

Cricket bat Industry in Kashmir Valley: Wood quality parameters of *Salix alba* var. *caerulea* and *Populus deltoides*

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Abstract

The present investigation was conducted in the Kashmir valley, India during the year 2017–2018. The main objective of this study was to assess the quality parameters of cleft that are used for cricket bat manufacturing. The units used wood of *Salix alba* var. *caerulea* as main raw material while *Populus deltoides* wood was also used for low quality bats. The mean values of moisture content, wood density and fiber length of wood samples of willow and poplar were 5.58% and 4.76%, 0.498 g cm⁻³ and 0.372 g cm⁻³, and 1.45 mm and 1.35 mm, respectively. Weight of the unfinished willow and poplar cleft was 2.03 kg and 1.76 kg, respectively. Studies conducted revealed that willow made bats were better than those made from Poplar.

Introduction

The restricted opportunities of wood production in natural forests and a rapid development of industrial processing of wood have brought about the decrease of timber supply and to the creation of the ever increasing deficit of wood as raw material. This problem has been somewhat mitigated by wood production in the plantations of fast growing tree species primarily poplars and willows (Markovic *et al.*, 2007).

Kashmir willow is mainly used with leather balls because of its strength and lightness. Poplar wood based bats are used to play with rubber/plastic tennis balls because of having low strength. Cricket bat willow trees are grown in Kashmir, right from the saffron fields of Pampore up to Sangam Bridge, the Jammu- Srinagar Highway is dotted with shops selling willow bats. Heaps of willow clefts kept for seasoning on rooftops or in open on roadside can be seen on this highway. This area is known as bat hub of Kashmir valley. Kashmir willow is known around the world as second only to the famous English willow grown mostly in Essex and Thames valley (England). The cricket bat industry has an impressive reputation of making Kashmir Willow bats which are exported outside.

Willows are eco-friendly, multipurpose, fast growing and are widely used for plantation world over. *Salix alba* consists of three varieties *var. alba*, *var. vitellina* and *var. caerulea*. *Salix alba* var. *vitellina* is commonly known as Golden willow is particularly used for decorative purposes whereas commercially important is *Salix alba* var. *caerulea* commonly known as cricket-bat willow. It is a female cultivar of hybrid origin between *S. alba* and *S. fragilis* (Stott, 1984).

Willow was introduced in Kashmir as a fast growing source of wood for fuel, packaging and wickerwork by the British in 1927. Cricket bat industry of Jalandhar in Punjab is also dependent on Kashmir willow clefts. Cricket bat willow trees are grown in Kashmir, when the tree attains the age of 15–20 years and the girth of 34 inches (trunks), the willow is ready for harvesting. After cutting the willow tree, the trunks are cut into sections using handsaw. The willow cut sections or rolls are carried out from the field on men shoulders and are loaded into trucks, and carried to bat manufacturing units for the process of bat manufacturing (Bilal, 2013). The broad objective of this study was to determine the wood quality

parameters of cricket bat industry in Kashmir and to examine the problems related to raw material quality.

Material And Methods

The present investigation was carried out in the laboratory of Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Benhama Campus during the year 2017.

The sampling technique for estimation of wood quality parameters was random sampling. Five units were selected randomly for this study in which industrial units were 5, tree species 2 and grades of cleft were 3. Therefore total number of samples was $5 \times 2 \times 3 = 30$ samples. These were analyzed for wood quality estimation. The log wood quality parameters like moisture content (MC), density of wood, fibre length, cleft wood quality were determined by using the following formulas given below:

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight-oven dry weight}}{\text{Oven dry weight}} \times \frac{100}{10}$$

The **Density** of wood log sample was calculated by the following formula.

$$\text{Density of wood} = \frac{\text{Weight of wood sample}}{\text{Weight of the same volume of water displaced}}$$

The **Sapwood/ heart wood ratio** was calculated with the help of scale. The measurements were made on cross sectional surfaces of the discs to determine the sapwood width and heartwood percentage (Nicholls and Pederick, 1979). The **Average width of growth** rings was calculated by following steps:

1. The piece of wood sample was dipped into water, so that rings will be clearly visible.
2. From centre mark the diameters on piece of wood sample on all directions.
3. Pins were inserted on all four directions from centre and calculate the rings. The side with minimum rings will give the accurate number of growth rings.

