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TERMITICIDAL ACTIVITY OF AQUEOUS EXTRACTS OF *Erythrophleum suaveolens* STEM BARK AND *Lagenaria breviflora* FRUIT PULP ON WOOD

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Abstract:
Immense indigenously known antimicrobial and insect repellent activities of many plants' tissues present a pool for selecting and formulating much needed alternative environmental friendly biocides to limiting wood degradation agents across the globe. Single and combined treatments of Erythrophleum suaveolens stem bark extract at 5%, 10%, 15% and 20%, and with 10 mL of Lagenaria breviflora fruit pulp juice extract on wood blocks of Triplochiton scleroxylon were comparatively investigated against outdoor field termites for three months in Port Harcourt, Nigeria. Erythrophleum suaveolens stem bark yielded 4.4% extract. Combination effect of Erythrophleum suaveolens stem bark extract and Lagenaria breviflora fruit pulp juice extract (ESLE) treatments comparatively showed lower absorption and retention but significantly enhanced better termiticidal activity than Erythrophleum suaveolens stem bark extract alone (ESEA). The two extract types showed the strongest antitermites' activities at the lowest concentration (5%) tested but ESLE significantly showed better effective wood protection than ESEA. The results suggested that ESEA, and ELSE could be better alternative substitute biocides, as they exhibited good termiticidal performance using small quantities.

Key words: *Erythrophleum suaveolens*; *Lagenaria breviflora*; Termiticidal activity; *Triplochiton scleroxylon* wood.

INTRODUCTION

In recent years, considerable attention has been directed to the development of environmental friendly biocides as well as more obvious characters of sustainability and affordability in any scheme or process of wood protection method. Immense indigenously known antimicrobial and insect repellent activities of many plants' tissues present a pool for selecting and formulating much needed environmental friendly biocides to limiting wood degradation agents. Hence, many investigations have revealed the excellent wood preservative profiles of some certain plant tissues across the globe. However, obtaining certain plant tissues extracts like heartwood extracts is not ecological friendly as its extraction does not compatible with conservation of the forests and to the tenets of sustainability of the species and wood protection method. The exploration of renewable parts of trees usually considered as waste like stem bark in the course of wood conversion and weed plants' parts for wood preservatives will not only solve the environmental problems but also improve their economics.

Erythrophleum suaveolens stem bark extract has been reported for the presence of appreciable high quantity of bioactive secondary metabolites (Adedeji *et al.* 2013) with significant excellent wood protection properties against; fungi (Ogunsanwo and Adedeji 2010), termites (Antwi-Boasiako and Baidoo 2010; Antwi-Boasiako and Eshun 2013; Asamoah *et al.* 2014), and including antibacterial activity (Aiyegoro *et al*. 2007). While Phytochemical studies of *Lagenaria breviflora* fruit revealed the presence of triterpenoids, saponins, phenols, alkaloids, anthraquinine, flavonoids, tannins and terpeniods (Elujoba *et al.* 1990, 1991; Banjo *et al*. 2013; Eyitayo *et al*. 2014) with significant interesting wood protection activity against termites in Nigeria (Emerhi *et al.* 2015).

E. suaveolens stem bark and *L. breviflora* fruits could be economically collected during wood conversion process and weeding operations respectively. Maoz *et al.* (2012) pointed out that the use of

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multi-component extracts may represent a method for enhancing better protection while creating the potential for reduced extracts consumption. This study therefore sought to comparatively assess the single and combined treatments of *Erythrophleum suaveolens* stem bark extract with *Lagenaria breviflora* fruit pulp juice extract on wood blocks of *Triplochiton scleroxylon* against outdoor field termites for three months in Port Harcourt, Nigeria.

