# PROPERTIES AND UTILIZATION OF *AILANTHUS ALTISSIMA* (MILL.) SWINGLE GROWN IN N.W.F.P.

**Iqbal Mahmood**[1]

## Abstract

Locally grown white bakain (*Ailanthus altissima*) wood has been tested for physical and mechanical properties in accordance with International Standards Organization (ISO). The results of the properties are compared with indigenous poplar (*Populus* spp.), shisham (*Dalbergia sissoo*) and mulberry (*Morus alba*) woods and the same wood species found in United States of America. The results of this study reveal that the local white bakain is superior in strength than exotic species. It has also better strength when compared with other commercial hardwoods and is recommended for a number of uses.

## Introduction

White bakain (*Ailanthus altissima*) is also known as Asmani and tree of Heaven. It is a moderately intolerant tree that stand some shade, and is extremely aggressive. It grows well on all kind of soil including porous, dry, hard, wet, acid alkaline, rocky, swampy and marginal sides in general. It is adapted to a precipitation zone of 350 to 600 mm per year or more, in a temperature range of –10 to 40°C and is frost hardy. It prefers to semi-arid temperature sub-tropical, sub-humid, cool, sub-tropical monsoon climate from 0 up to 1700 m elevation. It appears to be disease and insect free. The tree is native to China and Japan. It has been successfully cultivated throughout the world. It has become naturalized in Pakistan and can be found almost every where from 0 to 1700m elevation (Sheikh, 1993).

In Pakistan no significant work has been carried out regarding different physico-mechanical properties of Ailanthus for determining its suitability as timber. However, the wood was tested and evaluated for its strength properties for making tool handles (Stoehr *et al*, 1990).

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. Moreover, the logs of white bakain, purchased from the local timber depot, have been converted, and air seasoned. In the light of the present study it may be inferred that Ailanthus wood has considerable utilization potential as timber species.

## Material and Methods

Three logs of White bakain, 2.0 to 2.30 m in length, were obtained from local timber market. From each log a disc of about 7cm in thickness was removed in order to determine the initial moisture content, shrinkage and density of the wood. The research material was further converted into planks of 2.5 cm thickness to be tested for physical and mechanical properties.

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**1** Wood Seasoning and Preservation Officer, Pakistan Forest Institute, Peshawar

The initial average moisture content of the logs was determined 70 percent by oven dry method (Bachrich, 1980).

After conversion of the logs into planks, half of the planks from each log was 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 per methods and general requirements for physical and mechanical tests (ISO)

The planks to be tested in green condition were surfaced to 2cm thickness without letting them dry. Specimens of 2cm×2cm 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.

| | 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 |

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

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

## Results and Discussion

In this study white bakain has been tested for physical and mechanical properties in green and air dry conditions. The results of the properties are discussed as below:

**Physical properties:** The volumetric shrinkage of *Ailanthus altissima* was quite low. The shrinkage data from green to air-dry condition were: Tangential: 2.82%, radial: 2.56% respectively. However, there is no value of shrinkage reported in the literature for comparison.

The average moisture content of the logs was determined 70 percent. White bakain can be classified as moderately heavy wood (Koehler, 1924).The average air dry density of the samples was calculated as 0.607 g/cm$^3$. The average specific gravity of the specimens came out as 0.590.

The reported value of specific gravity is 0.530 which means that local white bakain is heavier than the exotic species.

Table 1. Physical properties of *Ailanthus altissima*

| S.No | Property | Average value |
|---|---|---|
| 1 | Specific gravity | 607 |
| 2 | Basic Density | 590 |
| 3 | Moisture content % (Air dry) | 8.6 |
| 4 | Moisture content % (Green) Maximum | 70 |
| 5 | Longitudinal shrinkage<br>From Green to Air-dry %<br>From Green to oven-dry% | <br>0.22<br>0.36 |
| 6 | Radial Shrinkage<br>From Green to Air-dry %<br>From Green to oven-dry% | <br>2.82<br>4.08 |
| 7 | Tangential Shrinkage<br>1)From Green to Air-dry %<br>2)From Green to oven-dry% | <br>2.56<br>4.48 |

## Mechanical properties

The small clear specimens of white bakain were tested for mechanical properties in green and air dry conditions. The average values of the properties of the wood in both conditions are compared with the reported values of the same species found in USA (Table2).