The fiber length (**mm**) of log wood samples was measured by Jeffery's fluid solution. The small segments were removed from the wedges. Fibers were macerated in Jeffery's fluid, i.e. 10 per cent chromic acid and 10 per cent nitric acid, for 48 hours. Pulp was thoroughly washed with water, stained with 2 per cent aqueous safranin, teased in 10 per cent glycerine and mounted with cover slip. The length of selected fibers was measured with the help of ocular micrometer scale standardized with the help of stage micrometer (Franklin, 1945).

Cleft wood quality

Numbers of grains per cleft was seen with the help of hand lens and calculate the number of all these grains on per cleft (Mehta, 2011). The length, width and thickness of cleft was measured with the help of measuring scale. The weight of cleft was recorded on the measuring balance. Knots were calculated by calculating the number of knots per cleft by counting the number of live and dead knots on the both surfaces of the cleft. The size of each knot was measured with the help of a measuring scale (Burawska *et. al*, 2013).

Results

The data presented in the Table-1 depicted the wood quality parameters of cricket bat samples collected from five randomly selected units. The table shows the mean values of wood quality parameters of poplar and willow wood sample used for making cricket bat. It was found that the average moisture content of bat willow was 5.58%, its average density was 0.498 g cm^{-3} , the average ratio of sapwood and heartwood was 1.35, the average width of growth ring was 0.76 cm and the average fiber length 1.45mm. These values for poplar wood used for bat making were 4.76%, 0.372 g cm^{-3} , 2.56, 0.77 cm and 1.35 mm, respectively.

The data displayed in the Table-2 shows the average number of grains in sampled clefts (15 numbers) from five sampling units. Table clearly shows in sampling unit 1 (Goodluck Sports, Hallmullah), grade A had 8, grade B had 5 and grade C had 4 numbers of grains per cleft. In sampling unit 2 (Decent Sports, Sether), grade A had 12, B had 6 and grade C had 5 numbers of grains. In sampling unit 3 (Crescent Sports, Charsoo), grade A had 7, B had 6 and grade C had 3 numbers of grains. In sampling unit 4 (Dar Cricket World, Sangam), grade A had 10, B had 5 and grade C had 5 numbers of grains per cleft. Similarly, in sampling unit 5, clefts sampled from the Goodwill Sports, Hallmullah had an average number of grains in grades A, B and C as 9, 7 and 4 grains per cleft, respectively. Mean values for number of grains per cleft found in A, B and C grade bats were 9.20, 5.81 and 4.20, respectively.

The data tabulated in Table-3 indicates the knot characteristics in different grades of clefts that were collected from five sampling units randomly. Maximum number of knots was observed in grade C followed by grade B and grade A, respectively. The data also revealed the size of knots, which was maximum (2.5cm) for grade C and minimum (1.2) for grade A. Samples collected from two units viz., Crescent Sports, Charsoo and Dar Cricket World, Sangam had one knot each in the Grade A bats while the other units had none in Grade A. Size of these knots were 2.0 and 1.2 cm in diameter, respectively. However, these knots were present on the back side of the clefts. Similarly in Grade B clefts, only two units viz., Decent Sports, Sether and Dar Cricket World, Sangam had no knots on their cleft. In the clefts sampled from Grade C bats of Crescent Sports, Charsoo and Goodwill Sports, Hallmullah had no knots at all. Whereas, Decent Sports, Sether had two knots having sizes 2.3 and 2.1 cm in diameter.

