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Enhencement of Life Span of Mahogany (*Swietenia macrophylla*), Raintree (*Albizia saman*) and Akashmoni (*Acacia auriculiformis*) Wood Treating with CCB Preservative

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ABSTRACT

This study summarizes results of a research aimed at assessing of preservative treatment of sapwood and heartwood of three important fast growing timber species of Bangladesh i.e., *Swietenia macrophylla* (mahogony), *Albizia saman* (raintree) and *Acacia auriculiformis* (akashmoni) with CCB by dipping method. Heartwood and sapwood of the three species treated with 8% concentration of Chromate-copper-boron (CCB) at 2:2:1 ratio using non-pressure dipping method for 72 h in the laboratory. The treated wood of these three species was inoculated with white-rot fungus (*Ceriporiopsis subvermispora*) to identify the effectiveness of CCB treatment. It was found that retention of CCB preservatives and penetration of boron was the highest for sapwood (7.29 kg m^{-3} and 98.63%) and heartwood (4.736 kg m^{-3} and 84.51%) of raintree among the three species. The weight loss percentage was the lowest for sapwood (0.62%) and heartwood (1.01%) of raintree among the three species. So, it was considered that heartwood and sapwood of raintree was provided best results.

Key words: CCB, *Swietenia macrophylla*, *Albizia saman*, *Acacia auriculiformis*, *Ceriporiopsis subvermispora*, weight loss (%)

INTRODUCTION

Wood deterioration is caused mainly by biological agents. The greatest financial losses from biodeterioration result from decay fungi (Hayhreen and Bowyer, 1982). Therefore, it is essential to increase life under service condition. Preservative treatment of timber therefore forms a very important part of the national effort to conserve the material resources of the country (FAO, 1986). Generally near the bark there is a light colored wood which is called sapwood. It is located next to the cambium. Secondary changes that take place as a result of this lead to formation of a physiologically dead part of the xylem called heartwood. Heartwood is the central portion of the wood is generally darker in color. The heartwood is the preferred portion of wood, because in many woods the discoloring substances are toxic to insects and fungi which decay wood (Panshin and Zeeuw, 1980). Actually, natural durability means the inherent ability of timber to resist decay and other destructive agencies. So, heartwood often offers greater resistance to decay than sapwood.

In its natural state, sapwood of all timbers is non durable while the heartwood of only a few species of timbers is durable (Desch and Dinwoodie, 1996). Preservative will be helpful for evaluating their potential for various end-uses.

The main object of all treatment processes is to get adequate quantity and uniform distribution of preservative inside the timber there are several methods of applying preservatives, some of which are superior to others and each method has certain advantages which make it suitable under a particular set of condition. Preservation method may be grouped into either pressure processes or non-pressure processes. Dipping method consists of simply immersing the wood in a bath of preservative chemical for few hours. It also gives more efficient result (FAO, 1986). Preservatives include such chemicals which are used to protect wood against deterioration from fungi, decay, insects, marine borers, fire and chemical action (Lahiry, 2001). White rot fungus is generally more virulent than brown rot fungi in hardwood species (Eaton and Hale, 1993). The preservative treatments depend on the treatability of the timber species, moisture content before treatment and its anatomical structure. The widely used preservation method in Bangladesh is full cell process. Beside this, soaking or dipping method should be used for different wood species because it is very simple method any one can treat wood by this method. Wood, Bamboo and sun grass were treated with Copper Chromated Arsenate (CCA) but after some laboratory trials at Forest Research Institute (FRI), Copper Chromated Arsenate (CCA) is being replaced by Copper Chromated Boron due to low cost and available in market (Latif *et al*., 1987).

Now-a-days people are very concern about Environment for this reason CCB preservative has got higher acceptance. Thus this study was intended to find out and compare the retention, penetration and efficacy of CCB preservative in sapwood and heartwood of mahogony, raintree and akashmoni by dipping method.

