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Mini Review

Effectiveness of extractives from parts of ghanaian pawpaw, avocado and neem

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Conventional preservatives are not only toxic to wood bio-deteriorators, but also to humans and animals. In an effort to find preservatives that are non-toxic to humans and animals, efficacy of water extracts of heartwood of *Azadirachta indica* (Neem) and leaves of *Persea americana* (avocado) and *Carica papaya* (pawpaw) at 0.24%, was tested on the durability of wood of *Alstonia boonei* by pressure impregnation and buried in a termite-prone field for 5 weeks following a modified EN 252 and Gay et al. (1957). Efficacy was tested on the basis of visual durability ratings, percentage hardness and mass losses of impregnated alstonia wood after burial. Though alstonia wood retained pawpaw extract least, pawpaw extract improved the durability of alstonia wood most. Pawpaw extract could be used to improve the durability of alstonia wood better at 0.72% (3x0.24%) and on triple treatment. 83% of Anloga furniture makers who saw the efficacy of pawpaw extract at 0.72% and on triple treatment, showed a high sense of interest in preservative botanical extracts.

Key words: Eco-friendly, termite, efficacy, standardization, percentage hardness loss, percentage mass loss, visual durability rating.

INTRODUCTION

Over the years, wood users have treated wood with conventional preservatives such as pentachlorophenol, tri-butyl-tin oxide, creosote, and Pyrinex 48EC. Creosote, an oil-based preservative, is acknowledged as one of the oldest and most effective industrial wood preservatives (Wood Preservation Canada, 2008). Pyrinex 48EC (chlorpyrifos), a well-known and effective agricultural insecticide, is a good choice against insect attack on wood, particularly termites (Wood Preservation Canada, 2008). These conventional preservatives are not only toxic to bio-deteriorators of wood, but also to humans and animals. Even chromated copper arsenate (CCA), the most widely used preservative in Ghana (Ofori and Bamfo, 1994), which was thought to be non-toxic to humans and animals because of its permanence and stability in wood (Wood Preservation Canada, 2008), is now known to leach into the environment over time (Richardson, 1978). Some of the hazards of conventional preservatives to humans and animals are damage to liver and foetuses (Findlay, 1985). These hazards have necessitated increased research into alternative preser-vatives, that are equally effective as conventional ones, but harmless to humans and animals in a chance contact.

One promising way of avoiding wood-preservative hazards is the use of extractives from durable wood species such as *Milicea excelsa* (odum), *Tectona grandis* (teak), *Azadiracta indica* (neem), *Erythropleum suaveolens* (potrodom) and *Piptadeniastrum africanum* (dahoma), which contain polyphenols such as tannins, lignans, lapacols, tectoquinones and terpene acids (Lame and McAnn, 1985) to preserve less durable wood species in service. Extractives of *A. indica* (neem), *Carica papaya* (pawpaw) and *Persea americana* (avocado) have not only been found to possess insecticidal, termicidal and anti-microbial properties but also preserve generic diversity, such that termite numbers for instance are con-trolled rather than eliminated, so that benefits provided by termites are not lost (Howtopedia, 2007). Their active compounds are biodegradable, hence environmentally

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Table 1. Least significant difference for retention of extracts in alstonia wood.

t Grouping	Mean	N	Extract
A	8.857	15	*A. indica*
B	5.836*	15	*C. papaya*
B	4.730 *	15	*P. americana*

Treatment means with the same treatment grouping are not significantly different; Alpha: 0.05; error degrees of freedom: 42; error mean square: 8.039892; critical value of t: 2.01808; least significant difference: 2.0895.

friendly and cost effective (Neemtreefarms, 2007; Burkill, 1985). Neem wood is tough and resistance to decay and termites (ICRAF, 1992). Haygreen et al., (1982) reported heartwood of neem to be generally resistance to decay fungi and insects. Thus, the efficacy of water extracts of heartwood of *A. indica* (Neem) and leaves of *P. americana* (avocado) and *C. papaya* (pawpaw) at 0.24%, was tested on the durability of wood of *Alstonia boonei* which is less durable and used due to high abundance in the forest (TEDB, 1994) by pressure impregnation and buried in a termite-prone field for 5 weeks, following a modified EN 252 and Gay et al. (1957). Likelihood of adoption of pawpaw extract was ascertained from two groups of 100 Anloga furniture-makers each (one for 0.24% and the other for 0.72%). The purpose of this study is to evaluate the efficacy of extractives from pawpaw, avocado and neem as preservatives to enhance the durability alstonia wood.