The data presented in Table-4 shows the characteristics of cleft before converting it into finished bat. It was found that the average length of five sampled willow cleft was 28.2 inch, average width was 4.56

inch and average weight was 2.03 kg. The result also reveals that the average length of five sampled cleft made of poplar wood was 24.4 inch, average width was 4.25 inch and average weight was 1.76 kg.

Discussion

Wood is the fibrous material in the trunk of trees under the bark, which is composed of a complex mix of plant polymers. Quantitatively, the most important is cellulose, followed by lignin, hemicelluloses, and then extractives (Walker, 2006). The physical characteristics of wood are mainly responsible for its use as cricket bat. Hence, one of the objectives of this study was to determine the various physical wood characteristics of bat willow and poplar samples. These two species were mainly used by the cricket bat manufacturing units in the Kashmir valley. The physical properties of wood viz., moisture content, density, sapwood/ heartwood ratio, average ring width and fiber length were estimated. The mean values of moisture content, density and fiber length of wood samples of willow were higher than those in poplar. These values were 5.58% and 4.76%, 0.498 g cm^{-3} and 0.372 g cm^{-3} , and 1.45 mm and 1.35 mm, in willow and poplar wood sample, respectively. Sapwood to heartwood ratio was, however, more (2.56) in poplar than in willow (1.35). Average width of growth rings was almost same (0.76 cm) in willow and (0.77 cm) and poplar samples (Table-17).

Some wood properties that are closely related to wood density are strength, dimensional stability, ability to retain paint. Kashmiri bats require constant knocking. Knocking makes the fibers of the willow blade compress together, which helps the bat, bear the impact of the ball. Constant knocking for several hours ensures that the edges of the bat are well shaped. During the present study wood density and fiber length of wood samples of willow was recorded 0.498 g cm^{-3} and 1.45 mm, respectively. Bilal *et al.* (2014) while studying the variation in specific gravity of *Salix alba* wood of Kashmir Himalaya, found the range of 0.42-0.48. Monteoliva *et al.* (2005) studied the variability of wood basic density and fiber length in six 13-year-old willow clones growing under two different site conditions. They found this in the range 0.364 to 0.455 kg/dm^3 . Raja (2014) while evaluating the variation with respect to wood density and fiber length in 162 clones along with 8 checks of willow reported that the wood density ranged from 0.40-0.56 g cm^{-3} with a mean value of 0.48 g cm^{-3} , whereas fiber length ranged from 0.61 - 0.79 mm with a mean value of 0.70 mm. Gupta *et al.* (2014) while studying basic density in willow, found maximum value of 0.53 g cm^{-3} clone 006/05 of *Salix alba*. Fiber length in *Salix alba* was recorded in the range of 0.61-0.79 mm by Deka *et al.* (1994). The density and fiber length of bat willow wood in the present study was quite comparable to the values reported in these studies or was slightly on the higher side. Higher values may be due to the fact that bat industry requires mature wood and the mature wood has more density and fiber length. Wood fiber length in species or clones increases with age or distance from the pith (Yanchuk *et al.*, 1984; Koubaa *et al.*, 1998).

Mature wood of poplar has been reported to have wood density values of 0.35 to 0.43 g cm^{-3} and mean fiber lengths from 1.3 to 1.4 mm (Haygreen and Bowyer, 1996; Panshin and Dezeew, 1980; Zobel and Sprague, 1998). Klansja and Kopitovic (1997) studied structural, physical characteristics and chemical

composition of wood of some white willow clones (*Salix alba*) of age 13 grown at Popular Research Institute, Novisad and found that the average length of wood fibers was above 1mm and the nominal wood density was found 340 kg/m³. The values of these parameters (0.372 g cm⁻³ and 1.35 mm) in the poplar wood in the present study were well within these ranges. The results are also in consonance with the findings of Isebrands and Richardson (2012) that mature wood of *Populus* have wood density values of 0.35 to 0.43 g cm⁻³ and mean fiber lengths from 1.3 to 1.4 mm.

