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Short communication

Diffusion treatment of coconut palm wood using organic preservatives

V. J. Jeeshma[1], E. V. Anoop*[1], T. K. Dhamodaran[2], K. Vidyasagaran[1], T. K. Kunhamu[1] and S. Gopakumar[1]

[1]*College of Forestry, Kerala Agricultural University, Thrissur 680 656, Kerala, India.;*
[2]*Kerala Forest Research Institute, Peechi, Thrissur 680 653, Kerala, India.*

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Abstract
Sawn coconut palm wood of differing wood densities (high and medium) were treated with three organic preservatives, viz., neem oil, cashew nut shell liquid (CNSL) and turpentine. The method adopted was diffusion treatment at various diffusion periods viz., 40, 80 and 120 minutes and absorption percentage of preservatives by sawn coconut wood samples (5 cm × 5 cm × 50 cm) was studied. Both high density wood (HDW) and medium density wood (MDW) samples of coconut palm showed no significant difference in absorption percentage with varying diffusion periods and no significant difference was observed between the chemicals and interaction between the chemicals and diffusion periods.

Keywords: Cashew nut shell liquid (CNSL), Coconut palm wood, Neem oil, Organic, Preservative treatment, Turpentine.

Coconut (*Cocos nucifera* L.) palm wood belongs to the class of perishable timbers which can be used as an alternative wood source with effective preservation. Preservative treatment of coconut wood can enhance its service life, so that it can be used as a potential alternative for conventional timber species. Effective utilization of coconut palm wood resource can be a solution for the diminishing timber supply. High density wood (dermal, over 600 kg/m^3) and medium density wood (sub-dermal, 400-600 kg/m^3) of coconut palm can be used for structural purposes. Conventional wood preservative was found to be effective in treating wood of commercial timbers; however, it also causes major environmental pollution and has mammalian toxicity (Onuorah, 2000). Over the past few decades, there has been substantial global awareness to develop eco-friendly wood preservatives, and those which do not cause any ill effects to the health of mammals. Researchers across the world have been attempting to develop eco-friendly preservatives with reasonably good results (Xu et al., 2013).

Green plants act as an inexhaustible source of innocuous fungicides or pesticides, which are mammalian non-toxic and are easily biodegradable. Plant extract based preservatives have large potential due to their target toxicity towards micro organisms and termites and safety for mammals. Plant products like terpenes, alkaloids, phenols and alcohols have anti-fungal and anti-bacterial properties (Saxena and Dev, 2002), and neem (*Azadirachta indica*) possesses a number of constituents exhibiting high toxicity against wood-destroying microbes (Dhyani et al., 2004). Efforts have been made by many workers to use these plant products for the amendment of toxic metals, and tested them for durability against termites or fungi (Dev and Nautiyal, 2004). Venmalar and Nagaveni (2005) evaluated the effectiveness of CNSL and neem oil in the preservation of rubber wood and

*Author for Correspondences: Phone: 91-9495375541, Email: anoop.ev@kau.in

found that treated wood showed resistance against wood rotting fungi and termites.

Subbaraman and Brucker (2001) studied the efficiency of neem oil on addition of binding and bittering agents. They also used hot neem seed oil on *Bamboosa vulgaris* at 60^{0}C. Bamboo showed improved water resistance, anti-swelling efficiency and dimensional stability. Islam et al. (2009) investigated the anti- fungal properties of neem extract and found that neem leaf extract alone showed high levels of resistance against the fungi *Schizophyllum commune*.

The present investigation focussed on the standardization of preservative treatment for coconut palm wood using organic preservatives and evaluated the effect of varying diffusion periods on absorption percentage of preservatives.

Preparation of samples

Wood samples (5 cm × 5 cm × 50 cm) were air dried to reduce the moisture content level to about 50 per cent. The samples were then sorted into high density (HDW) and medium density wood (MDW) samples using a pilodyn (FUJI TECK, Tokyo, Japan) in which 6.0 Joule force and 2.5 mm pin diameter were used for taking measurements. The readings were taken at the middle point of each sample and grouped into high and medium density wood on the basis of the pin penetration depth (PPD). All the samples that showed ≤ 20 PPD were sorted as high density wood, and those with readings between ≤ 20 to ≥ 28 PPD as medium density wood. The samples having reading above 28 PPD were grouped as low density material (LDW) which could not be used for structural purposes, and were hence discarded.