MATERIALS AND METHODS

Study area

The field test yard was located at the Institute of Agricultural Research and Development Conservation Plot (IARDCP) within Abuja campus (Latitude 4^o 53' 25'' and 4^o 54' 35''N and Longitude 6^o 54' 25'' and 6^o 55' 55''E) of the University of Port Harcourt (UNIPORT). The university falls within subequatorial region. The rainfall distribution is nearly all year round though its intensity is seasonal and variable (Adedeji and Emerhi 2015). A moist south-west wind and northeast trade winds are responsible for the variations in weather conditions experienced in Port Harcourt City (Eludoyin *et al.* 2015). The peak of rainy season usually occurs from June to October, with the total annual rainfall of more than 2500mm. The moist south-east air stream blows over the region between February and November and the region receives its rains, while the northeast trade wind blows over Port Harcourt in from November up to February, which ushers in the dry season. Port Harcourt records a mean annual temperature of 28ºC and high relative humidity of 85% mean annual figure. The soil of Port Harcourt city is of the recent alluvial soil. Port Harcourt is dominated by low-lying coastal plains which structurally belong to the sedimentary formation of recent Niger delta, with an elevation less than 15.24m (Eludoyin *et al.* 2015). The study area was highly prone to varying termites' species attacks and it has been previously reported to be suitable for field study using ground contact exposure method (Emerhi *et al.* 2015).

Plant materials and preparation of extracts

Dried stem bark of *E. suaveolens* (DSBES) was collected from Mese Sawmill, Imeko, Nigeria in August 2014, transported, and ground using milling machine at the Wood workshop Unit of the Department of Forest Resources Management, University of Ibadan. Two hundred gram (200g) ground sample of DSBES was subjected to extraction in 1000mL of hot distilled water sequentially twice with constant shaking for 2 days. The solution was then filtered and the filtrate was concentrated yielding 4.45±0.03% at 40°C by rotary evaporator. While fresh fruits of *L. breviflora* (Fig. 1) were collected from Choba campus of UNIPORT open field/farm in November, 2014. The fruits were washed cleaned to remove adhering dirt, peeled and seeds removed. Then, the juice was extracted from the pulp by means of juice extractor.

Fig. 1.
Fresh L. breviflora fruits.

Formulation of biocides and treatments of test wood blocks

A total number of eighty (80) 2x2x6cm of 22 years *Triplochiton scleroxylon* wood blocks obtained from Wood Laboratory Unit of the Department Forest Resources Management, University of Ibadan were oven dried to constant weight at 103±2^{o}C for 22hrs. Then conditioned, weighed as $\mathbf{W_1}$ and kept in air-tight Ziploc nylons prior to treatments. Two types of biocide formulations were developed from the final yield of DSBES

(4.45±0.03% or 8.89±0.07g) and *Lagenaria breviflora* fruit pulp juice extract. The formulations were prepared to get dilutions at 5%, 10%, 15%, and 20% of the *Erythrophleum suaveolens* stem bark extract alone (ESEA), and combined *Erythrophleum suaveolens* stem bark extract at 5%, 10%, 15%, and 20% with 10mL of *Lagenaria breviflora* fruit pulp juice extract (ELSE) at each concentration level in 0.75L of distilled water. The formulations were thoroughly stirred to form uniform solutions and then introduced eight pieces of oven dried *T. scleroxylon* test blocks as replicate to each treatment for 24 hours soaking period.

After the 24 hours of soaking, the treated wood blocks were removed from the treatment solutions, drained, and reweighed as $\mathbf{W_2}$ to determine the levels of gross absorption and retention of the extracts. The treated test blocks were then re-oven dried at 103±2°C for 22 hours, conditioned and reweighed as $\mathbf{W_3}$ before exposure to field test. The absorption and retention of extracts were calculated and expressed volumetrically using formulae (Eqns. 1 and 2) adopted by Yildiz *et al*. (2010), Hien *et al*. (2012):

Absorption, kgm^{-3} = 1000(G) /V ……………………………………Eqn. 1
Retention, kgm^{-3} = [(G x C)/V] x 10 ………………………………..Eqn. 2

where: **G** = ($\mathbf{W_2}$-$\mathbf{W_1}$) **=** amount of the treating solution absorbed by the test wood blocks (g),
$\mathbf{W_1}$ = is the oven dried weight of the conditioned wood blocks before treatment (g),
$\mathbf{W_2}$ **=** is the weight after treatment,
V = volume of wood test block ($24cm^3$).

Field tests

The field tests were carried out at the Institute of Agricultural Research and Development Conservation Plot (IARDCP) of UNIPORT between December, 2014 and March, 2015. Two field plots (6x6m) were laid for the two main experiments with 5m distance gap from each other. Within each plot, eight replicate of each treatment at 5%, 10%, 15%, 20% including control were placed closely side by side and spaced 1m apart from one another, and exposed to ground termites attack according to the methods described by Lenz *et al.* (2003), Emerhi *et al.* (2015) for three months.

