WOOD ANATOMY AND TECHNOLOGICAL PROPERTIES OF SOME TREE SPECIES GROWN IN BALOCHISTAN

Ghulam Mustafa Nasir[1]

ABSTRACT

Wood structure of eight tree species grown in Balochistan was studied and basic anatomical data were compiled to evaluate their technological properties supportive to improve the quality of wood before utilization. Permanent slides of cross, radial and tangential sections of each wood species were prepared and observed under the microscope for various structural features. Results revealed that Babul and Phulai wood may be strong and hard and Jand, Mulberry, Ghaz, Ash and Ber wood may be better in strength and moderately hard due to longer, thick-walled or narrow lumened fibers. The Apple wood may be medium in strength and comparatively soft because of thin-walled and wide lumened fibers. The wood of all the studied species may be non-durable due to higher frequency or larger size of wood rays and need preservative treatment to increase the service life. The process of wood seasoning and preservation may be slow because of small to medium diameter of vessels however Mulberry and Ash wood could behave better due to larger diameter of earlywood vessels. Further, on the basis of fiber morphological characteristics, the wood of all the studied species may also be suitable for pulp and paper manufacture.

INTRODUCTION

Extensive utilization of valuable timber resource in the country is increasing tremendous pressure on the commercial wood species and these are becoming scarce. It is therefore, important to test and evaluate properties of the other successfully growing, commercially less important wood species so that these can also be used as substitute of the commercial species for manufacturing of various products.

Jand (*Prosopis cineraria*) is an almost evergreen large shrub or small sized tree, grows up to 12m tall. The tree is native to Pakistan, India, Afghanistan and some parts of the Middle East. In Pakistan, it is found in the dry plains and hills of Sindh, Punjab, Khyber Pakhtonkhwa and Balochistan. Babul (*Acacia nilotica*) is an evergreen moderate sized tree 20m tall and up to 1m in diameter. The tree is native to Pakistan and found in Sindh, Punjab, Balochistan and Khyber Pakhtonkhwa. It is wild and extensively cultivated throughout the world. Phulai (*Acacia modesta*) is also a moderate sized tree 3 to 9m tall and diameter up to 2m has been recorded. It is native to Pakistan, Afghanistan and India. In Pakistan it is found below 1200m in the foothill ranges of the Himalayas, Salt Range, Sulaiman Hills, Balochistan and Kirthar Range. It is also found in plains close to these mountains. Ghaz (*Tamarix aphylla*) is an erect medium to large sized evergreen tree. It reaches up to a height of 10 to 18m with a diameter of 1m. The tree is native to Middle East including Pakistan, Central Asia, North Africa and Arabia. In Pakistan it is common to the plains of the Punjab, Sindh, Balochistan and Khyber Pakhtonkhwa. It is extensively planted in the sand dunes area of the Thal desert. Mulberry (*Morus alba*) is a medium sized deciduous tree grows up to 9 to 15m tall and a diameter of 0.6 to 0.8m. The tree is native to Pakistan, China, Central Asia and Afghanistan. It has been planted in many parts of the world. Ber (*Zizyphus mauritiana*) is a deciduous or evergreen shrub or small tree, 12m tall with a diameter of 40cm. The tree is native to south Asia including Pakistan. It has been successfully planted in many parts of the World. It grows best at lower elevations in the Punjab, Khyber Pakhtonkhwa, Sindh and Balochistan (Sheikh, 1993).

[1] Logging Officer, Pakistan Forest Institute, Peshawar

Ash (*Fraxinus excelsior*) is a large to very large tree, attaining a girth up to 3m and a bole length of 27m. It is found natural in the forest areas and cultivated on private lands in the North-western hilly regions of Pakistan up to 1,825m elevation (Siddiqui *et al*., 1996). Apple (*Pyrus malus*) is a small and deciduous tree, reaching up to 3 to 12 meters tall. The tree is originated in Western Asia where it is wild ancestor. It is one of the most widely cultivated tree fruits (wikipedia.org). In Pakistan, it is cultivated in the hills especially in Balochistan, Swat, the Murree hills and Kashmir (Stewart, 1972).

