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Effect of Chromate-Copper-Boron preservative treatment on physical and mechanical properties of Raj koroi (*Albizia richardiana*) wood

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Abstract

This experiment was carried out to analyze the effects of CCB (chromate-copper-boron) preservative treatment on physical and mechanical properties of *Albizia richardiana* wood using dipping method. Retention of preservative was maximum at 8% concentration of the preservatives. Based on the retention at this concentration, the physical and mechanical properties of the treated wood were examined. The density of untreated *A. richardiana* wood was 521 kg/m³. It changed to 542 kg/m³ on treatment. This increase in density by 2.30% for treated wood was significant. On the other hand, modulus of rupture (MOR) increased significantly from 93 to 107 N/mm² on treatment of the wood. The modulus of elasticity (MOE) increased from 3205 to 4861 N/mm². Physical and mechanical properties of the wood improved by treating with CCB preservative.

Keywords: Chromate-copper-boron; *Albizia richardiana*; Physical properties; Mechanical properties

Introduction

Wood is the world's most valuable and abundant renewable natural resources (Lahiry, 2001). It is the material used by man for thousands of years without precise knowledge of its properties (Wangaard, 1981). Wood is always been a pre-eminent construction and industrial material. Its low cost and availability in various forms and sizes, together with such properties such as relatively great strength with respect to weight, ease of shaping, low heat conductivity qualities etc., made it outstanding material (FAO, 1986).

The primary importance of the preservation treatment of wood is to increase the life of the material in service. As such the ultimate cost of the product decreases in the long run by avoiding the need for frequent replacements (Jayanetti, 1986). It is well conceived that the extension of the service life of timber by the application of appropriate preservatives has significant effect in the field of wood utilization (Jayanetti, 1986). Preservative treated products give a desired result in service performance (Lahiry, 2001).

Preservative treatment is done with a variety of preservatives chemicals. Due to arsenic toxicity of CCA (chrome-copper-arsenic), it is not used now. Today, increasing emphasis is placed on using preservatives that are targeted more specifically to particular applications. Such

preservatives are safer to use and potentially less damaging to the environment. To this end, a water borne preservative named CCB is used for this study in which the components are sodium dichromate, copper sulfate and boric acid. In CCB preservatives, copper acts as a fungicide, boron as a biocide and chromium as fixative (Lahiry, 2001). Boron compounds, usually in the form of boron salts, have long been known and used as effective wood preservatives for timber (Carlidge *et al.*, 1995).

The preservative treatment of wood modifies its properties making it dimensionally stable and durable for efficient utilization (Winandy, 1991).

Albizia richardiana (raj koroi) locally known as chambal is a promising fast growing species with shallow root system and light demanding species. This is an exotic from Madagascar (Africa) and planted as road side avenue tree in Bangladesh for its beautiful habitat since British period. It also occurs in the forest of Chittagong Hill Tracts (Kaptai) and Chittagong and in the village of Northern districts. It is one of the most important species of coastal area in Bangladesh (Latif *et al.*, 1987). In Bangladesh this tree is used for furniture and frame manufacturing, house post, roofing, etc. (Das and Alam, 2001). It is a useful species for social forestry (BFD, 2011).

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In this study, it was tried to determine the effect of CCB preservative treatment on physical and mechanical properties of *A. richardiana* wood.

Materials and methods

Two *Albizia richardiana* trees, 14-years-old, grown in Khulna University Campus, Khulna (22° 48' 0" N and 89° 33' 0" E), Bangladesh were collected for this study. Samples were collected from the bottom, middle and top containing heartwood. The samples were in the form of 35.0 cm × 5.5 cm × 2.5 cm for MOR and MOE tests. The size of sample for physical properties was 5.0 cm × 5.0 cm × 2.5 cm. The specimen for compression strength perpendicular to grain test was in the form of 8.0 cm × 4.0 cm × 2.0 cm and compression strength parallel to grain tests was in the form of 8.0 cm × 3.0 cm × 3.0 cm. The converted samples were dried in open air for 30 days to reduce the moisture content of the wood samples. The samples were dried in the oven at 105°C to get constant weight before treating with preservative.

Chromate-copper-boron (CCB) preservative was used in this study. The desired CCB preservative was made by mixing of sodium dichromate, copper sulfate and boric powder as salt-based ratio of 2:2:1 respectively (Lahiry, 1996).

All the wood samples were dipped into the preservative solutions of 4, 6, 8 and 10% concentrations for 72 hours. After the desired duration, the treated samples were taken out from preservative solutions step by step, removed excess preservative from the surface of the samples and placed on polythene sheet for air drying.

The volumetric analysis was used to calculate preservative retention of wood samples. Oven dry weight before treatment and oven dry weight after treatment were taken to determine the retention. The difference of the two weights was the weight of preservative solution penetrated into the sample. Retention was expressed as kg/m³.

