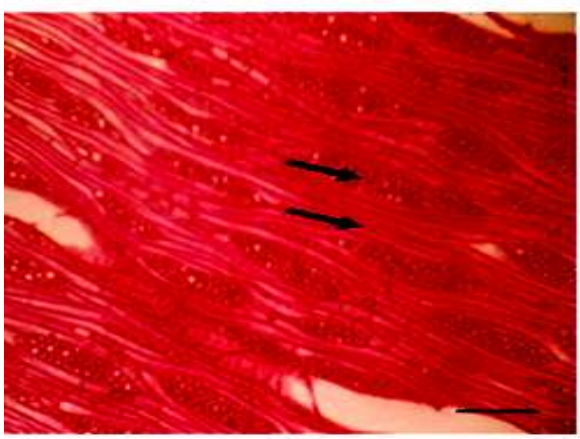

Figure 3

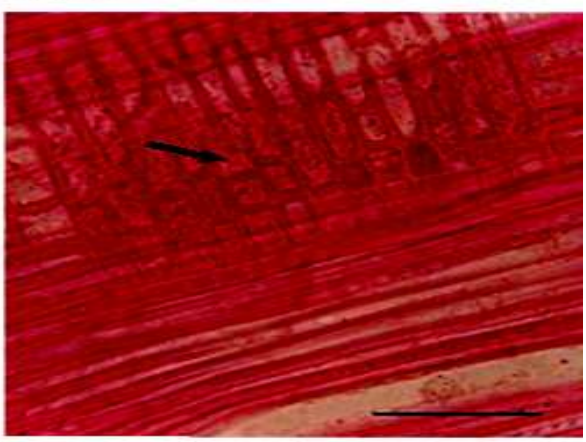

Figure 4

Figure 1: Transverse section showing pores mostly solitary or in radial multiples of 2-4; oval or round in shape; **Figure 2 and 3.** Transverse longitudinal section showing broad multiseriate rays, intermingled with fibers; **Figure 4.** Radial longitudinal section showing homogeneous rays (Scale bar Figure 1 and 3 = 50 µm, Figure 2 and 4 = 40 µm).

Wood anatomical structure of *Juglans regia* linn. growing in the Kashmir Valley was investigated. According to the records in the literature, there have not been any studies on the wood anatomy of walnuts in Kashmir except few studies by Wani and Khan (2008, 2010 and 2013). Further these studies were mainly oriented towards the wood variability and cambial activity in *Juglans regia*. The most detailed information on wood anatomy of *Juglans regia* is given by Metcalfe and Chalk (1965) in *Anatomy of Dicotyledons.* Also Safdari *et al.* (2008) provided hand lens wood anatomy of walnut with schematic and anatomical illustrations. In the present study, the Sapwood of *Juglans regia* was found greyish-white broad and heart wood greyish brown with few or no markings

or with darker streaks .Same was reported by Timar *et al*.(2010) The sap wood of a new wood provides a pipeline for the movement of water and nutrients through the trunk and into the leaves (Medhurst and Beadle, 2002). The heartwood was found uniformly light red at first and afterwards turns light reddish brown with passage of time and having irregular contour in the transverse section. Also in the present study, wood of *Juglans regia* was found to be diffuse porous with distinct growth rings. Vessels were few mostly in short to long radial multiples of 2-4. Vessel elements were found to be long with simple perforations and with alternate intervessel pits. Libriform fibres were thin walled ,long with simple pits mainly restricted to radial walls . Axial parenchyma was narrow and with discontinous bands. Rays uniseriate as well as multiseriate. The similar results were obtained by Metcalfe, (1939); Miller,(1976); Blokhina, (2007); Safdari, *et a*l (2008) and Timar *et al* (2010, 2013)

Conclusions

Wood anatomical studies of the *Juglans regia* Linn**.** a versatile natural resource of Kashmir Himalaya which is chiefly used in high class and decorative joinery for furniture and tableware, have been carried out . The dimensions of cellular structures viz., vessels, fibers, rays, and parenchyma present in the *Juglans regia*, which have direct bearing on the properties of wood, have been discussed.

References

Blokhina, N. I. 2007. Fossil wood of the juglandaceae: some questions of taxonomy, evolution, and phylogeny in the family based on wood anatomy. ***Paleontological Journal***. **41(11):** 1040–1053

Chowdhury, K .A. and Ghosh, S. S. 1958. ***Indian Woods, their Identification, Properties and Uses*** (Vol. I). Manager Publications, New Delhi. pp. 304.

Johansen, D. A. 1940. ***Plant Microtechnique***. McGraw-Hill Book Iompany, Inc., New York.

McIntosh, M. 1995. ***Shotguns and Shooting***, Country Sport Press, Selma, Alabama.

Medhurst, J. L. and Beadle, C. L .2002. Sapwood hydraulic conductivity and leaf area-sapwood area relationships following thinning of a *Eucalyptus nitens* plantation. ***Plant, Cell and Environment.*** **25(8):** 1011–1019.

Metcalfe, C. R. and Chalk, L. 1965. ***Anatomy of the Dicotyledons*** (Vol. 2). Oxford, Clarendon Press.

Miller, R. B. 1976. Wood anatomy and identification of species of Juglans**.** ***Bot. Gaz.*** **137(4):** 368-37.

Rao, K. R. and Juneja, K. B. S. 1971. ***Field Identification of Fifty Important Timbers of India***, FRI. New Forest, Dehradun.

Safdari, V., Moinuddin, A., Jonathan, P. and Mirza, B. B. 2008. Identification of Iranian commercial wood with hand lens. ***Pak. J. Bot.*** **40(5):** 1851-1864.

Shalit, M. S. 1951. ***Wild Useful Plants of Turkmen***, Turkmen Botany-Plant Industry, Institute of the Academy of Science of USSR. Moskovskoe Obshestvo Ispitateley Prirodi. Moscow.

Sharma, R. 2012. ***Area and Production Database of Fruit Crops.*** Directorate of Hortic State Department of Horticulture, Government of J & K, India.

Timar, M. C., Gurau, L., Cionca, M. and Porojan, M. 2010. Wood species for the biedermeier furniture- A microscopic characterisation for conservation. ***International Journal of Conservation Science***. **1(1):** 3-12.

Timar, M. C., Gurau, L., Cionca, M., Porojan, M. and Emanuela, B. 2013. Microscopic identification of wood species an important step in furniture conservation. ***European Journal of Science and Theology***. **9(4):** 243-252.

Wani, B. A. and Khan, A. 2008. Ratio of fusiform and Ray initials in *Juglans regia* L. from Temperate climate of Kashmir Himalaya. ***Indian J. Applied and Pure Bio*****. 23(1):** 63-66.

Wani, B. A. and Khan, A. 2010. Effect of cement dust pollution on the vascular cambium of *Juglans regia* L. ***Journal of Ecology and the Natural Environment***. **2(10):** 225-229.

Wani, B. A. and Khan, A. 2013. Wood fiber variability in stems of *Juglans regia* L. from temperate climate of Kashmir Himalaya. ***Journal of Indian Academy of Wood Science***. **10(2):** 95-102.

Wheeler, E. A., Bass, P. and Gasson, P. E. 1989. IAWA List of microscopic features of hardwood identification: with an appendix on non-anatomical information. ***IAWA Bull. N. S.*** **10:** 219-332.