The objective of this study was to evaluate technological properties like strength, durability, seasoning and preservation behaviour etc. of the above wood species grown in Balochistan on the basis of their wood structure (Nasir, 2010) and to find out, how the quality of wood of these species can be improved before their utilization and ultimately of the products manufactured from these wood species.

MATERIAL AND METHODS

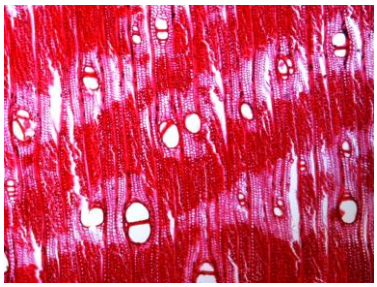
The wood material of Jand, Babul, Phulai, Ghaz, Mulberry, Ash, Ber and Apple was collected in log form from Balochistan. To study the anatomical properties, a disc of about 6 cm in thickness was removed from the end face of butt log of each species. Then the sample blocks were removed from each disc and prepared for sectioning by softening. Permanent slides of cross, radial and tangential sections of each wood species were prepared by standard laboratory techniques (Anon.1970) and observed under the microscope for various structural features. A small portion of wood of each species was macerated in 20% Nitric acid and Potassium Chlorate (Wallis, 1965) to separate the fibers and observe the fiber length. Data were collected for the following microscopic features in each species.

- Number of vessels per unit area
- Diameter of vessels
- Number of wood rays per unit area in tangential section
- Number of wood rays per unit distance in cross section
- Height of wood rays in cells and microns
- Width of wood rays in cells and microns
- Fiber length
- Fiber diameter
- Fiber wall thickness

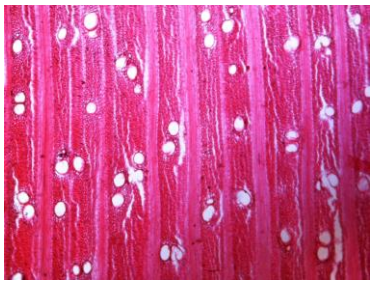
The data collected was analyzed for statistical variables such as average values, standard deviation and co-efficient of variation of each anatomical feature in each species.

To determine suitability of the studied wood species for pulp and paper manufacture, Runkel ratio (2 x fiber wall thickness/ lumen width) was also calculated for each species (James, 1980).

Photomicrographs of the cross sections of wood of all the studied species were prepared to show the wood structure (Fig.1).

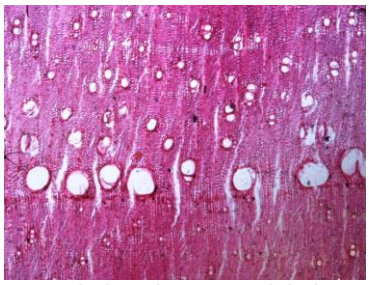


Jand (*Prosopis cineraria*)

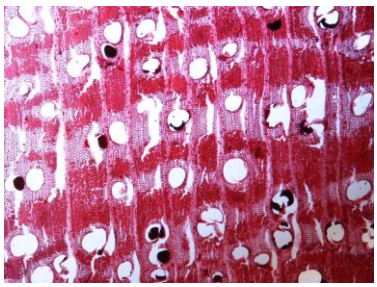


Ghaz (*Tamarix aphylla*)

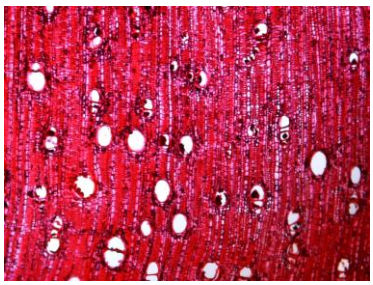
Babul (*Acacia nilotica*)