MATERIALS AND METHODS

Collection and preparation of wood samples: Defect free mahogany, raintree and akasmoni were collected from commercial plantation at Batiaghata, Khulna, Bangladesh. The age of each tree was 10 years. Diameter of mahogany, raintree and akasmoni were 20, 28 and 30 cm, respectively. The trees were sectioned into three parts i.e., top, middle and bottom. The samples were collected from each position and the size of the sample was 35×5×2.5 cm. The converted samples were dried into oven at 105°C to get constant weight.

Treatment of CCB preservatives: The CCB preservative was made by mixing chromium, copper and boric acid with the salt-based ratio of 2:2:1 or 40%: 40%: 20% in one liter of water which are equivalent to oxide based ratio of 45.33%: 21.33%: 33.33% respectively (Lahiry, 1996). All the samples were dried in oven under a constant temperature (105°C) for getting constant weight. The samples were submerged under 8% CCB solution for 72 h. After the desired duration, the dipped samples were taken out from preservative solutions removing excess preservative from the surface of the samples and placed in newsprint paper. Then the final weight was taken as quick as possible in room temperature before testing preservative penetration for copper and boron using standard reagents as approved by AWPA (1996).

Determination of preservative retention: Preservative retention of wood samples was calculated by volumetric analysis. To determine the retention, two weights of every sample were taken i.e., initial weight before treatment and initial weight after treatment. Then the weight of

preservative solution penetrated in the sample, was calculated from the difference of these two weights. Retention was expressed as kg m^{-3}. Finally, the following equation was used to determine the retention (Jayanetti, 1986).

$$\text{Retention} = \frac{\text{Weight of salt (kg)}}{\text{Volume of sample (m}^3\text{)}}$$

Here,

$$\text{Weight of salt} = \text{Solution strength} \times \text{volume of solution}$$

Determination of preservative penetration: After dipping, the samples were dried in the oven for the determination of penetration and retention. The penetration of preservatives into the timber can easily be determined on site by using color reagents. The 15×5×2.5 cm wood samples were cut into two parts longitudinally. Then reagents were given on fresh cut surface to determine the depth of penetration of copper and boron used in CCB preservative solution.

Boron: The indicator solutions were prepared in the laboratory following AWPA standard (AWPA, 1996). Solution 1 was applied, preferably by spraying on the surface to be treated. The surface was then allowed for a few minutes to dry. Solution 2 was then applied in a similar manner to the areas that had been colored yellow by the application of solution 1. The color change was observed carefully and after a few minutes the yellow color of turmeric solution turned red because of the presence of boron. After reagent application, the wood samples were placed in warm oven to accelerate and intensify the color reaction. The deep red color shows better penetration of boron from the preservative solution.

Copper: Concentrated chrome azurol (0.5 g) and 5 g sodium acetate were dissolved in 80 mL of water and diluted to 500 mL (AWPA, 1996). The solution was sprayed over freshly cut surfaces of treated wood sample. Deep green color reveals the presence of copper and dried wood gave better results (AWPA, 1996).

Determination of mass loss: The sample size of sapwood and heartwood was 1×1×1 cm. Every sample was dried into oven at 103±2°C until constant weight to determine dry weight (initial weight, $M_{o)}$ sterilized (autoclaved) and exposed to actively growing pure culture of *C. subvermispora* cultivated in petri dishes. Petri dishes were incubated for 6 weeks at 35°C and 70% relative humidity. At the end of the exposure after 6 weeks the samples were withdrawn from the cultured Petridis. The test blocks were carefully brushed off the fungal mats (mycelium) and dried in the oven at 103±2°C to obtain constant weight (final weight, M). The mass loss due to decay was calculated by using the following equation (Amusant *et al*., 2007).

$$\text{Loss of mass in wood (\%)} = [(Mo-M)/Mo] \times 100$$

Mo = Oven dry weight of wood before the decay test
M = Oven dry weight of wood after the decay test

