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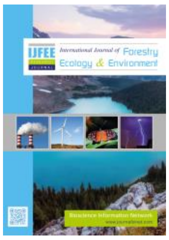

Some machining and handtool properties of tetuya koroi (*Albizia odoratissima*) wood

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ABSTRACT

The study was conducted to determine the suitability of tetuya koroi (Albizia odoratissima) wood for furniture manufacturing i.e., planing, shaping, boring, mortising, turning, etc machining and handtool property tests of this species grown in south-east Bangladesh.. The evaluation in both machining and handtool property tests was based on the frequency of the defect-free sample. Finishing property was also determined by implementing two types of polishing materials, viz.: carpa and shellac. The defects of the sample were estimated by visual and tactile observation. The percentage of defect free samples was evaluated for each property operation and classified based on five quality grades. The study's findings mainly introduced good working properties, and tetuya koroi wood may be suitable for furniture. All properties exhibited 63 % to 76 % grade 1 and 95 % to 100 % qualified grade. The finishing property of this wood showed good quality as well.

Key Words: *Planing, Shaping, Mortising, Turning, Carpa and Shellac.*

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I. Introduction

Tetuya koroi (*Albizia odoratissima*) is a large erect tree, mainly known as black siris, native to Bangladesh, China, Myanmar and Sri Lanka. The tree can grow to 72 – 85 feet, and it belongs to the Leguminosae family (Troup, 1921; Jain and Häggman, 2007). This is a distinctly valued species as a shade tree that can improve soil in tea plantations in the Asian subcontinent. This tree is primarily popular in North-East India as well as Bangladesh. It is being cultivated in Bangladesh as a shade tree about three-fourths of the total species (Sana, 1989; Hossain, 1995). Wood is being used as a prime industrial and construction material from the beginning of civilization. Wood is available everywhere globally, and it is an excellent material because of its different properties and qualities such as strength, density, low heat conductivity, ease of shaping, various 56 structures and sizes etc (FAO, 1986; Shanu et al., 2015). To improve civilizations and human lives' survival, wood is particularly considered the pre-eminent material (Sattar et al., 1999). It is essential to evaluate different machining

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properties and relate raw material characteristics (Sofuoglu and Kurtoglu, 2014). For the variation of manufacturing imperative products of wood, using new and cheap species depends on its information (Qasem et al., 1981).

According to local conditions, the commercial timber quality varies. The variations that might be exhibited within a particular geographic area are no more significant over its whole extent. Those variations can mainly affect the wood hardness, colour and density (Kukachka, 1959). Since the population growth tremendously increases, the demand for wood products is being increased gradually in Bangladesh. There is a big difference between the requirement and resource. Consequently, our forest resources are being unavailable day by day (Biswas et al., 2017). The mature wood of tetuya koroi (*A. odoratissima*) shows brown colour with some streaks. This wood could be utilized for manufacturing quality furniture, cabinet, carts, paneling and agricultural implements (Jain and Häggman, 2007). As it is being cultivated in tea garden as a shade tree, it is available in Bangladesh. But the wood from *A. odoratissima* tree is not being used properly and working properties of this wood are also unknown to the users. So, the working and finishing properties of this wood are imperative to find as an alternative source to traditional timber species and magnify its economic value. Consequently, under the present condition, the study was designed to determine different machining, handtool and finishing properties and introduce it to the users for better utilization.

II. Materials and Methods

The materials (*A. odoratissima* wood) for the test were procured in the log form from the Bandarban district. The logs were converted to planks and sawing quality was determined. Samples, 1" × 5" × 48", were made out of wood species. Before conducting the tests, these samples were again converted into smaller pieces suitable for different tests. The test samples had 12 to 15 percent moisture content during the tests. The samples were immediately examined visually to sort out the defect-free ones after completing tests and classified based on five quality grades (Table 01). The percentage of defect free samples based on total samples was determined. The percentage was considered to be the measure of its property quality. The test was carried out by ASTM Standards: D-1666-64 (Anon, 2004). Similar property tests for the study were conducted using carpenter's handtool, and it was accomplished at Bangladesh Forest Research Institute, Chattogram during July 2019 to June 2020.

