Treatment of *Albizia lebbeck* Wood by Soaking and Diffusion Method Using Chromated-Copper-Boron (CCB) Preservative

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Abstract

The experiment was undertaken to investigate the retention of 10% Chromated-Copper-Boron (CCB) solution (2:2:1) in Kala-koroi (*Albizia lebbeck*) (L.) Benth. wood applying soaking as well as diffusion method. The assessments were applied for 5, 7, 9 and 11 days for both the method. Retention was recorded 1.96 kg/m^3, 11.78 kg/m^3, 12.92 kg/m^3 and 13.61 kg/m^3 in *A. lebbeck* wood where soaking method applied. Moreover, retention was found 5.22 kg/m^3, 6.43 kg/m^3, 7.32 kg/m^3 and 12.36 kg/m^3 in *A. lebbeck* wood when diffusion method applied. In case of both methods the highest retention was recorded 13.61 kg/m^3 and 12.36 kg/m^3 for 11 days. Considering the Standard of Bangladesh Standards and Testing Institution (BSTI), i.e., 13.61 kg/m^3 and 12.36 kg/m^3 retention can meet the suitability of the study.

সারসংক্ষেপ

কালাকড়ই কাঠের ধারণ মূল্যায়নের জন্য চুবানো এবং ডিফিউশন পদ্ধতিতে ১০% ক্রোমাটেড-কপার-বোরন (সিসিবি) দ্রবণ (২:২:১) দ্বারা পরীক্ষাটি করা হয়েছিল। উভয় পদ্ধতিতে ৫, ৭, ৯ এবং ১১ দিনের জন্য এ পরীক্ষাটি প্রয়োগ করা হয়েছিল। উক্ত সময়ে চুবানো পদ্ধতি প্রয়োগ করে ১.৯৬, ১১.৭৮, ১২.৯২ এবং ১৩.৬১ কেজি/ঘনমিটার ধারণ রেকর্ড করা হয়েছে। অধিকন্তু, ডিফিউশন পদ্ধতি প্রয়োগ করে ৫, ৭, ৯ এবং ১১ দিনের জন্য যথাক্রমে ৫.২২, ৬.৪৩, ৭.৩২ এবং ১২.৩৬ কেজি/ঘনমিটার ধারণ রেকর্ড করা হয়েছে। উভয় পদ্ধতিতে ১১ দিন প্রয়োগ করে কালাকড়ই কাঠের সর্বোচ্চ ধারণ ১৩.৬১ এবং ১২.৩৬ কেজি/ঘনমিটার রেকর্ড করা হয়েছে। কালাকড়ই কাঠের ধারণ ১৩.৬১ এবং ১২.৩৬ কেজি/ঘনমিটার রেকর্ড করা হয়েছে, যা বাংলাদেশ স্ট্যান্ডার্ডস অ্যান্ড টেস্টিং ইনস্টিটিউশন (বিএসটিআই)-এর মান বিবেচনা করে উপযুক্ততা পূরণ করতে পারে।

Key words: *Albizia lebbeck*, Diffusion method, Penetration, Retention, Soaking method.

Introduction

Albizia lebbeck (L.) Benth. is native to tropical Africa, Asia and Northern Australia. It is widely naturalized within sub-humid, semi-arid tropics and subtropical areas where there is a marked dry season and a reliable rainy season. It is found from sea level up to an altitude of 1800 m (Cook *et al.* 2005; Lowry *et al.* 1992; Duke 1983). Native and exotic range of *Albizia lebbeck* of the world distribution is showing in Fig. 1 (Orwa *et al.* 2009). *A. lebbeck* is a common exotic species in Bangladesh. It is planted in roadsides as shade tree, in homestead forests for fuel wood production and in front of school or college premises as ornamental tree. Although, the species grows on all types of soils in

Bangladesh, but frequently planted on the northern and southern parts of the country (Khan and Ungar 1996; Das and Alam) especially on the wet damped soils of the village areas of greater Barishal, Patuakhali and Noakhali district (Uddin *et al.* 2007). The plant is found almost everywhere in Bangladesh. May be that's why the plant has many local names: East Indian walnut, lebbeck, lebbek tree, flea tree, fry wood, koko, woman's tongue tree. It has also vernacular name: Kala-koroi (Chittagong), siris, shirish (Beng.), harish, moroi (Sylhet), bhutkoroi (Dinajpur, Rangpur), (Das and Alam 2001).