Results and discussions

Retention of CCB preservative

Albizia richardiana wood was treated with four different preservative concentrations viz., 4, 6, 8 and 10% for 72 hours. The maximum retention was 32.2 kg/m³ with 8% concentration while the lowest retention was 20.6 kg/m³ with 4% concentration (Fig. 1). The retention for 6 and 10% concentration level were 25.4 and 23.4 kg/m³ respectively (Fig. 1). Analysis of variance revealed that there had been significant variation for retention of preservatives among the four different concentrations (F=12.92, df=3 and P<0.05).

The concentration of 8% was considered enough for the treatment. Thus, wood samples treated with 8% concentration were evaluated for the physical and mechanical properties.

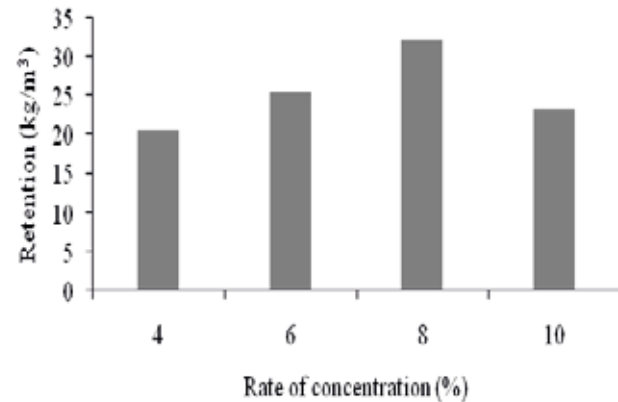


Fig. 1. Average retention of CCB preservatives

Effects on physical properties

The density of untreated was 521 kg/m³ and that of the treated wood of *Albizia richardiana* was 542 kg/m³ (Fig. 2). From the statistical analysis, it was observed that there was significant difference (t=3.76, df=16, P<0.05). The density of *A. richardiana* wood increased by only 2.3% on preservative treatment. Any treatment that alters the structure of the wood or composition and hygroscopic character may influence its physical properties (Wangaar, 1979). Ashaduzzaman *et al.* (2007) reported that density of *Sonneratia apetala* increased 18% due to waterborne preservatives. The density of *A. richardiana* was lower than *Acacia nilotica* (882 kg/m³) for both treated and untreated (Alam *et al.*, 2015). *Cocos nucifera* showed lower density (370 to 430 kg/m³) than *A. richardiana* (Rana *et al.*, 2015).

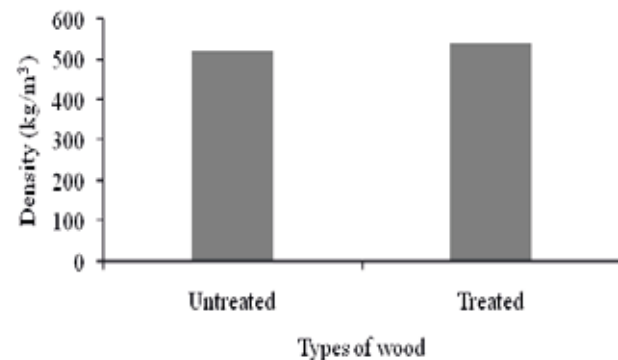


Fig. 2. Effect of CCB preservative treatment on density of *A. richardiana* wood

It was found that the moisture content of untreated and treated wood of *A. richardiana* were 27.6 and 26.0% (Fig. 3). Untreated wood was not significantly different ($t=1.55$, $df=16$, $P>0.05$) from treated wood for moisture content. The moisture content of *A. richardiana* wood decreased to 4.80% due to preservative treatment. On the other hand Lahiry (1998) found that moisture content increased 4% for boron treated *Mangifera indica*.

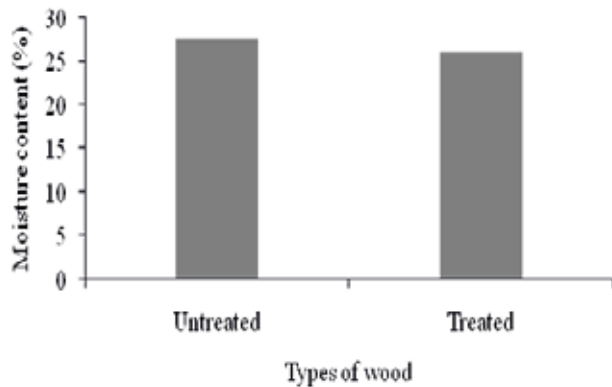


Fig. 3. Effect of CCB preservative treatment on moisture content of *A. richardiana* wood

Fig. 4. shows that the radial shrinkage was 2.78, tangential 4.30 and volumetric 7.22% of untreated wood of *A. richardiana*. Radial, tangential and volumetric shrinkage of treated wood of *A. richardiana* was 2.48, 3.67 and 6.27% respectively (Fig. 4). Treated wood was significantly ($t=3.49$, $df=16$, $P<0.05$ for radial, $t=5.89$, $df=16$, $P<0.05$ for tangential and $t=1.97$, $df=16$, $P<0.05$ for volumetric) different from untreated wood. The radial, tangential and volumetric shrinkage of *A. richardiana* wood decreased by 10.8, 14.7 and 13.2% for preservative treatment.

