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Research Article

Exploration and comparison of the untapped utilization potential of white ash (*Fraxinus excelsior*)

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Locally grown white ash (*Fraxinus excelsior*) wood had been tested for its physico-mechanical properties in accordance with International Standard Organization (ISO). The results of physico-mechanical properties were then compared to the indigenous Shisham (*Dalbergia sisso*), White Bakain (*Alianthus altissima*), Mulberry (*Morus alba*) and Poplar (*Populus* spp.). It was found to have comparable properties to aforesaid commercial timbers and its utilization suitability had been recommended on the bases of its properties.

Key words: White ash, timber, physico-mechanical properties

INTRODUCTION

The area of forest/tree cover extends over an area of 4.55 million ha, that makes 5.1% of the total land country (Bukhari SSB, 2012). Besides having a small forest cover, Pakistan is also faced with a problem of having a small number of commercial timber proportions. Moreover, the demand of these commercial timbers is increasing day by day due to heavy consumption (Brockman, 2001). To solve this problem it is necessary to pay attention to other locally grown timbers those are yet not being utilized commercially due to lack of information despite the fact that these are being grown successfully in Pakistan.

This current piece of research has been conducted in view of the of the green economy concept to both capture the true value of woods as well as efficient, wise and economic utilization of timbers (Geneva Timber and Forest Study Paper, 2013).

In Pakistan no significant work has been published in research journal/s regarding different physico-mechanical properties of white ash for determining its suitability as a timber. In this study an effort has been made to test the wood specimen in accordance with methods of testing described in international organization for standards and subsequent publication of its results.

Fraxinus excelsior (white ash), one of the five species of Fraxinus occurring in Indian flora, is a large to very large tree in Hazara district of North-West Frontier Province and in western Himalayas, has a maximum girth up to 10 ft. The name White Ash is derived from the glaucous present underside of the leaves. *Fraxinus excelsior* is a flowering plant species in the olive family Oleaceae. Its vernacular name is "Himalayan Ash". It is a large deciduous tree growing to 12 m–18 m tall. Its bark is smooth and pale grey in young trees which gradually thickens with vertical fissures in older trees. The distinguishing feature of White Ash from other Ash species is that it has jet-black buds whereas other ash species have grey or brown buds. The leaves are opposite with no stipules that distinguish it from Mountain Ash in which the leaves are alternate with paired stipules. European ash rarely exceeds 250 years of age. It also exists in America and is known as *Fraxinus americana*. It has a gray bark with diamond shaped-ridges appearing on the trunk of older trees to 80 feet tall and 3 feet in diameter. The wood is white and quite dense, strong, and straight-grained. It shows highest antibacterial activity in the context of manufacturing chopping boards.

The tree yields uniquely valuable timber and is easily recognized in winter by its hard, black buds always set in pairs except for the one at tip of the each twig. Its ash-gray bark bears shallow ridges and fissures, and its trunk up to 22 ft. round bears an open framework of branches up to 148 ft. high. In Europe it is utilized for making handles of tools which are used under strain, e.g. hammer, axe, spade and garden fork etc.

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MATERIALS AND METHODS

The research material was converted into planks of 2.5 cm thickness to be tested for physical and mechanical properties. After conversion of the logs into planks, half of the planks from each log were used for physical and mechanical properties in green condition while the remaining material was used for testing in air dry condition. The samples were prepared as by the methods and general requirements for physical and mechanical tests (International Standard Organization, ISO).

The planks to be tested in green condition were surfaced to 2 cm thickness without letting them dry. Specimens of 2 cm × 2 cm cross sectional area were sawn starting from the side of the planks up to the pith. One set of specimens of the following sizes were sawn from each plank (Table 1).

The values of the properties tested for air-dry condition were adjusted at 12% moisture content using the formulas given in ISO standards.

The tests were performed on Amsler Universal Wood Testing Machine with a total loading capacity of 4,000 Kg. An effort was made to use only defect free specimens for determination of strength properties.

RESULTS AND DISCUSSION

Physical properties

In this study white ash (*Fraxinus excelsior*) has been tested for physical and mechanical properties in green and air dry conditions. The results of the properties are discussed as below.