After three months of exposure, the test wood blocks were exhumed, rinsed and scrubbed to remove all soil particles, and then finally re-oven dried at 103±2°C for 22 hours, conditioned and weighed as $\mathbf{W_4}$ to evaluate weight loss percentage. The weight loss was calculated in percentage thus using equation 3:

Wood block weight loss% = [(W_3-W_4)/W_3] x 100 ………………….Eqn. 3

where: $\mathbf{W_3}$ = is the oven dry weight before field exposure tests,
$\mathbf{W_4}$ = is the oven dry weight after field exposure tests.

Statistical analysis

Data were statistically analyzed using STATISTICA 7 software. The measurements were expressed in term of means with standard deviation. One-way analysis of variance (ANOVA) statistical techniques were used determine significant differences at the 95% level of confidence. Treatments that have the same Duncan's grouping (alphabet) are not significantly different from each other.

RESULTS AND DISCUSSION

Extraction yield

The yield from the hot water extraction of *E. suaveolens* stem bark was 4.45±0.03% (n = 2) ± S.D. The yield recorded in this study was lower than 6.1% of water extraction reported by Ogundeko *et al.* (2014), 9.0% chloroform, 33.0% methanol and 37.7% combined chloroform/methanol extractions reported by Ogunsanwo and Adedeji (2010). The difference between this study and previous investigations' findings could most likely due to the variation in extraction solvent and dampness at which the yields were evaluated. The extraction yield was sufficient for the treatment of wood suggesting that water is an effective solvent for *E. suaveolens* stem tissue extraction.

Treatability of *T. scleroxylon* test wood blocks

The degrees of absorption and retention of extracts by the *T. scleroxylon* test wood blocks are shown in Fig. 2 and 3. The absorptions were statistically similar but ESEA was appreciably more absorbed than ELSE at all the concentration levels. More so, ESEA showed significant inconsistent absorption trend with concentrations while ELSE showed decreased consistent trend with concentrations. The variation between ESEA and ELSE could likely be attributed to the increased viscosity and reduced diffusivity additive impacts of *L. breviflora* fruit pulp juice extract in ELSE. The absorptions ranged (210.41±38.18 and 255.20±64.30Kgm^{-3}) for ESEA and (205.72±27.16 and 227.60±49.78Kgm^{-3}) for ELSE of this study were closely similar to the absorption range of 190.10±34.49 and 206.77±35.13Kgm^{-3} recently reported Emerhi *et al.* (2015). And substantially higher than those previously reported by Omole and Onilude (2000) 24.9Kgm^{-3}, Olajuyigbe *et al.* (2010) ranged between 54.86 and 64.90Kgm^{-3}, Ogunsanwo and Adedeji (2010) ranged between 70.37 and 117.13Kgm^{-3}. These variations in solution uptake could most likely the result of differences in density of the solvents, period of treatment, preservatives used, and methods of extraction.

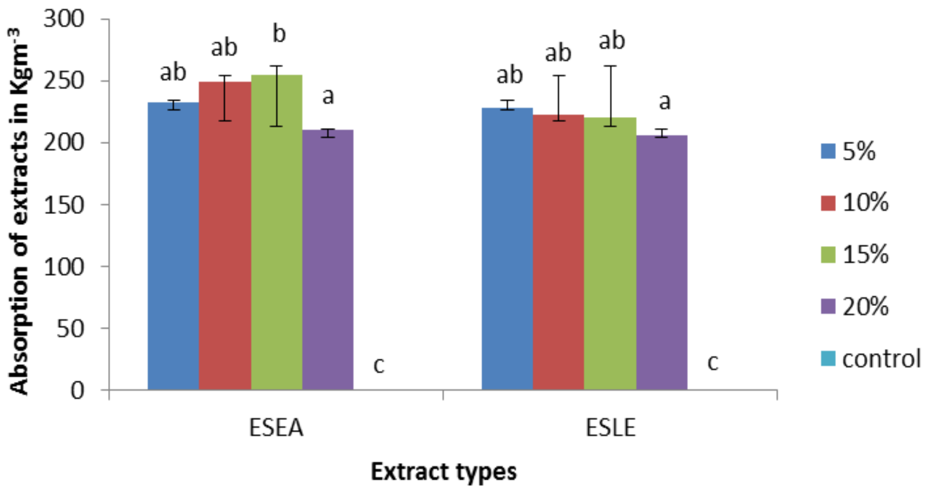

Fig. 2.
Absorption of extracts by T. scleroxylon wood. Means with the same alphabet are not significantly different from each other at α = 0.05.