MATERIALS AND METHODS

Extractives extraction method

Heartwood or leaf granules of neem, avocado and pawpaw were dried and milled to 40 to 60 mesh size. Extracts were removed from meal by gentle warming on hot plate at 60°C or lower (Rudman and Da Costa, 1959) for 3 h. Neem, avocado and pawpaw meal (1018.8 g) were steeped in 10188 ml distilled water. Extracted solution was decanted into a plastic drum and stored in a conditioning room to maintain its concentration. Concentration (%) of extract was determined by evaporating a 100 ml aliquot on a water bath to solute.

Timber treatment method

5 L of extracts at 0.24% concentration were used to impregnate 250 x 25 x 2.5 mm air-dried (25 to 30% moisture content [MC]) of alstonia wood stakes. With each extract, controls (untreated) apart, 15 stakes (250 x 25 x 2.5 mm) were impregnated at 120 kPa, 123°C for 2 h). Stakes were conditioned for 90 min to allow for fixation after impregnation and then reweighed to the nearest 0.5 g to determine uptake of preservative chemical. Retention of chemical preservatives (g/mm^3) in each stake (R1) was determined as $[R1 = (q2 - q1)/v]$ (Asamoah et al., 2008), where q1 is the mass of air-dried untreated stake, q2 is the mass of air-dried treated stake, and v is the volume of air-dried untreated stake.

Consequently, mean retention (Rn) was determined as $[Rn = (R1 + R2 + R3 \ldots Rn)/n]$, where Rn is the nth treated stake in a charge of 15 stakes (one treatment-chamber load).

Field installation of stakes

Treated and untreated stakes were buried after reweighing in a termite-prone field to accelerate attack for 5 weeks. Efficacy was tested on the basis of visual durability ratings, percentage hardness and mass losses of impregnated stakes after 5 weeks of burial. Stakes were rated visually following Gay et al. (1957) on a scale of 1 to 4 (1 = No contact/ surface nibbles ≤ ⅛ in. deep, 2 = Surface attack ≤ ¼ in. deep, 3 = Surface / localised attack to >¼ in. deep, 4 = Pronounced attack >¼ in. deep) and the average rating for each treatment was calculated. Hardness of stakes was taken with Proceq Pilodyn {0 being no penetration [highest hardness] and 40 the deepest penetration [lowest hardness]}. Percentage hardness losses of stakes were calculated on air-dried hardness instead of oven-dry hardness of stakes as Hardness loss $= [(Rh - Ih)/Ih] \cdot 100\%$, where Ih is initial hardness of stakes and Rh is final hardness of stakes.

Percentage mass losses of stakes were calculated on air-dried mass instead of oven-dry mass of stakes as mass loss $= [(I - R)/I] \cdot 100\%$ (Kumi-Woode, 1996), where I is initial mass of stakes and R is the final mass of stakes. Setup was completely randomized (CRD) with visual durability ratings, percentage hardness loss or percentage mass loss as a single-factor (efficacy response) in which corresponding control, neem, avocado and pawpaw-extract-treated values were treatments (levels of each single factor). Differences between means of treatments of each single factor were analysed for significance, using least significant difference (LSD) at 5% significance level with SAS (2008) software. To ascertain likelihood of adoption of pawpaw extract by Anloga furniture-makers, two groups of a 100 (one treated once at 0.24% and the other treated three times over at 0.72%) were asked to test pawaw extract on freshly made Alstonia furniture against powder post beetle attack for 5 weeks by brushing.

RESULTS

Typical of most perishable timbers (Ofori and Bamfo, 1994), extract retention in alstonia wood varied, with neem extract being retained the most, pawpaw extract intermediarily and avocado the least (Table 1). Alstonia wood treated with pawpaw extract recorded the lowest visual durability rating, percentage hardness loss and percentage mass loss (that is least susceptible to attack), while that treated with neem intermediary visual durability, percentage hardness loss and percentage mass loss and that treated with avocado, recorded the highest visual durability rating, percentage hardness loss and percentage mass loss (that is most susceptible to attack) (Figures 1, 2 and 3). From ANOVA, there was no significant difference in the visual durability ratings and percentage hardness loss of pawpaw, neem and avocado extracts treated alstonia wood (Tables 2, 3 and 4). 50 and 83% of Anloga furniture makers reported that, pawpaw extract at 0.24 (treated once) and 0.72% (treated three or times over) respectively, resisted