The shrinkage data from green to oven-dry conditions are: Tangential: 10%, radial: 5% respectively. White ash (*Fraxinus excelsior*) can be classified as moderately heavy wood (Koehler, 1924). The average air dry density of the samples was calculated as 0.657 g/cm^3 or 657 Kg/m^3 in comparison with the European ash with the density value of 710 Kg/m^3 as strength properties are correlated with density (Desch and Dinwoodie, 1983). So, European ash is expected to be superior to local (Pakistani) ash in strength properties (Table 2).

Mechanical properties

The small clear specimens of white ash were tested for mechanical properties in green and air dry conditions (Tables 3 and 4).

Table 1. Specimen sizes.

	Property	Specimen Size
1	Density	2cm × 2cm × 3cm
2	Shrinkage	2cm × 2cm × 3cm
3	Static bending	30cm × 2cm × 2cm
4	Impact Bending	30cm × 2cm × 2cm
5	Compression parallel to grain	6 cm × 2cm × 2cm
6	Tensile Strength perpendicular	7cm × 2cm × 2cm
7	Cleavage	4.5cm × 2cm × 2cm
8	Hardness	10cm × 2cm × 2cm

Table 2. Physical properties of white ash.

S.No	Property	Average value
1	Average air dry density Kg/m^3	657
2	Basic density	561
3	Green density Kg/m^3	840
4	Tangential shrinkage from green to oven-dry%	10
5	Radial Shrinkage from green to oven-dry%	5

Table 3. Strength properties of *Fraxinus excelsior* in green conditions.

S.NO	Property	Unit	Average	Standard deviation	C.V.%
1	Modulus of rupture	(kg/cm^2)	1214	38.93	2.11
2	Modulusof elasticity,	(kg/cm^2)	77407	17.44	0.022
3	Compression parallel to grain	(kg/cm^2)	245	44.68	18.23
4	Cleavage	Kg/cm	27	3.8	14.17
5	Hardness	Kg			
	Side grain		495	30.082	5.94
	End grain		506	35.45	7.1629

Table 4. Strength properties of *Fraxinus excelsior* in air-dry conditions.

S.NO	Property	Unit	Average	Standard deviation	C.V.%
1	Modulus of Rupture	(kg/cm^2)	1744	27.22	2.24
2	Modulus of elasticity	(kg/cm^2)	87320	15.55	0.017
3	Compression parallel to grain	(kg/cm^2)	541	34.6	6.39
4	Cleavage	Kg/cm	30	4.44	13.4
5	Hardness	Kg			
	Side grain		655	27.13	4.14
	End grain		811	23.45	2.89

On the bases of MOE value, wood can be classified as "ordinary group" which has the value ranging between 56000-98000 Kg/cm^2. So it is suitable for small (3 m-6 m) span structures. Compressive strength, elasticity, hardness and cleavage values are so good enough that these can be compared with some commercial species as shown in the comparison table. Keeping in view the results of various physical and mechanical properties, White ash (*Fraxinus excelsior*) is classified as medium dense wood and therefore it can easily be worked on machines or tools by hand. The wood has its cleavage value 30 kg/cm (air dry) which means it has better resistance to splitting than majority of local timbers. This means that the wood has comparatively better nail/screw holding power when used for making different articles.

Ultimate bending strength, MOR of white ash (air dry) is 1744 kg/cm^2 which show the ability of the timber to withstand against stress offering more resistance. This behavior of the wood also favors its utilization in construction, furniture, sports goods, tool handles etc. Similarly white ash has reasonably high value of resistance to indentation, side hardness (655 kg) and end hardness (811 kg). These values of hardness reveal that the timber is quite suitable for carving and to be worked on lathe machine.

Comparison

The results of different properties of local white ash (*Fraxinus excelsior*) were also compared with four commercial hardwoods; White Bakain, Shisham, Poplar and Mulberry woods. Although white ash was classified as moderately heavy wood as compared to heavy woods, Shisham and Mulberry, yet its most of the mechanical properties were comparable with the properties of these woods. However, it is heavier than Poplar and White Bakain species (Table 5).

Table 5. Comparison of physical and mechanical properties of white ash with some commercial hardwoods.