The acceptable moisture levels in wood depend on the final use of the wood, the type and thickness of the wood, and the average relative humidity (RH) in the environment where the wood is to be used. Based on common guidelines or recommendations, the acceptable moisture level for willow and poplar species should be within range 6%-9%. During the present study moisture content was observed 5.58 % and 4.76 % for willow and poplar samples respectively. The lower value might due to this reason that our samples were seasoned wood samples.

The study revealed that average width of growth rings (0.77cm) and sapwood/heartwood ratio (2.56) was higher for poplar (Table-17). It may be because poplar is a fast growing species as compared to willow. A fast-growing tree may possess wide heartwood sapwood width (Hunter and Goggans 1968; Hillis and Ditchburne, 1974). It is proposed here that the proportion of sapwood and heartwood is a function of tree age. Environmental factors such as site (Nelson 1976), elevation (Lassen and Okkonen 1969), and climate (Chalk, 1951) have some impact on the sapwood and heartwood width. Moreover, a close relationship between heartwood width and tree age was reported by Hillis (1962) in *Eucalypts*. A positive relationship exists between sapwood and heartwood width and tree age (Yang *et al.*, 1985).

The most important qualities of wood required for cricket bat manufacturing are quality related to the straightness of the grain number and the number of blemishes or knots (Leclercq 1997). The finished clefts are then graded on the basis of number of grains per cleft. Almost all the mechanical characteristics of wood depend on the grain quality, i.e. strength, toughness and elasticity Simo-Pekka *et al.* (2002). The data related to the number of grains in different grades and knot characteristics in different grades presented in Table 18 and 19. The data revealed that average number of grains (9.2 per cleft) was found in grade A bat. The minimum number of grains required for grading a bat is 9 per cleft. This shows that, in general, the industry is complying with this standard. However, samples of two manufacturing units among those five sampled units, did not truthfully the criteria. In the presented study it was observed that number of knots and size (2.5cm) was maximum in grade C cleft (Table- 19). All the knots were present on the back side of the cleft except in Grade C bat. The front side of the bat should be free of any knot, lest the bat may split more quickly. Presence of knots lowers grade of timber and strength parameters, depending on their size, location and condition (Burawska *et al.*, 2013). It was estimated that presence of knots decreases tensile strength by up to 85% (Dahl, 2009).

The findings of the study (Table-4) indicate that the weight of the willow cleft was higher (2.03 kg) than the poplar cleft (1.76 kg) which indicates that willow bat is heavier than poplar bat. The length and width of willow cleft were observed 28.2 and 4.56 inches, respectively. Those for poplar were 24.4 and 4.25

inches, respectively. Based on common guidelines or recommendations of ISO, the length of a cricket bat should not be more than 38 inches (965 mm), the width not more than 4.25 inches (108 mm) and its weight should lie between 1.2 to 1.4 kg (Lloyd and Singh, 2008). The difference in length might be due to reason that our samples were semi finished clefts that did not include bat handle. Poplar cricket bats are generally low quality bats used mostly to play with tennis balls or for kids.

Conclusion

It was observed these wood quality parameters are important for bat industry. These parameters were closely related to some wood properties like wood density, strength, dimensional stability, weight and durability. With respect to wood characteristics, the examination of status of wood quality parameters revealed that the willow was better than poplar. It was observed these wood quality parameters are important for bat industry. It was recorded that maximum number of grains was found in grade A (> 9). This might be due to the fact that the almost all the mechanical characteristics of wood depend on the grain direction, i.e. strength, toughness and elasticity. The study of knots revealed that lowers grade of timber and strength parameters and presence of knots decreases tensile strength. The findings of the study indicate that the weight of the willow cleft was higher (2.03 kg) then the poplar cleft (1.76 kg) which indicates that willow bat is heavier then poplar bat. The study revealed that average width of growth rings (0.77cm) and sapwood/heartwood ratio (2.56) was higher for poplar. It may be because poplar is a fast growing species as compared to willow. The density and fiber length of bat willow wood in the present study was quite slightly on the higher side as comparable to Poplar. Higher values may be due to the fact that bat industry requires mature wood and the mature wood has more density and fiber length. Growing willow of high quality in Kashmir can help Cricket bat industry to became competitive at global scale and provide a pathway to international markets.