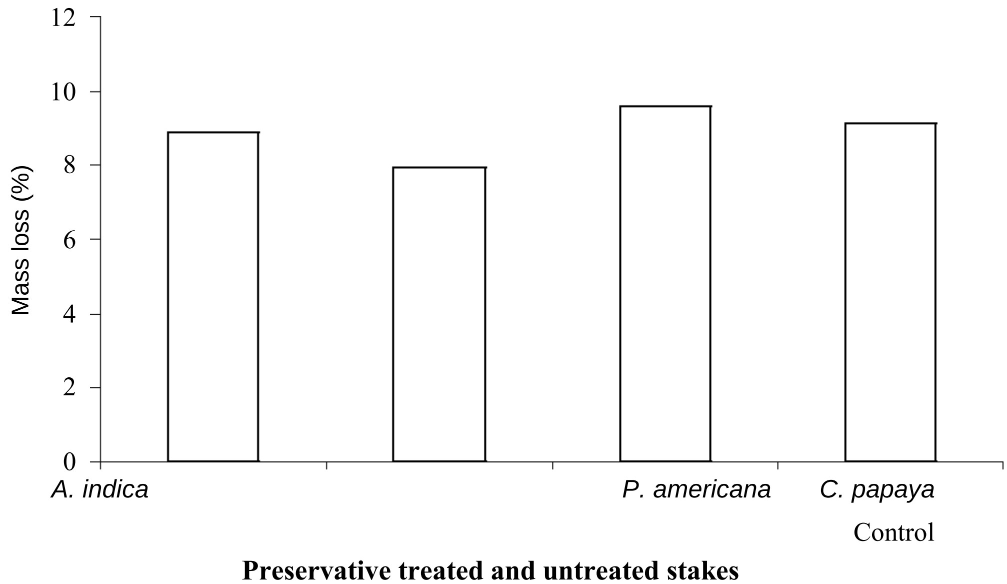

Figure 1. Percentage mass loss of alstonia wood.

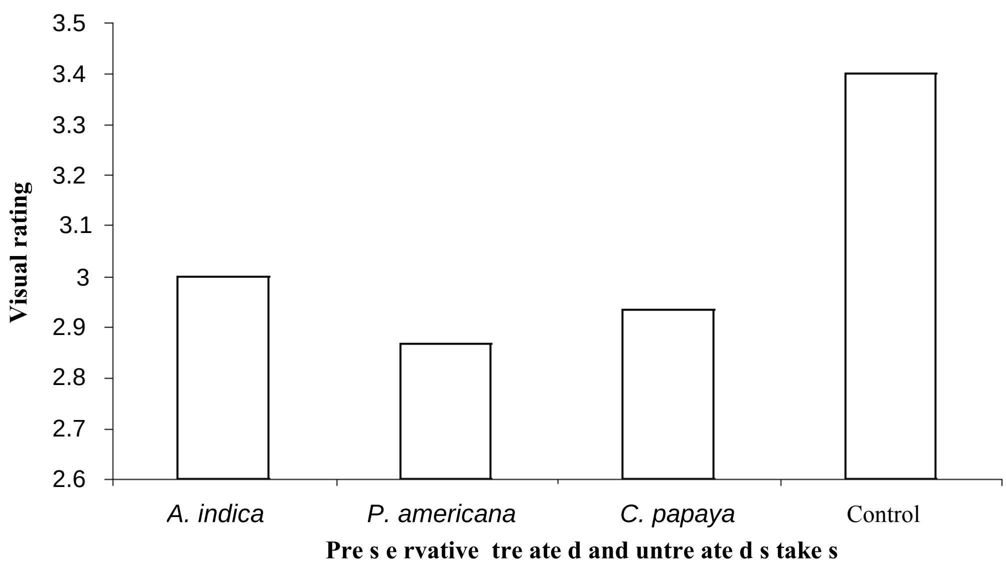

Figure 2. Visual durability rating of alstonia wood.

powder post beetle attack in furniture made from alstonia wood.