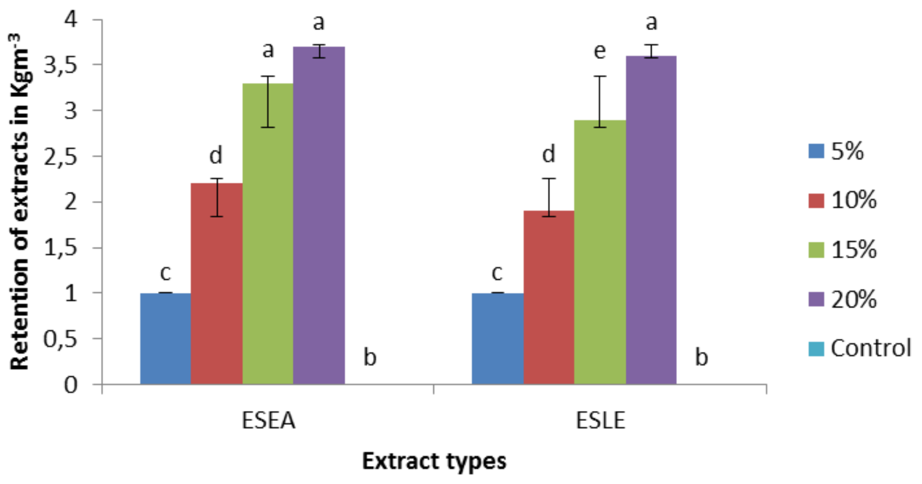

Fig. 3.
Retention of extracts by T. scleroxylon wood. Means with the same alphabet are not significantly different from each other at α = 0.05.

The retentions of the extracts in Fig. 3 indicated similar consistent increased retention trend with increase concentrations between the two extract types. As expected, the higher absorption of ESEA over ELSE translated to corresponding higher retention of ESEA than ELSE at all the tested concentrations, however, ESEA significantly different from ELSE at 15% concentration. These results suggested that multiple extracts' formulations could impart reduced fluid diffusivity and retention than individual extracts' formulations.

Termiticidal effects of the extracts

The results of the field tests are presented in Fig. 4, which showed the comparative termiticidal effects of the extract types. The results indicated that two extract types apparently showed different degrees of termiticidal effects at all the extracts' concentrations tested. ELSE was more effective against termites than ESEA at all the concentrations. The lowest concentration of two extract types was most effective towards termites but ELSE appreciably shown better performance than ESEA. This higher effectiveness of ELSE over ESEA was expected and it could be attributed to synergism consequence of their chemicals composition. Surprisingly, the higher retentions recorded from higher concentrations did not result in better protection of the wood against the termites' attacks as reflected in wood weight loss (Fig. 4). The trend of the ELSE results recorded in this study were in contrary to those of Emerhi *et al.* (2015) who reported better resistance performance of *L. breviflora* fruit juice extract treated wood at higher concentration. However, the ESEA results were similar to the biological activity of *E. suaveolens* stem bark extracts against fungi previously reported (Ogunsanwo and Adedeji 2010). These results are interesting, implying that the threshold efficacy might be achieved using small quantities below 5% concentrations used for this study. The results of this study suggested good utilization of *E. suaveolens* stem bark extracts singly and better combined with *L. breviflora* fruit juice extract for wood protection at lower concentrations. These results implied greater advantages in conservation of natural resources because small quantity of mixture extracts formulations effected better positive result than individual extracts formulations. This implication was in agreement with the assertion of Maoz *et al.* (2012) who pointed out that the use of multi-component extracts may represent a method for enhancing better protection while creating the potential for reduced extracts consumption.