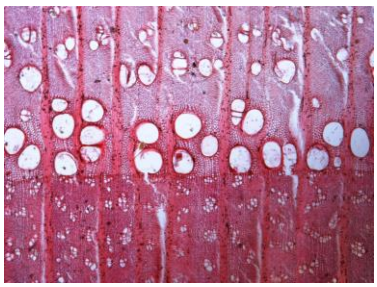
Ash (*Faxinus excelsior*)



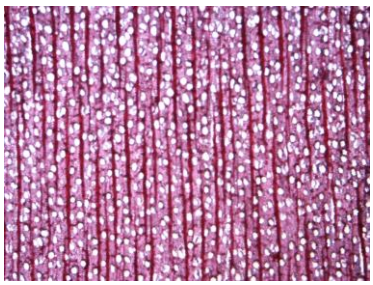
Phulai (*Acacia modesta*)



Ber (*Zizyphus mauritiana*)



Mulberry (*Morus alba*)



Apple (*Pyrus malus*)

Fig.1. Photomicrographs showing the wood structure of some tree species grown in Balochistan

RESULTS AND DISCUSSION

Results shown in Table 1 revealed that in Jand (*Prosopis cineraria*) wood, the fibers are longer, larger in diameter, thick-walled and wide lumened. The wood may be better in strength and moderately hard. The wood rays are higher in frequency and somewhat larger in size and the wood may be moderately non-durable. The vessels are lower in frequency and small to medium in diameter for the reason chemical treatment of the wood may be slow. Similarly seasoning process of the wood may also be slow.

In Babul (*Acacia nilotica*) wood, the fibers are comparatively longer, smaller in diameter, thick-walled and narrow lumened and the wood may be strong and hard. The wood rays are a bit higher in frequency and larger in size because of that the wood may be moderately non-durable. The vessels are medium in frequency and smaller in diameter and preservative treatment of the wood may be a bit difficult. Likewise, seasoning process of the wood may also be not easy.

In Phulai (*Acacia modesta*) wood, the fibers are longer, smaller in diameter, thick-walled and narrow lumened and the wood may be strong and hard. The wood rays are somewhat higher in frequency and larger in size for the reason the wood may be moderately non-durable. The vessels are medium in frequency and small to medium in diameter due to that seasoning and preservation process of the wood may be slow.

In Mulberry (*Morus alba*) wood, the fibers are medium in length, very small in diameter, medium in wall thickness and narrow lumened. The wood may be better in strength and moderately hard. The wood rays are medium in frequency but larger in size and the wood may be non-durable. The vessels are of two sorts. The earywood vessels are lower in frequency and medium in diameter whereas, the latewood vessels are higher in frequency but smaller in diameter. The wood could behave better during seasoning and preservation due to reasonable size of earlywood vessels and higher frequency of the latewood vessels.

In Ghaz (*Tamarix aphylla*) wood, the fibers are medium in length, larger in diameter, thick-walled and wide lumened. The wood may be better in strength and moderately hard. The wood rays are lower in frequency but much larger in size because of that the wood may be highly non durable. The vessels are lower in frequency and small to medium in diameter and the process of preservation may be slow. In the same way, drying process of the wood may also be slow.

In Ash (*Fraxinus excelsior*) wood, the fibers are reasonably longer, larger in diameter, thick-walled and wide lumened. The wood may be better in strength and somewhat hard. The wood rays are smaller in size but much higher in frequency for the reason the wood may be non-durable. The vessels are of two sorts. The earlywood vessels are lower in frequency but larger in diameter and the latewood vessels are higher in frequency but very small in diameter. The wood could behave better during seasoning and preservation due to larger diameter of earlywood vessels.

In Ber (*Zizyphus mauritiana*) wood, the fibers are longer, smaller in diameter, thin-walled but narrow lumened. The wood may be better in strength and moderately

hard. The wood rays are much higher in frequency and larger in height because of that the wood may be non-durable. The vessels are medium in frequency and smaller in diameter. Therefore, chemical treatment and drying process of the wood may be slow.