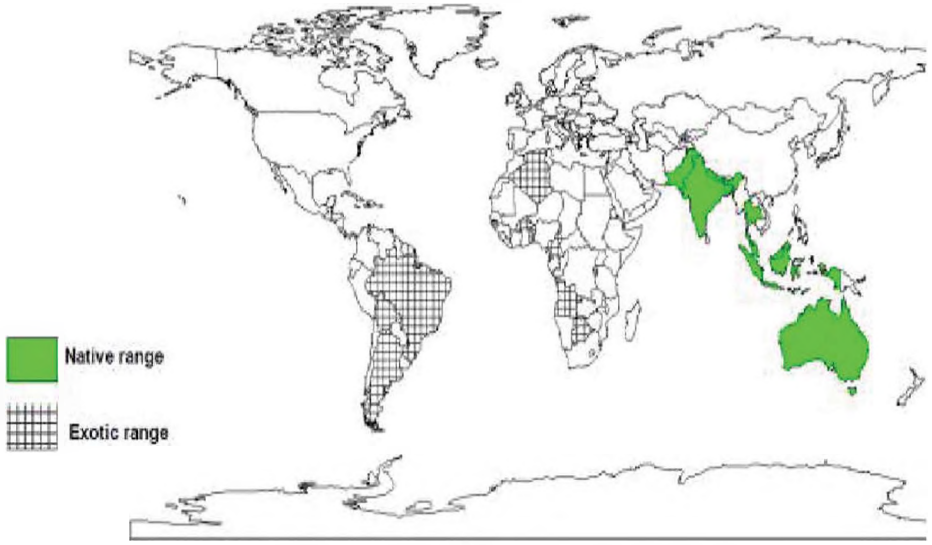

Figure 1. World distribution of *Albizia lebbeck*.

A. lebbeck is a deciduous, perennial medium-sized legume tree. It reaches 3–15 m in plantations and up to 30 m in the open. Its dense shade-producing crown can be as large as 30 m in diameter. Leaves are bi-pinnate with 3–11 pairs of bright green, oblong leaflets, 1.5–6.5 cm long × 0.5–3.5 cm broad. Inflorescences are globular clusters of 15–40 white fragrant flowers. The fruits are 10–30 cm long × 3-6 cm broad, reddish-brown pods that contain 5–15 flat rounded, free moving seeds. They produce an incessant rattle in the wind, reminding women's chatter, hence the name "women's tongue" (FAO 2010; Orwa *et al.* 2009; Lowry *et al.* 1992). *A. lebbek* is a multipurpose tree. As a fodder tree, its foliage, twigs, flowers and immature pods are relished by different classes of livestock (camels, cattle, small ruminants and rabbits) (FAO 2010). It has an extensive, fairly shallow root system thus can be a good soil binder and may be used to prevent soil erosion. It is also a source of firewood and timber. *A. lebbek* is suitable for agroforestry regimes and it is used for shelter belts and as shading tree in coffee and tea plantations (Orwa *et al.* 2009; Duke 1983). Optimal growth conditions are average day temperatures ranging from 19°C to 35°C, annual rainfall between 500 mm and 2500 mm and fertile, well-drained loamy soils. It may,

however, withstand lower and more irregular rainfall conditions. It can also grow on a wide diversity of soils such as acid, alkaline or saline soils, eroded soils and laterites except heavy clays (Orwa *et al.* 2009; Lowry *et al.* 1992). It is tolerant of heavy grazing and fire (Lowry *et al.* 1992). Seedlings are sensitive to frost and heavy browsing but older plants can survive (NAS 1980). Wood-boring is carried out by many insects either to obtain food or as a means of protecting their eggs, larvae and pupae. Many insects and a few other invertebrates are wood-borers. Some of them obtain both sustenance and shelter from the wood, while others use it only as their habitat. Certain species attack only living trees, others are found mainly in freshly felled or dying trees; a few infest only dry woodland, while others attack only old moist wood. Those that attack trees and fresh logs frequently bore and live in the inner bark for a variable period of time, before they penetrate the wood. They also can be considered to be inner back borers. Some insects that attack only freshly killed or felled trees can survive and develop slowly in dried wood. Therefore these species often continue boring into wood that has been dried and processed (Anderson 1960). Wood remains a major raw material for furniture manufacturing in Nigeria despite the relatively recent incursion of plastic, glass and aluminum. Also, wooden furniture manufacturing remains a major source of employment generation in the country (Olorunnisola 2000). It is also the most widely distributed of all wood-based industries in the country. Wood-borers constitute the greatest threat to timber and timber products, even more than other factors combined (Beal 1981). Insects attack the lumbers of *A. lebbeck* which are not seasoned or partly seasoned. The finished timber product is also threatened by termites and other wood borers (Wood and Sands 1978). A worrisome fact about insect destruction of wood is that there is no stage of development that is free of their attacks. There is an array of insect's injuries at one particular time or the other (Ashiru 1996).