RESULTS AND DISCUSSION

Retention of CCB preservatives in three different species: The retention of mahogony, akashmoni and raintree of heartwood were 3.91, 2.74 and 4.74 kg m^{-3}, respectively whether the retention of these thee species of sapwood were 6.10, 6.14 and 7.29 kg m^{-3}, respectively (Fig. 1). The higher retention is found in heartwood and sapwood of raintree (Fig. 1). Retention of sapwood of the three species is higher than heartwood of the three species and raintree sapwood is the highest retention among all treated sample. In this study, the treatment results show that raintree sapwood can easily be treated by dipping method achieving adequate retention. According to REB standard (REB, 1988), the retention of CCB is 8.00 kg m^{-3}. For outdoor overhead cross arms 6.40 kg m^{-3} CCA are required. The retention is dependent upon the density of the species (Desch and Dinwoodie, 1996).

According to Akther *et al.* (1992) the retention of CCB treated rubber wood 9.86 kg m^{-3}, having moisture content 20% of the wood sample for 4 days socking period. Similar findings were noticed with the hardwoods of temperate regions (Smith and Williams, 1969). According to different findings, the retention was lower for heartwood where the retention of sapwood was more or less similar of the three species. So, after treating with CCB, these three species can be used for various types of interior purposes.

Penetration of CCB preservatives in three different species: The effectiveness of a wood Preservative depends on several factors, one of which is depth of penetration of the preservative into the wood. Inadequate penetration may allow fungi and insects to enter through checks or through the thin sell of less treated wood in order to reach the inner unprotected wood. The depth of penetration attainable by a wood preservative depends on the wood species, the maturity of wood and the treatment procedure used. Generally in all timber products do not show 100% preservative penetration and always, it does not require 100% penetration for all items or commodities (Johnson *et al.*, 1982). But the general opinion is that it should be treated with well penetrated for desired durable life.

Penetration of boron: The boron penetration of heartwood of mahogony, akashmoni and raintree were 58.18, 46.02 and 84.51%, respectively (Fig. 2). But the boron penetration of sapwood of mahogony, akashmoni and raintree were 66.36, 79.31 and 98.63%, respectively (Fig. 2). The higher penetration was in heartwood and sapwood of raintree (Fig. 2). Even, the penetration was higher in sapwood than that of heartwood. This variability of penetration can be described by different author. According to Desch and Dinwoode (1996) the free movement of liquids in case of