DISCUSSION AND CONCLUSION

Neem extract was most retained in alstonia wood because its extractive bonded well with the cell lumen, walls and extractives of alstonia (Richardson, 1978). Consequently, neem extract-treated alstonia wood recorded less attack by visual durability rating, percentage hardness loss and percentage mass loss. Avocado extract was retained least in alstonia wood because the cell lumen, walls and extractives of alstonia did the reverse with avocado extract. Though pawpaw extract was retained intermediarily in alstonia wood, avocado extract made alstonia wood least susceptible to attack by visual durability rating, percentage hardness loss and percentage mass loss because its extractives were more efficacious, than that of neem and pawpaw extracts. 50 and 83% of Anloga furniture makers reported that, pawpaw extract at 0.24 (treated once) and 0.72% (treated three or over) respectively, resisted powder post beetle attack in furniture made from alstonia wood and shows that conditions of preservatives can be manipulated to derive desired results (Ibach, 1999).

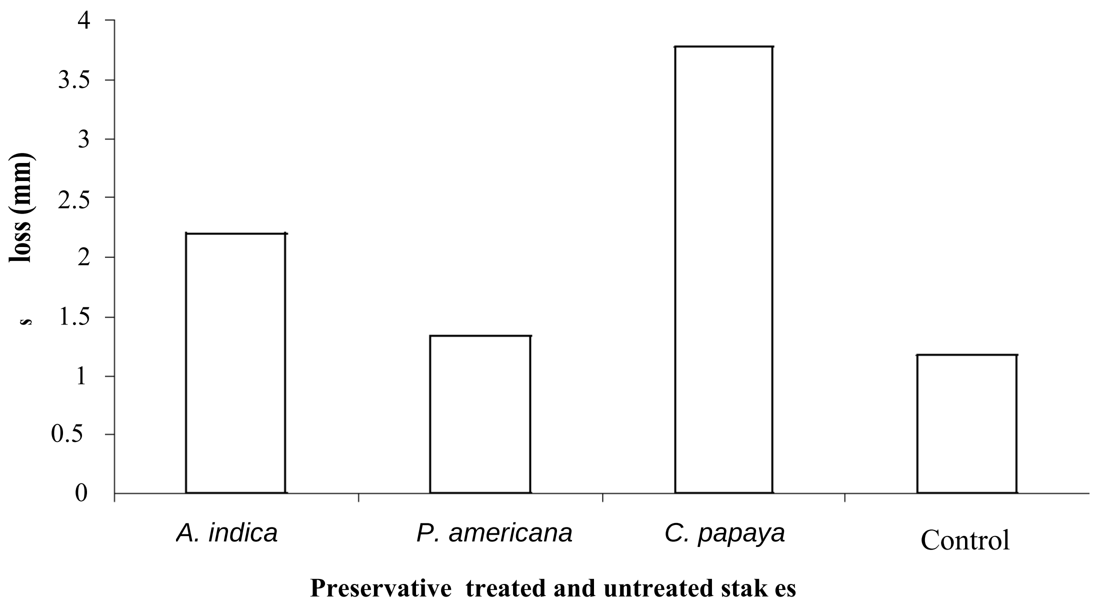

Figure 3. Percentage hardness loss of alstonia wood.

Table 2. ANOVA for visual durability rating of alstonia wood.

Source	DF	Sum of squares	Mean square	F value	Pr >F
Treatment	3	2.58333333	0.86111111		
Error	56	90.26666667	1.61190476	0.53	0.660ns
Corrected total	59	92.85000000			

ns: P is not significant at 0.05 significance level; R-square: 0.027823; coefficient variant: 41.62650; root MSE: 1.269608; visual rating mean: 3.050000.

Table 3. ANOVA for percentage hardness loss of alstonia wood.

Source	DF	Sum of squares	Mean square	F-value	Pr >F
Treatment	3	63.6833333	21.2277778		
Error	56	611.5000000	10.9196429	1.94	0.1330ns
Corrected total	59	675.1833333			

ns: P is not significant at 0.05 significant level; R-square: 0.094320; coefficient of variation: 156.1176; root MSE: 3.304488; hardness loss mean: 2.116667.

Table 4. ANOVA for percentage mass loss of alstonia wood.

Source	DF	Sum of squares	Mean square	F value	Pr >F
Treatment	3	21.685475	7.228492		
Error	56	2258.755746	40.334924	0.18	0.9101ns
Corrected total	59	2280.441221			

ns: P is not significant at 0.05 significant level; R-square: 0.009509; coefficient of variation: 71.57392; root MSE: 6.350978; mass loss mean: 8.873313.

Regardless of extract retention, pawpaw extract did not significantly improve the durability of alstonia wood at 0.24% (treated once) but quite significantly at 0.72% (treated three or over). 83% of Anloga furniture makers who saw the efficacy of pawpaw extract at 0.72% and on triple treatment showed a high sense of interest in preservative botanical extracts.

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