A. lebbeck wood is used for fabricating furniture and construction material. Generally Kala-koroi wood is used for making furniture after 25 to 30 years when maximum heart wood formed. Due to scarcity of wood, people are using Kala-koroi wood of 15 to 20 years containing more sapwood content. As a result, the untreated wood deteriorates quickly and therefore need to be replaced frequently within short time. Normally untreated Kala-koroi wood survives 25 to 36 months in outdoor condition. But properly treated wood might be last 4 to 5 times in outdoor condition. Sapwood is rather thick; heart wood dark blackish brown with darker streak and much valued as timber for decorative furniture and veneer. It is also suitable for construction work (Das and Alam 2001).

Materials and Methods

The Wood Preservation Division of Bangladesh Forest Research Institute (BFRI) carried out the treatability and natural durability of Kala-koroi (*Albizia lebbeck*) (L.) Benth. wood species which were collected from Patiya, under Chattogram district. The age of the tree was 20 years. Then the logs were sawn and dried planks at shed of Wood Preservation Laboratory in BFRI to reduce the moisture content. Average moisture content was 72.4% when the wood was collected. Before treatment, all planks were sized into 50.8 cm × 5.08 cm × 2.54 cm. A total number of 48 wood samples were prepared for the experiment (Fig. 2).

Figure 2. Untreated Kala-koroi wood samples.

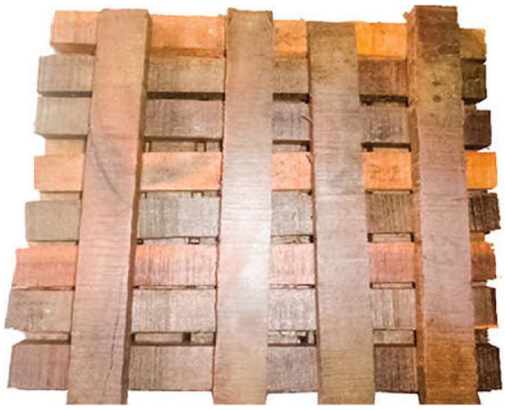

Figure 3. Treated Kala-koroi wood samples.

Then, all specimens were allowed to dry for reducing moisture content up to fiber saturation point (FSP) at 25–30% moisture content for treatment. Out of 48 samples, 24 samples were taken for soaking method and remaining 24 for diffusion method. 10% CCB aqueous solution was used in both the method. If the percentage is less than 10%, then retention rate become lower than the standard level. If the percentage is higher than 10%, and then retention rate become higher than the standard level but treatment cost rapidly increase, which is not economically viable. Wood will be treated by water-borne preservatives solution for obtaining required retention and reducing experimental period. The physical and mechanical properties of wood increase after treatment using 10% CCB aqueous solution (Shanu *et al.* 2015).

Firstly, for soaking method, every 6 samples were immersed into 10% CCB aqueous solution (2:2:1) for 5 days, 7 days, 9 days and 11 days separately. Tweenty four specimens were staked after treatment by soaking method (Fig. 3).

The average absorption and retention of immersed samples were determined by weighing the samples before and after treatment. Again, the samples were dried. First of all, dry samples were crossed-section for determination of penetration. Then, Chrome-azurals solution was applied in split wood samples which reacted with CCB preservatives and changed color. The blue color indicates the penetration of treated samples. Depth and intensity of blue color indicates penetration range and treatability group of treated samples. Finally, penetration and retention were measured of the specimens.

The maximum and minimum moisture content of wood specimens were 57.21% and 41.76% for diffusion method. Every 6 samples were immersed into 10% CCB aqueous solution (2:2:1) for 5 days, 7 days, 9 days and 11 days separately. The treated samples were removed from 10% CCB aqueous solution and kept 12 hours for drying. The average absorption and retention of immersed samples were determined by weighing the samples before and after treatment. The dried and treated

samples were crossed-section for determination of penetration. Then, Chrome-azurolS solution was applied in split wood samples which reacted with CCB preservatives and changed color. The blue color indicates the penetration of treated samples. Depth and intensity of blue color indicates the penetration range and the group of treated samples. Finally, penetration and retention were calculated of treated wood samples. Afterward, treated and untreated samples were kept in the stake yard for service test (Fig. 4).