References

1. Bilal, A., Wani, W., Bodha, R. H. and Khan, A. 2014. Wood specific gravity variation among five important hardwood species of Kashmir Himalaya. *Pakistan Journal of Biological Sciences* **17**(3): 395-401.
2. Burawska, I., Zbiec, M., Kalicinski, J. and Beer, P. 2013. Technical simulation of knots in structural wood. *Forestry and Wood Technology* **82**: 105-112.
3. Bendtsen, B. A. and Senft, J. 1986. Mechanical and anatomical properties in individual growth rings of plantation- grown eastern cottonwood and loblolly pine. *Wood Fiber Science* **18**(1): 23- 38.
4. Klansja, B. and Kopitovic, S. 1997. Structural, physical characteristics and chemical composition of wood of some white willow clones (*Salix alba* L.) *Drevarsky Vyskum* **42**(1): 1-10.
5. Deka, G. C., Wong, B. M., and Roy, D. N. 1994. Variation of specific gravity, fiber length and cell wall thickness in young *Salix* clones. *Journal of Wood Chemistry and Technology* **14**(1): 147-158.
6. Dahl, 2009. Planar strain measurements on wood specimens. *Experimental Mechanics* **49**(4): 575-586.

7. Franklin, G. L., 1945. Preparation of thin sections of synthetic resins and wood resin composites, and a new macerating method for macerating woods. *Nature* **155**(3924): pp. 51.
8. Gupta, A., Singh, N. B., Choudhary, P., Sharma, J. P. and Sankhayan, P. H. 2014. Estimation of genetic variability, heritability and genetic gain for wood density and fibre length in 36 clones of white willow (*Salix alba*). *International journal of Agriculture, Environment and Biotechnology* **7**(2): 299-304.
9. Lloyd, S. and S. Harsimranjeet. 2008. An Examination of Cricket Bat Performance. Proceedings of 7th ISEA conference pp. 1- 7.
10. Hillis, W.E. and Ditchburne. N., 1974. The distribution of heartwood diameter in *radiata pine* trees. *Wood Science Technology* **4**: 524-529.
11. Hillis, W.E. 1962. Heartwood formation and its influence on utilization in *Eucalyptus*. *Wood Science Technology* **2**: 260-267.
12. Hunter, A. G. and Goggans, J. F. 1968. Variation in specific gravity, diameter growth and colored heartwood of sweet gum in Alabama. *Tappi journal* **51**: 76- 79.
13. Isebrands, J. G., and Richardson, J. 2012. Poplars and willows: trees for society and the environment. *Published by CAB International and FAO*. pp. 699.
14. Markovic, M., Karadzic, D., Lararev, V. P., Paljakovic, L. and Pajnik. 2007. Mycological complex on leaves and bark of *Salix* species in Central Danubae Basin. *Acta Silvatica Lignaria* pp. 75-80.
15. Stott, K. G. 1984. Improving the biomass potential of willows by selection and breeding. In: *Ecology and management of forest biomass production system Uppsala*: Swedish University of Agriculture Science. Department of Ecology and Environmental Research **15**: 233-260.
16. Bilal, A. D. 2013. Status and viability of wood based industry in district Anantnag with special reference to cricket bat industry. M. Phil thesis, Post-graduate Department of Economics University of Kashmir, pp. 107.
17. Chalk, L. 1951. Water and growth of *Douglas fir*. *Quarterly Journal Forestry* **45**(4): 237- 242.
18. Monteoliva, S., Senisterra, G. and Mariats, R. 2005. Variation of wood density and fiber length in six willow clones (*Salix spp.*). *International association of Wood Anatomists journal* **26**(2): 197-202.
19. Nicholls, J. W. P. and Pederick, L. A., 1979. Variation of some wood characteristic of *Eucalyptus nitens*. *Australian Forestry* **9**(4): 309-321.
20. Lassen, L. E. and Okkonene, A. (1969). Sapwood thickness of *douglas-fir* and five other western softwoods; U. S. D. A. Forest Service Research Paper; *Forest Products Laboratory* 124.
21. Simopekka, J., Simonahoa, Y. Palviainen, Tolonen, Raimo and Silvennoinen. 2002. Determination of wood grain direction from laser light scattering pattern. *Optics and Lasers in Engineering* **41**: 95–103.
22. Nelson, N. D. 1976. Gross influences on heartwood formation in black walnut and black cherry trees. *USDA, Forest Service* pp. 268.
23. Raja, R. 2014. Evaluation of progenies of tree willows. M.Sc. Thesis. Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP). 87p.