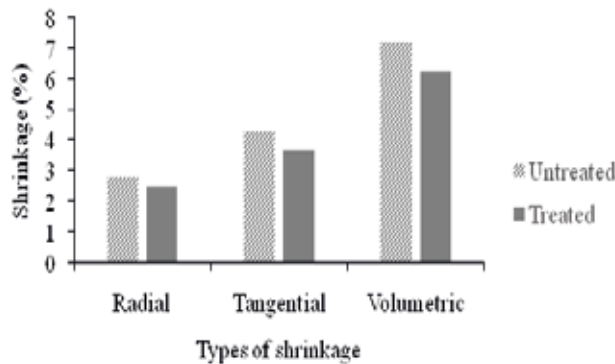


Fig. 4. Effect of CCB preservative treatment on shrinkage of *A. richardiana* wood

Effect on mechanical properties

Untreated wood of *A. richardiana* showed modulus of rupture (MOR) 97.9 N/mm² and treated wood showed 106.3 N/mm² (Fig. 5). Statistical analysis showed that there was significant ($t=3.84$, $df=16$, $P<0.05$) difference between two types of wood. By preservative treatment, the MOR of *A. richardiana* wood increased by 5.52%. It was reported by Kabir *et al.* (1994) that MOR increased by 11.11% for the treated wood of *Eucalyptus camaldulensis*. Ashaduzzaman *et al.* (2007) stated that MOR of *Soneratia apetala* increased by 8.50% due to waterborne preservatives. Alam *et al.* (2015) found MOR 127 N/mm² for *A. nilotica* and it was higher than that of *A. richardiana*. According to Rana *et al.* (2015) MOR of *C. nucifera* was 27.1 to 37.7 N/mm² which was lower than MOR of *A. richardiana*.

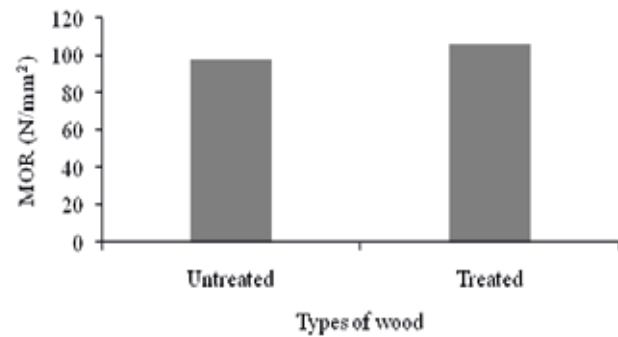


Fig. 5. Effect of CCB preservative treatment on MOR of *A. richardiana* wood

Fig. 6. shows that the modulus of elasticity (MOE) for untreated and treated wood of *A. richardiana* were 3783 and 3947 N/mm². Significant difference ($t=4.86$, $df=16$, $P<0.05$) was found between two types of wood for MOE. The MOE of *A. richardiana* wood increased by 4.3% on preservative treatment. Kabir *et al.* (1994) found that MOE increased by 3% due to preservative treatment of *Acacia mangium* wood. MOE of *S. apetala* increased by 4.30% by treating with waterborne preservatives (Ashaduzzaman *et al.*, 2007). The MOE of *A. richardiana* was higher in comparison to MOE of *A. nilotica* (1950 N/mm²) (Alam *et al.*, 2015). *C. nucifera* showed MOE 2310 to 2620 N/mm² (Rana *et al.*, 2015). This finding was lower than MOE of *A. richardiana*.

Compression strength perpendicular to grain for untreated and treated wood of *A. richardiana* were 14.57 and 16.54 N/mm² (Fig. 7). Untreated wood was significantly ($t=3.78$, $df=16$, $P<0.05$) different from treated wood. Preservative treatment increased the compression strength of *A. richardiana* wood 9.11%.



Fig. 6. Effect of CCB preservative treatment on MOE of *A. richardiana* wood

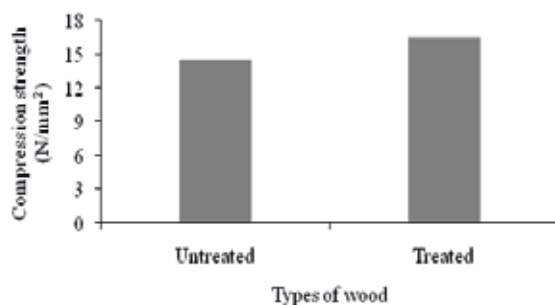


Fig. 7. Effect of CCB preservative treatment on compression strength of *A. richardiana* wood

Conclusion

Albizia richardiana showed the highest retention with 8% concentration of CCB for 72 hours. Due to 8% CCB preservative treatment, most of the physical and mechanical properties of *A. richardiana* increased from 3 to 14%. The preservatives treatment did not cause any serious problem in case of the strength properties of wood. Thus the CCB treated *A. richardiana* can be used satisfactorily as interior exercise like furniture and frame manufacturing, house post, roofing etc.

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