Figure 4. BFRI Stake yard

Statistical design of experiment and analysis

The experiments were carried out in a completely randomized design (CRD) with 6 replications. SPSS statistical software was used for the data analysis. Analysis of variance (ANOVA) and least significant difference (LSD) test were carried out to evaluate the significant of differences among the different retentions of treated specimens.

Results

Wood specimens of Kala-koroi (*Albizia lebbeck*) (L.) Benth. were treated by soaking method using 10% CCB aqueous solution for different duration. Penetration and retention of treated samples were measured. Retention of preservatives of wood samples were recorded 1.96 kg/m^3, 11.78 kg/m^3, 12.92 kg/m^3 and 13.61 kg/m^3 when soaked for 5, 7, 9 and 11 days respectively (Table 1).

Table 1. Retention of preservatives in Kala-koroi (*Albizia lebbeck*) (L.) Benth. wood sample using soaking method.

Charge No.	Sample size (cm)	Treatment period (day)	Retention (kg/m^3) ± Standard error
1	2.54×5.08×50.8	5	1.96 ± 0.01
2		7	11.78 ± 0.02
3		9	12.92 ± 0.02
4		11	13.61 ± 0.02
		*F-value	0.68
		p-value	0.42

Note: The data is significant for 5% probability level (*F > p)

Wood specimens of Kala-koroi (*Albizia lebbeck*) (L.) Benth. were treated by diffusion method using 10% CCB aqueous solution for different duration. Penetration and retention of treated samples were measured. Retention of preservatives were recorded 5.22 kg/m^3, 6.43 kg/m^3, 7.32 kg/m^3 and 12.36 kg/m^3 when diffused for 5, 7, 9 and 11 days respectively (Table 2).

Table 2. Retention of preservatives in *Albizia lebbeck* (L.) Benth. wood sample (Size: 2.54 × 5.08 × 50.8 cm) using diffusion method.

Charge No.	Average moisture content (%)	Treatment period (day)	Retention (kg/m^3) ±
1	41.76 ± 0.09	5	5.22 ± 0.01
2	50.29 ± 0.10	7	6.43 ± 0.01
3	54.62 ± 0.07	9	7.32 ± 0.01
4	57.21 ± 0.62	11	12.36 ± 0.01
		*F-value	0.01
		p-value	0.91

Note: The data is insignificant for 5% probability level (*F < p)

Discussion

In this study, the highest retention of Kala-koroi was 13.61 kg/m^3 using soaking method for 11 days which can be supported with BSTI Standard. The retention of wood at 11 days is acceptable with the species of Kala-koroi. Different retention was measured in Kala-koroi applying different method and time period. The lowest retention was found 1.96 kg/m^3 at 5 days for this species when soaking method applied. The rate of retention increased rapidly at soaking period of 5 to 7 days. On the other hand, the rate of retention increased slowly at soaking period of 7 to 11 days. If treatment period was continued for more than 11 days in soaking method, retention would probably motionless.

In 57.21% moisture content, the highest retention was recorded 12.36 kg/m^3 with diffusion method which supports BSTI standard. In this study, the retention at 11 days is acceptable with the species of Kala-koroi. Different retention was found in wood samples due to applying different moister content and time period. The lowest retention was found 5.22 kg/m^3 at 5 days in the species of Kala-koroi when diffusion method applied. The rate of retention increased slowly at treatment period of 5 to 9 days. On the other hand, the rate of retention increased rapidly at treatment period of 9 to 11 days.

According to Bangladesh Standard Testing Institute (BSTI), timbers in direct contact with ground or water, especially in outside locations, such as poles, piles, fence-posts, etc. the required retention for CCA preservative chemical is 8–16 kg/m^3 (Anon 1975). In this study, the retention results of treated samples at 11 days are acceptable for both the methods.

Chandra and Gupta (1972) stated that, 16 kg/m^3 of dry salt was necessary for the effective preservation of the poles in contact with ground. In the experiment, the highest retention was found 13.61 kg/m^3 and 12.36 kg/m^3 for the species which is near up to standard level and matched with Chandra and Gupta (1972). Research report of Commonwealth Scientific and Industrial Research (CSIR) (Du Toit and Conradie 1988) indicated that average sapwood retention levels are required for adequate protection of poles against wood rot and termite attack. Findings of the present study prove that penetration and retention level can be maximized into Kala-koroi wood by applying soaking and diffusion method. Accordingly, this wood can be free from wood rot and termite attack resulting in escalating the durability.