24. Koubaa, A., Hernandez, R. E., Beaudoin, M., and Poliquin, J. 1998. Interclonal, intraclonal, and within tree variation in fiber length of poplar hybrid clones. *Wood Fiber Science* **30**(1): 40-47.
25. Walker, J. C. F. 2006. Primary wood processing: principles and practice. *Springer*, Netherlands, pp. 583.
26. Yanchuk, A. D., Dancik, B. P., and Micko, M. M. 1984. Variation and heritability of wood density and fiber length of trembling aspen in Alberta, Canada, *Silvae Genetica*. **33**(1), 11- 16.
27. Yang, K.C., Hazenberg G., Bradfield, G.E. and Maze, J. R. 1985. Vertical variation of sapwood thickness in *Pinus banksiana* Lamb. and *Larix laricina* (Duroi). *Canadian Journal Forest Research* **15**: 822-828.
28. Haygreen, J. G. and Bowyer, J. L. 1996. Selected mechanical properties of fast-growing *Poplar* hybrid clones. *Wood Fiber Science* **30**(2):138–147.
29. Panshin, A. J. and C. Dezeuw. 1980. Textbook of wood technology, 4th ed. McGraw-Hill-Publishing Co., New York pp. 722.
30. Zobel, and J. R. Sprague. 1998. Juvenile wood in forest trees. *Springer-Verlag*, New York, pp. 300.

Tables

Table- 1: Wood quality parameters of wood samples collected from selected bat units

Species	Moisture (%)	Density (g cm ⁻³)	Sapwood/ heartwood ratio	Average width of growth rings (cm)	Fiber length (mm)
Willow	5.58±0.82	0.498±0.03	1.35±0.04	0.76±0.06	1.45±0.33
Poplar	4.76±1.34	0.372±0.03	2.56±0.12	0.77±0.07	1.35±0.60

Table -2: Number of grains found in the clefts of different grades of bat

S.No.	Sampling units	Grade A	Grade B	Grade C
1	Goodluck Sports, Hallmullah	8	5	4
2	Decent Sports, Sether	12	6	5
3	Crescent Sports, Charsoo	7	6	3
4	Dar Cricket World, Sangam	10	5	5
5	Goodwill Sports, Hallmullah	9	7	4
Mean		9.20	5.81	4.20

Table -3: Knot characteristics found in the cleft of different grades of bat

Sampling units	Knots in Grade A		Knots in Grade B		Knots in Grade C		Grade
	Number	Size (cm)	Number	Size (cm)	Number	Size (cm)	
Good luck Sports, Hallmullah	0	-	1	1.8	1	2.5	
Decent Sports, Sether	0	-	0	-	2	2.3, 2.1	
Crescent Sports, Charsoo	1	2	1	2.5	0	-	
Dar Cricket World, Sangam	1	1.2	0	-	1	1.7	
Good will Sports, Hallmullah	0	-	1	2.5	0	-	

Table- 4: Characteristics of cleft made of willow and poplar wood

Species used	Length (inch)	Width (inch)	Weight (kg)
Willow	28.2±0.96	4.56±0.15	2.03±0.23
Poplar	24.4±0.81	4.25±0.17	1.76±0.04