Table 2. Comparison of properties of white bakain with reported values

| S.No | Properties | Green | | Air dry | |
|---|---|---|---|---|---|
| | | Actual | reported | Actual | Reported |
| 1 | Specific gravity | 590 | - | 607 | 530 |
| 2 | Modulus of elasticity, MOE(kg/cm$^2$) | 61463 | 64631 | 90180 | 106781 |
| 3 | Modulus of rupture (kg/cm$^2$) | 915 | 421 | 1155 | 829 |
| 4 | Compression parallel to grain (kg/cm$^2$) | 214 | 140 | 495 | 370 |
| 5 | End hardness (kg) | 504 | 318 | 834 | 785 |

Locally grown white bakain is slightly heavier than the reported value of specific gravity. Many factors influence the strength of a particular wood species. However, specific gravity has direct relation with the strength of the wood tested for various mechanical properties (Desch and Dinwoodie, 1983). The indigenous white bakain is superior in strength while comparing with reported species. The actual values of modulus of rupture maximum compression parallel to grain and end hardness of the wood are better than the reported values of the same properties (Table 2). However, the value of modulus of elasticity of local white bakain is lesser than the reported values in both conditions (Moslemi and Bhagwat, 1970).

The results of different properties of local white bakain are also compared with three commercial hardwoods; shisham, poplar and mulberry woods. Although white bakain is classified as moderately heavy wood as compared with heavy woods: shisham and mulberry yet it is better in most of the mechanical properties than these woods. However, it is heaver than poplar species (Table 3).

Table 3. Comparison of physical and mechanical properties of White bakain with some commercial hardwoods

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

The comparison of strength properties shows that white bakain has greater value of modulus of rupture as compared with other three hard woods. It has comparable or better value of modulus of elasticity with poplars and Shisham but it is lesser than mulberry wood. Similarly white bakain has greater value of compression parallel to grain than mulberry and popular. However, it is lesser than shisham. The timber is superior to the three commercial hardwoods regarding the end hardness.

White bakain is useful timber for making the handles of small and big axes, sappies etc. The results of home-grown white bakain reveal that it is overall better in strength than the same species previously tested at Forest Products Research Division (Stoehr *et al*., 1990).

Keeping in view the results of various physical and mechanical properties White bakain 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 33 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 bakain (air-dry) is 1155 $kg/cm^2$ which shows the ability of the timber withstand against stress offering more resistance. The wood has also higher value of tensile strength perpendicular to grain (43$kg/cm^2$) to determine suitability as a beam when compared with other woods of same density class. This behavior of the wood also favors its utilization in construction, joinery work, furniture, sports goods, tool handles etc.

Similarly white bakain has reasonably high value of resistance to indentation, side hardness (536 kg) and end hardness (634 kg). These values of hardness reveal that the timber is quite suitable for carving and to be worked on lathe machine.

Maximum compression parallel to grain of the wood is 495 kg/cm$^2$ which is superior in crushing strength with same density woods. Higher value of the property determines the suitability of the timber for distribution of load vertically on its members. So the wood is suitable for posts, poles, struts etc.

The resistance to sudden shocks applied to the wood (impact bending strength) is however low (2.1 m-kg) but the wood can be used in small pieces through lamination for the manufacturing of sport goods.

## Conclusion

White bakain is better in strength properties as compared with poplar, shisham and mulberry. It is also superior to the same species grown in different parts of the world regarding its various mechanical properties.

The results of physico-mechanical properties reveal that locally found white bakain is better in strength than a number of hardwoods of its density class. It has been found that Ailanthus wood has better strength in terms of modulus of rupture, maximum compression parallel to grain, tensile strength perpendicular to grain, cleavage, side hardness and end hardness. On the basis of these properties, the timber has considerable potential to be used for making tool handles, packing cases, furniture, rural construction, sport goods, posts and poles, door window frames etc.

White bakain is easy to work on machines or by hand. Its high value of hardness makes the timber suitable for different machining operation without its failure. It is concluded that wood has the tendency to resist when it is subjected to compressive stress and is suitable for vertical columns/members for constructional work.

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