S.No	Properties	White ash	White bakain	Shisham	Mulberry	Poplar
1	Density (kg/m^3)	657	607	801	763	460
2	Modulus of Rupture, MOR (kg/cm^2)	1744	1155	1120	964	824
3	Modulus of elasticity, MOE, (kg/cm^2)	87320	90180	85790	113540	91979
4	Compression parallel to grain(kg/cm^2)	541	495	560	481	357
5	Hardness (kg)					
	Side	655	536	650	613	322
	End	811	834	800	624	402

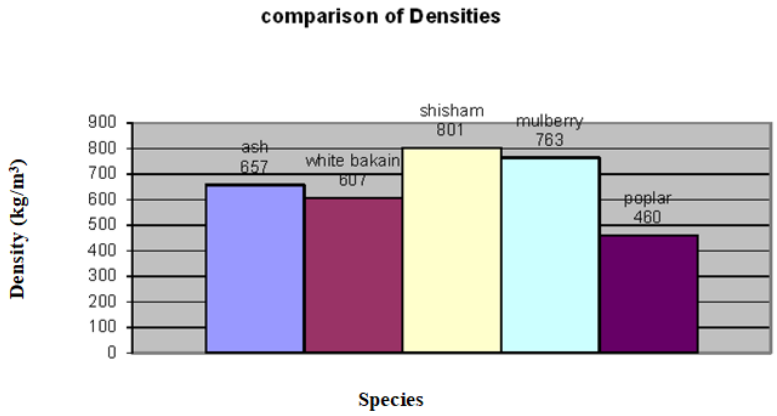

Chart 1. Comparison of densities of different commercial species with white ash. (■) ash; (■) white bakain; (■) shisham; (■) poplar

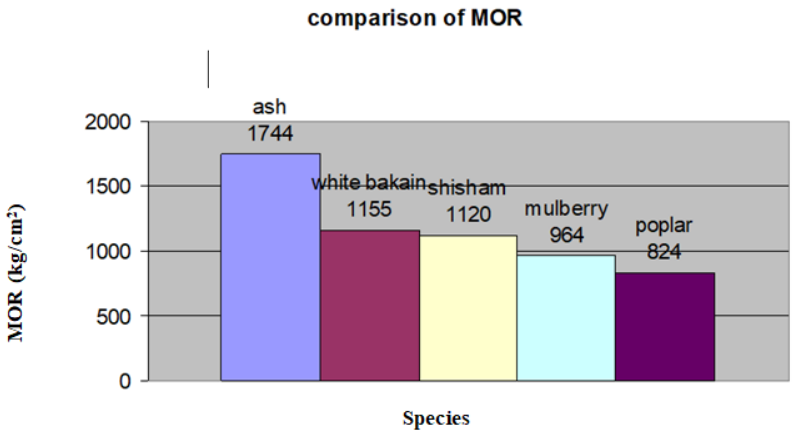

Chart 2. Comparison of modulus of rupture values and white ash. (■) ash; (■) white bakain; (□) shisham; (□) mulberry; (■) poplar

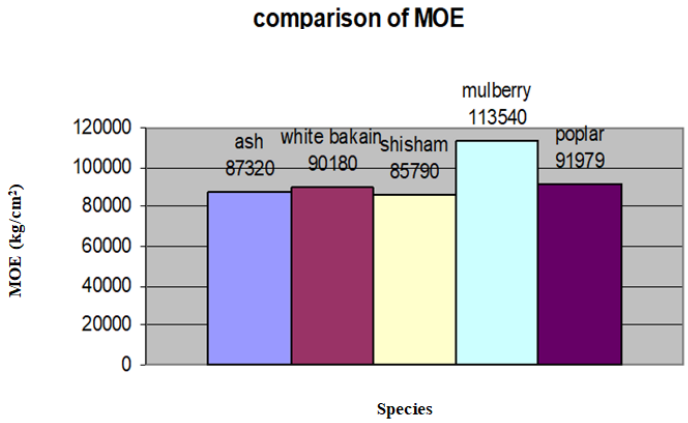

Chart 3. Comparison of modulus of elasticity values. (■) ash; (■) white bakain; (□) shisham; (□) mulberry; (■) poplar