Conclusion

Kala-koroi can be treated with CCB solution. Subsequently the wood can be used commercially. It is mentionable that untreated samples were affected by insects, fungus etc. within 8 to 9 months. Till now, the treated samples are in good condition. Treated and untreated wood samples were kept in BFRI stake yard for service test. Longevity of *Albizia lebbeck* was enhanced in association with soaking and diffusion method. Prescribed to use the wood with the narrated treatment for short time use at outdoor and for life time use at indoor condition.

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References

Anderson, F.R. 1960. Forest and shade tree entomology. John Wiley and Sons, Inc. New York, London 428 pp.

Anon. 1975. Code of practice for preservation of timber. Bangladesh Standards of Testing Institution BDS. 819: 1975, Dhaka 33 pp.

Ashiru, M.O. 1996. Management of insect pest and diseases of forest tree species in Nigeria. *Proceeding of IUFRO Symposium on Impact of Disease and Insect Pest in Tropical Forest.*

Beal, R.H. 1981. Termite control Studies in Panama. US Department of Agriculture, Forestry Services and Resources, 6 pp.

Chandra, A. and Gupta, R.B. 1972. Fence-Posts Preservation by the Sap-displacement method. *Journal of Timber Development Association India* (8) 4: 5–9.

Cook, B.G.; Pengelly, B.C.; Brown, S.D.; Donnelly, J.L.; Eagles, D.A.; Franco, M.A.; Hanson, J.; Mullen, B. F.; Partridge, I.J.; Peters, M. and Schultze-Kraft, R. 2005. *Tropical forages*. CSIRO, DPI & F (Qld), CIAT and ILRI, Brisbane, Australia.

Das, D.K. and Alam, M.K. 2001. Trees of Bangladesh. Bangladesh Forest Research Institute, Chattogram. 342 pp.

Du Toit, C.B. and Conradie, W.E. 1988. Preservative retention requirements based on sapwood volume for E.qrandis and Eclocziana. September 1988. (R20 & GST). ISBN: 9780798843904, 079884390X; OCLC Number / Unique Identifier: 122281310

Duke, J.A. 1983. Handbook of Energy Crops. New CROPS web site, Purdue University.

FAO. 2010. Grassland Index. A searchable catalogue of grass and forage legumes. FAO, Rome, Italy.

Khan, M.A and Ungar, I.A. 1996. Comparative study of chloride, calcium, magnesium, potassium, and sodium content of seeds in temperate and tropical halophytes. *Journal of Plant Nutrition* 19 (3–4): 517–525.

Lowry, J.B.; Petheram, R.J.; Tangendjaja, B. 1992. Plants fed to village ruminants in Indonesia. Notes on 136 species. Their

composition and significance in village farming systems. ACIAR Technical Reports No. 22 .

NAS. 1980. Firewood crops: Shrub and tree species for energy production. NAS, Washington D.C., USA.

Olorunnisola, A.O. 2000. Workshop structure in the small-scale furniture industry in ibadan metropolis. *Journal of Tropical Forest Resources* 16(1): 46–57.

Orwa, C.; Mutua, A.; Kindt, R.; Jamnadass, R. and Anthony, S. 2009. Agro-forestry Database: a tree reference and selection guide version 4.0. World Agroforestry Centre, Kenya.

Shanu, S.A.; Das, A.K.; Rahman, M.M. and Ashaduzzaman, M. 2015. Effect of Chromate-Copper-Boron preservative treatment on physical and mechanical properties of Rajkoroi (*Albizia richardiana*) wood. *Bangladesh Journal of Scientific and Industrial Research* 50 (3): 189-192.

Uddin, M.B.; Ahmed, R.; Mukul, S.A. and Hossain, M.K. 2007. Inhibitory effects of *Albizia lebbeck* leaf extracts on germination and growth behavior of some popular agricultural crops. *Journal of Forestry Research* 18 (2): 128−132.

Wood, T.G. and Sands, W.A. 1978. The role of termites in ecosystems. In: Brain, M.V., Ed., Production ecology of ants and termites. Cambridge, Cambridge University Press, 245–292 pp.