Table 01. Performance wise quality grades of all property tests

Defects	Performance	Quality grade
No defect	Excellent	1
Few slight defects	Good	2
Lots of slight defects	Fair	3
Serious defects	Poor	4
Very serious defects	Very poor	5

Planing and finishing test

The test samples' size for planing and finishing property was 1" × 4" × 36". The test was carried out in a Whitney No. 105 single surface planer with four straight knives. The cutter head speed was 3000 rpm. The depth of cut was 1.59 mm for all runs. The feed rate was adjusted to 636 mm per minute so that the target number of knife marks was 40 per 2.54 cm. The run was made with a sharpness angle of 30 degrees and cutting angle of 25 degrees. The exact number of samples was tested with the carpenter's hand planner, and a similar testing procedure was applied. The planning test samples were used for the test of finishing after completing all planning property tests. In the finishing test, two polish types, namely: shellac and carpa were applied, and performance was recorded based on the surface finish and physical appearances.

Boring Test

The size of the test species for boring property was 1" × 3" × 12". The test was conducted in a 508 mm single spindle hand feed drill press of Walker Turner Model No. 1113-41. A one-inch single twist solid center bred point type of wood boring bit was used for the test. The drill machine was adjusted to maintain a spindle speed of 2850 rpm. In terms of handtool property operation, boring was done by a carpenter's hand drill. A one-inch single twist solid center screwed point type wood boring auger bit was used for the test. Solid hardboard was used as backing underneath to avoid the tearing and splintering of samples at the bottom during boring both for machining and handtool test.

Shaping Test

The test samples used for boring were also used for carrying out shaping tests of machining and handtool, respectively. The test was carried out in a hand-fed single spindle shaper of J. A. Fay and Egan Company, Model No. 252, with two knives having a spindle speed of 6500 rpm. Here the cutting angle was 25 degrees. The cutter used to obtain a quarter round pattern had a radius of curvature of 12.7 mm. In case of handtool test, ripping of the sample was done by carpenter's handsaw to obtain the quarter round pattern. The shaping was carried out by carpenter's chisel of half-round type.

Mortising Test

The samples used for boring and shaping tests were also used for the mortising test. Machining and handtool property tests were ascertained from the separate samples. It was used as a hardboard backing when mortises were cut on each sample. Each mortise was cut with two sides parallel to the grain and perpendicular to the grain. The machining test was carried out in a foot feed vertical square hollow mortising chisel of Oliver Machinery Com., Model No. 91D. The spindle speed of the drill machine was 3600 rpm. A one fourth inch square chisel was applied in this property test.

Turning Test

The size of the test samples used for turning property was 1" × 1" × 6". The test was carried out in a variable speed wood lathe of Oliver Machinery Com., Model No. 159A. The speed of the variable lathe was 2400 rpm. A set of high-speed steel cutters was used to give head and cove for having different turning features and the ability to cut at different angles with the grain.

III. Results and Discussion

In conformity with the variation of grain orientation and the load applied to the saw blade, tetuya koroi (*A. odoratissima*) wood required medium pressure on the saw blade, which exhibited medium to saw (Table 02). Lambu (*Khaya anthotica*) wood was light, and it required less pressure on saw blade which indicated easy to saw. In the same case, jhau (*Casuarina equisetifolia*) wood was hard and heavy, showing difficult sawing quality (Sarker et al., 2015). The type of wood and sawing and finishing quality depend on wood's fiber and grain structure. All kinds of finishing quality of tetuya koroi wood showed promising results. According to specific gravity, this wood responded moderately heavy timber.