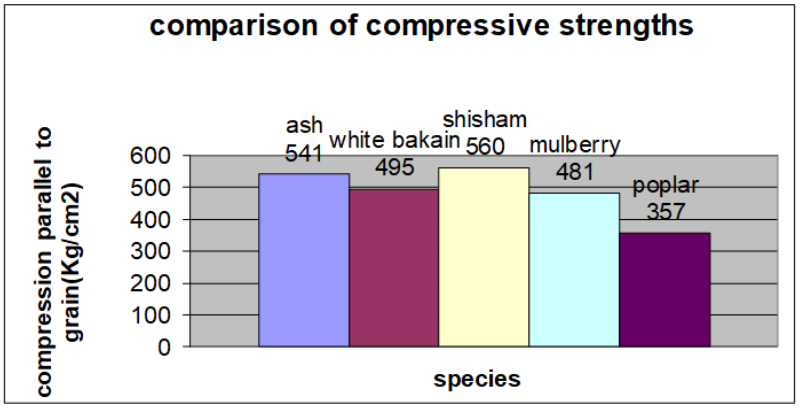

Chart 4. Comparison of compressive strengths. (■) ash; (■) white bakain; (□) shisham; (□) mulberry; (■) poplar

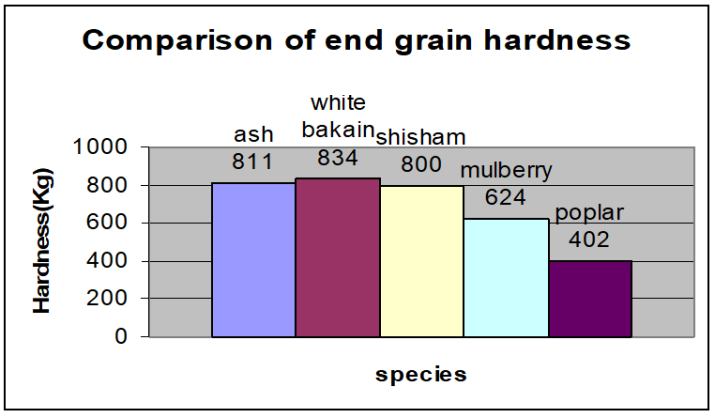

Chart 5. Comparison of hardness values. (■) ash; (■) white bakain; (■) shisham; (■) poplar

Chart 1 showed the comparison of densities of different commercial species with white ash (*Fraxinus excelsior*). It could be seen that the wood (white ash) had low density as compared to Shisham (*Dalbergia sisso*) and Mulberry (*Morus alba*).White ash (*Fraxinus excelsior*) could be classified as medium density wood.

Chart 2 showed a comparison of Modulus of Rupture values and white ash (*Fraxinus excelsior*) has the greatest value amongst all.

Chart 3 showed comparison of Modulus of Elasticity values. It could clearly be seen that white ash (*Fraxinus excelsior*) had a comparable MoE value with shisham (*Dalbergia sisso*) and white bakain (*Alianthus altissima*).

Chart 4 showed compressive strengths. Ash (*Fraxinus excelsior*) has comparable compressive strength with shisham (*Dalbergia sisso*).It is one of the properties considered for utilization in tool-handle making.

Chart 5 compared the hardness values. Ash (*Fraxinus excelsior*) had comparable value with Shisham (*Dalbergia sisso*), suggesting it to be suitable for tool handle making.

CONCLUSION

The results of physico-mechanical properties showed that locally found white ash (*Fraxinus excelsior*) is better in strength than a number of hardwoods of its density class. It had been found that ash wood had better strength in terms of modulus of

rupture, maximum compression parallel to grain, cleavage, side hardness and end hardness. So it was recommended that the White ash could be used for making class 1, class 4 and class 5 tool handles. It could also be used for making walking sticks and hockey sticks.

Class 1=All tool handles over 75 cm in length required for heavy duty striking tools, like, axes.

Class 4=Handles required for scooping tools, such as shovel and spades.

Class 5=Handles required for cutting and shaping tools, such as chisels, files.

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