Table 1. Frequency and dimensional measurements of different wood elements/ structures in some wood species grown in Balochistan
(Average values)

Anatomical features	Jand (*Prosopis cineraria*)	Babul (*Acacia nilotica)*	Phulai (*Acacia modesta)*	Mulberry (*Morus alba)*	Ghaz (*Tamarix aphylla)*	Ash *Fraxinus excelsior)*	Ber *Zizypphus mauritiana*)	Apple (*Pyrus malus)*
Fiber length (mm)	1.05	1.27	1.00	0.968	0.939	1.04	1.07	1.00
Fiber diameter (u)	19.02	14.72	14.93	14.02	19.38	19.53	14.02	15.86
Fiber wall thickness (u)	4.25	3.13	3.16	2.70	4.13	3.41	2.53	2.57
Fiber lumen width (u)	10.52	8.46	8.61	8.62	11.12	12.71	8.96	10.72
Number of Vessels (/mm²)	4.60	11.08	8.21	*E.W 10.72 **L.W 79	6.04	*E.W 2.06 ** L.W 16	10.02	128.93
Vessel diameter (u)	146.95	116.20	144.04	E.W 159 L.W 33.53	130.07	E.W 203 L.W 55.71	125.90	47.04
Number of rays in (/mm²) Tangential section	30.34	14.57	21.18	10.04	12.31	85.83	40.85	63.78
Number of rays in (/mm) cross section	6.53	4.63	4.37	3.51	2.82	7.71	14.99	13.25
Height of ray (microns)	330.57	384.99	295.46	417.10	932.10	123.77	469.28	176.54
(cells)	19.72	20.68	18.11	29.65	38.90	6.5	9.48	11.8
Width of ray (microns)	31.49	70.03	42.38	64.69	106.21	34.83	28.20	29.45
(cells)	2.43	3.56	3.06	5.66	9.75	2.36	1.2	2.44

*E.W Earlywood **L.W Latewood

In Apple (*Pyrus malus*) wood, the fibers are reasonably longer, medium in diameter, thin-walled and wide lumened. The wood may be medium in strength and relatively soft. The wood rays are medium in size and very high in frequency because of that the wood may be highly non-durable. The vessels are very small in diameter due to that preservative treatment of the wood may be difficult however their frequency is higher which may ease the process. Equally drying process of the wood may also be slow.

Suitability for Pulp and Paper

As shown in Table 2, all the studied species have the value of Runkel ratio below 1. Hence, on the basis of fiber morphological characteristics, the wood of all these species may also be suitable for pulp and paper manufacture.

Table 2. Runkel ratio of some wood species grown in Balochistan

S.No	Wood species	Runkel ratio (2 x fiber wall thickness/ Lumen width)
1.	Jand (*Prosopis cineraria*)	0.807
2.	Babul (*Acacia nilotica*)	0.739
3.	Phulai (*Acacia modesta*)	0.734
4.	Mulberry (*Morus alba*)	0.626
5.	Ghaz (*Tamarix aphylla*)	0.742
6.	Ash (*Faxinus excelsior*)	0.536
7.	Ber (*Zizuphus mauritiana*)	0.564
8.	Apple (*Pyrus malus*)	0.479

CONCLUSIONS

- Babul, Phulai, Jand, Mulberry, Ghaz, Ash and Ber wood may be stronger or better in strength and can be used for manufacturing of various products whereas Apple wood may be medium in strength and suitable for light wooden articles.

- The wood of Babul and Phulai may be hard and somewhat difficult whereas that of Jand, Ghaz, Ash, Mulberry and Ber, moderately hard and not difficult or easy to saw and work. The Apple wood may be relatively soft and easy to process.

- In order to increase the service life, chemical treatment of wood before utilization may be required for all the species that may be slow however, Mulberry and Ash could behave better during the process. Seasoning behavior of the woods may also be the same as preservation.

- On the basis of fiber morphology, the wood of all the species may also be used as raw material for pulp and paper manufacture.

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