Table 02. Specific gravity, age and sawing and finishing quality of *A. odoratissima wood species*

Sl. No.	Property/Parameter	Value /quality	Remarks
01	Age of the tree	37 (Years)	According to annual growth rings
02	* Specific gravity (Green condition)	0.56	Moderately heavy timber
03	*Specific gravity (Oven-dry condition)	0.60	
04	Finishing quality	Good	Two types of polishing
05	Sawing quality	Medium	According to load application

(*Data source: Seasoning and Timber Physics Division, BFRI, Chattogram)

The qualified grades of planning, shaping, boring and turning properties of *A. odoratissima* wood were assumed the summation of grade 1 and grade 2 (Table 03). All of the above properties of this wood showed 95 to 100 % qualified grade (Figure 01; 02; 03; 04; 05). Among the properties, shaping had 100 % qualified grade in both machining and handtool test while boring scored 95 % qualified grade. In the planning and mortising test, machining property exhibited 100 % and 95 % qualified grade and handtool property, respectively, 96 % and 100%. Turning property of this wood rated 100% qualified grade too. For instance, it could be shown the same property results of other familiar species. In terms of property evaluation, mahogany (*Swietenia macrophylla*) wood exhibited 100 % qualified grade in all machining and handtool tests except machining property of planning operation that rated 95 % qualified grade (Sarker et al., 2019).

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Table 03. Performance of different machining and handtool property tests

Property		Number of Species	Grade of property (%)					
Name	Type		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Qualified grade
Planing	Machining	25	68	32	00	00	00	100
	Handtool	25	76	20	04	00	00	96
Shaping	Machining	20	75	25	00	00	00	100
	Handtool	20	70	30	00	00	00	100
Boring	Machining	20	65	30	05	00	00	95
	Handtool	20	70	25	05	00	00	95
Mortising	Machining	20	65	20	10	05	00	95
	Handtool	20	65	35	00	00	00	100
Turning	Machining	35	63	37	00	00	00	100

Figure 01. Planing (machining) property test sample of tetuya koroi wood

Figure 02. Planing (handtool) property test sample of tetuya koroi wood

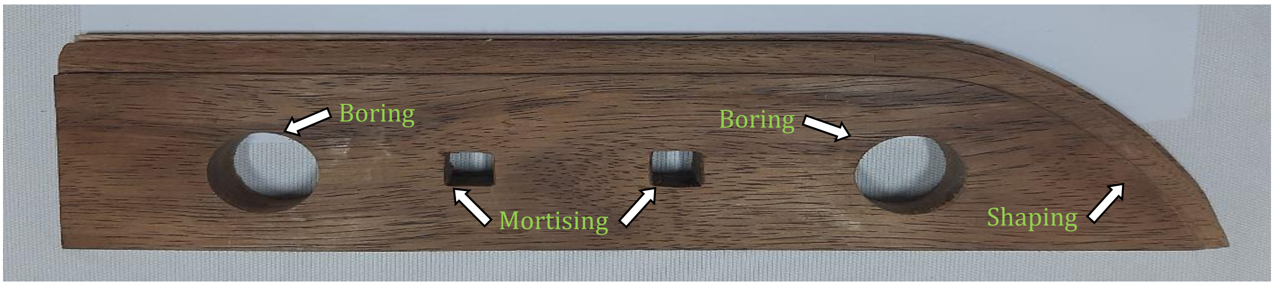

Figure 03. Shaping, boring and mortising (machining) test sample of tetuya koroi wood

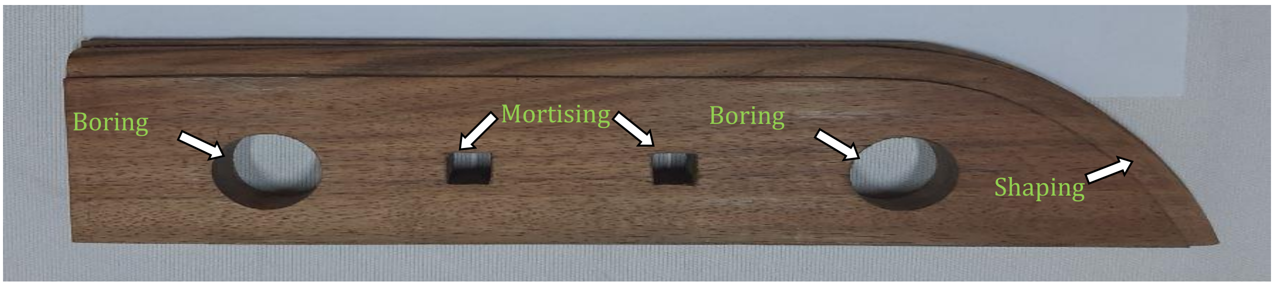

Figure 04. Shaping, boring and mortising (handtool) test sample of tetuya koroi wood

From the comparisons of the defect free samples for different property operations between two wood species, it appeared that all of the property results of tetuya koroi wood exhibited good quality, and acacia hybrid wood indicated mostly an excellent quality of property results (Figure 06). The most common defects of planing tests were fuzzy grains for those wood species. On the contrary, some raised grains were found in machining and handtool property tests of tetuya koroi wood.