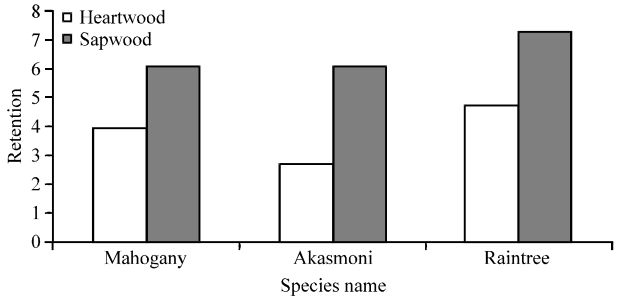

Fig. 1: Retention in three different species

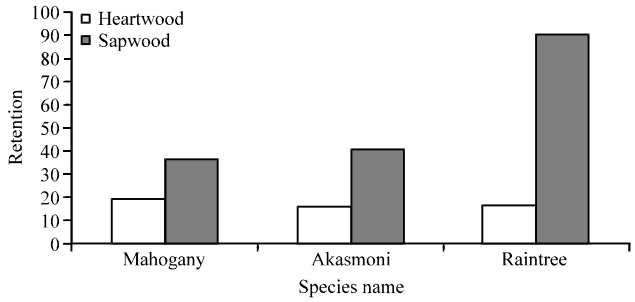

Fig. 2: Penetration of boron in three different species

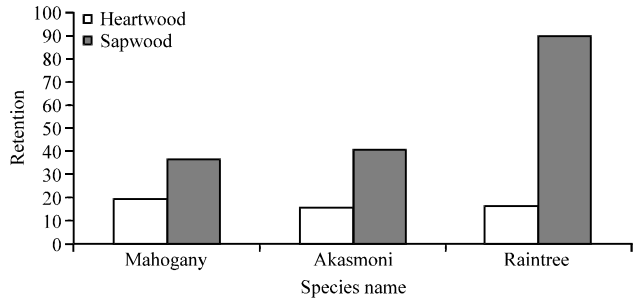

Fig. 3: Penetration of copper in three different species

heartwood is interrupted due to the deposition of various substances on the walls of most cells of heartwood. In addition, the permeability of heartwood is decreased due to deposition and hardening of some extractives, e.g. gums, resins, tannin etc. In some inorganic granules are deposited, e.g. silica which protects wood (Wilkinson, 1979). Boron is impregnated in these three species sufficiently because boric acid can penetrate the heartwood of some timber species as it is a diffusible preservative.

Penetration of copper: In case of heartwood, the copper penetration of mahogony, akashmoni and raintree were 19.40, 16.41 and 16.76%, respectively (Fig. 3). On the other hand, the copper penetration of mahogany, akashmoni and raintree was 36.95, 41.09 and 90.22%, respectively for sapwood (Fig. 3). The higher copper penetration was found in heartwood of mahogany and sapwood of raintree (Fig. 3). It was also found that the higher copper penetration was in sapwood than that of heartwood. The reason of variability of penetration of copper is same which is described in case of boron. As a result, Sapwood is treatable and penetrable by copper sufficiently.

Weight loss of three different species: The weight loss of treated heartwood of mahogony, akashmoni and raintree were 1.60, 1.71 and 1.01%, respectively (Fig. 4). On the other hand, the weight loss of treated sapwood of mahogony, akashmoni and raintree were 1.48, 1.60 and 0.62% respectively (Fig. 4). The lowest weight loss was for sapwood and heartwood of raintree whether highest weight loss for heatwood of mahagony and sapwood of akashmoni (Fig. 4). But the weight loss of treated sapwood was always lower than treated heartwood for all the three species. This difference is due to the penetration of CCB into the two types of treated wood. The penetration was higher in sapwood than heartwood for all the three species. This difference has been described in

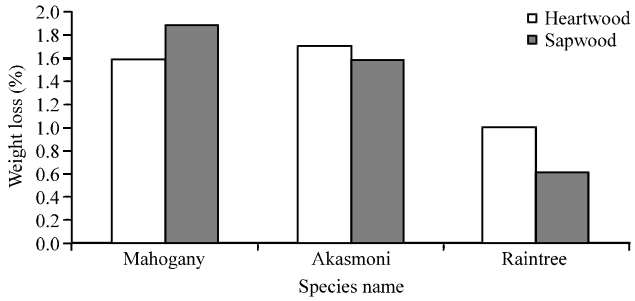

Fig. 4: Weight loss in three different species

Table 1: Analysis of variance

Retention of CCB		Penetration of boron		Penetration of copper		Weight loss	
Heartwood	Sapwood	Heartwood	Sapwood	Heartwood	Sapwood	Heartwood	Sapwood
ns	*	*	*	ns	*	*	*

*Significant difference, $p<0.05$ and ns: Not significant difference, $p>0.05$

case of boron penetration. On the basis of weight loss (%) the treated wood can be divided into different durability class. According to Yamamoto *et al.* (1996), Weight loss less 1% is very durable, 1-5% durable, 5-10% is moderately durable, 10-30% is non durable and over 30% is perishable. So, raintree sapwood was very durable where other treated samples were durable.

From the analysis of variance, it was found that there was significant difference (Table 1) for retention of sapwood, boron penetration of heartwood and sapwood, copper penetration of sapwood, weight loss of heartwood and sapwood among the three species. It was also found (Table 1) that there was no significant difference for copper penetration of heartwood, retention of sapwood among the three species.

CONCLUSION

Easily available CCB is more effective for both fungus and insects. Even, it acts fire-retardant as well as it is environment friendly. Diffusion method is the easiest one which is possible to treat without any complexity. In this study, it was found that the retention of CCB in the three species is near to the different findings. It was also found that the treated heartwood and sapwood were durable to very durable. These treated woods can be used for both outdoor and indoor uses. This study is necessary for other fast growing non durable species.

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