Diffusion treatment

Diffusion treatment achieves deep penetration of water-borne preservatives by the gradual diffusion of the chemicals from a solution. The wood samples were immersed in chemical solutions having 100 percent concentration (crude form) for a time period, allowing penetration of the chemicals into the wood (Findlay, 1985). In the present study, the durations of diffusion was fixed as 40, 80 and 120 minutes.

Preservation of samples

Both HDW and MDW samples were immersed in organic chemicals, *viz*., CNSL, neem oil and turpentine, for varying durations of diffusion period and all the preservatives were applied in crude form. The major observation recorded in the study was absorption percentage. The weight (kg) of each sample was recorded before and after treatment. Absorption percentage for organic chemicals was calculated as follows:

$$\text{Absorption percentage (\%)} = \frac{\text{Weight after treatment - Weight before treatment}}{\text{Weight before treatment}} \times 100$$

Statistical Analysis

Three replications were used in the study and the data was analysed by two-way ANOVA model using IBM SPSS (Ver.21.) for the comparison between preservatives and the effect of diffusion period on absorption percentage.

Diffusion treatment

Tables 1 and 2 compare the means of absorption percentage of organic preservatives by HDW and MDW respectively. Both HDW and MDW showed no significant difference between chemical concentrations and treatment durations and the interactions of these factors were also non-significant. Neem oil showed an increasing trend of absorption with increasing duration of diffusion

Table 1. Absorption percentage with respect to duration of diffusion treatment in HDW

Chemicals	Duration (Minutes)		
	40	80	120
CNS liquid	13.69	12.98	6.84
	(3.61)	(3.61)	(3.61)
Neem oil	9.31	12.76)	15.32
	(3.61)	(3.61)	(3.61)
Turpentine	6.75	14.15	10.44
	(3.61)	(3.61)	(3.61)

Values within parentheses are standard errors (SE) of means

Table 2. Mean of absorption percentage with respect to duration period in diffusion treatment in MDW

Chemicals	Duration (Minutes)		
	40	80	120
CNS liquid	8.98 (5.60)	11.08 (5.60)	14.78 (5.60)
Neem oil	11.86 (5.60)	20.53 (5.60)	20.42 (5.60)
Turpentine	19.70 (5.60)	19.64 (5.60)	15.93 (5.60)

Values within parentheses are standard errors (SE) of means

treatment in HDW, whereas CNSL showed an increasing trend of absorption with increasing duration of diffusion period in MDW. All other chemicals did not follow any definite pattern and there was no observable difference between HDW and MDW in absorption of chemicals. Venmalar and Nagaveni (2005) observed slightly higher absorption for CNS liquid when absorption of neem oil was compared to CNS liquid. Contradictory to this, neem oil achieved higher absorption than CNS liquid in our study. There was no significant difference among the preservatives and more or less similar absorption was achieved by the chemicals. According to Kaur et al. (2016), CNS liquid treated wood panels showed resistance up to 24 months of exposure. Pressure treated wood using CNS liquid was reported to provide good protection against white and brown rot fungi. Machado et al. (2013) observed resistance of turpentine against five species of decay fungi and two species of termites. Neem oil absorption showed an increasing pattern between 40 and 80 minutes, but did not absorb any more chemicals during 120 minutes of diffusion period (Table 2). Dhyani et al. (2004) reported effectiveness of neem oil against wood decaying fungi. Islam et al. (2009) made similar observations while treating mango timber with neem oil and boric acid. He found that neem oil alone showed comparable performance in anti-fungal efficiency. Turpentine had least chemical retention after 120 minutes of diffusion period as compared to 40 and 80 minutes. Machado et al.(2013) observed resistance of turpentine against five species of decay fungi and two species of termites. The difference in absorption may be due to the unique anatomy of coconut wood and variation in the moisture content of wood samples.

The present study showed that the trend of absorption followed no specific pattern, and density and diffusion period had no marked influence on the absorption percentage of chemicals. Furthermore, the effectiveness of all preservatives will have to be evaluated through grave yard tests to validate the results obtained in this investigation.

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Figure 1. (a)Wood samples treated with neem oil (b) Wood samples treated with turpentine (c)Wood samples treated with CNS liquid

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