Figure 05. Turning (machining) property test sample of tetuya koroi wood

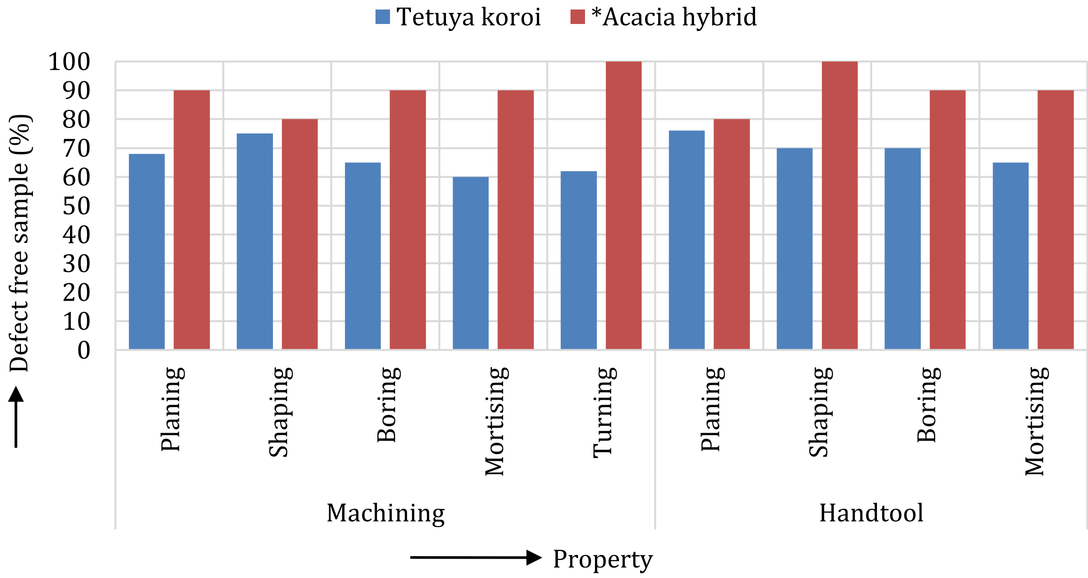

Figure 06. Comparisons of defect free samples between two wood species
(*Data source: Sarker et al., 2015)

Another native species such as mango (*Mangifera indica*) wood could be compared with tetuya koroi wood. It was determined that all the machining and handtool tests of mango wood showed poor results. Defects due to raised grain were prominent in this species (Hannan et al., 1992). In the case of tetuya koroi wood, machining properties' main defects were fuzzy grain, tear out, and raised grain, but broken corners were absent in shaping tests. On the other hand, fuzzy grain, tear out and broken corners were the defects in handtool properties while there was no raised grain in any sample. In boring operations, no other defects appeared except tear out and fuzzy grain in machining properties and some tear out, broken corner and fuzzy grain were found in handtool properties. In terms of mortising tests, machining properties showed tear out and broken corner defects and handtool properties indicated few fuzzy grains and broken corner defects. There was no raised grain in both machining and handtool properties. In turning property tests, the main defects were fuzzy grain, tear out, broken corner and raised grain. In case of planing and turning property operations, some fuzzy grain and raised grain defects were negligible that could be removed easily by adequate sanding. Knife marks were present in almost all the property test samples, but they were not considered as defects. Since each test's property results were evaluated by visual and tactile inspection, it was impossible to quantify them properly.

IV. Conclusion

The study's results showed that this wood's functional properties were of good quality. The property value should be considered as an indicative value only. According to the results, it can be said that tetuya koroi wood may be used as a quality furniture material. Using this wood in case of manufacturing furniture will reduce pressure on conventional timber species. Further investigation should be needed to get advanced information.

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