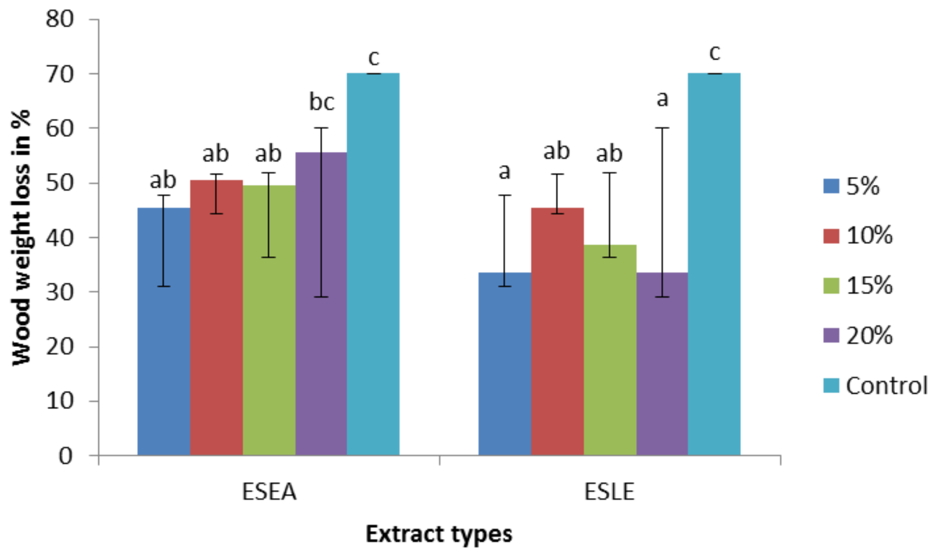

Fig. 4.
Wood weight loss caused by termites. Means with the same alphabet are not significantly different from each other at α = 0.05.

CONCLUSIONS

This study described the significant termiticidal activity of ESEA and ELSE formulations on wood against soil dwelling termites for 4 months. The formulations exhibited different degree of effectiveness with strongest antitermite's activity found at lowest concentration (5%) tested of both extract types but ESLE significantly showed better effective wood protection than ESEA. Thus, the result suggests that synergising both extracts lower than 5% may offer excellent performance comparable to standard chemicals. Further studies are necessary to determine excellent threshold performance against wood degrading agents with reduced extracts consumption. The results of this study coupled with previously reported antimicrobial studies clearly indicate that sawmill waste (*E. suaveolens* bark) and weed (*L. breviflora* fruits) could become sources of promising natural antidegradation agents with potential applicability in wood protection industry for limiting fungi and termites.

AUTHORS' CONTRIBUTIONS

EAE and GAA conceived and designed the work. GAA carried out the experiments. BAO managed the data and performed the statistical analyses. GAA wrote the first draft and all authors contributed substantially to the final revision.

REFERENCES

Adedeji GA, Emerhi EA (2015) Occupancy of *Azadirachta indica* A. Juss. by fungus and termites in Port Harcourt: Implications for integrated protection strategies. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSRJESTFT) 9(2-III):68-72.

Adedeji GA, Ogunsanwo OY, Aiyeloja AA (2013) Characterisation of Solvent Components in *Erythrophleum suaveolens* (Guill. & Perr.) Brenan Stem Bark Extracts Treated *Triplochiton scleroxylon* K. schum. Wood. International Journal of Scientific and Engineering Research (IJSER) 4(10):926-937.

Aiyegoro OA, Akinpelu DA, Okon AI (2007) In vitro Antibacterial Potentials of the Stem Bark of the Red Water Tree (*Erythrophleum suaveolens*). Journal of Biological Science 7(7):1233-1238.

Antwi-Boasiako C, Eshun D (2013) Termiticidal potency of *Erythrophleum suaveolens* (Guill. And Perr.) Brenan bark, *Thevetia peruviana* (Pers.) K. Schum and *Moringa oleifera* Lam. Root extracts as alternative to commercial synthetic preservative-chemicals. Journal of the Indian Academy of Wood Science 10(2):147-154. DOI: 10.1007/s13196-013-0108-5

Antwi-Boasiako C, Baidoo AH (2010) Accelerated field durability assessment of two Non-durable timbers (*Ceiba pentandra* (L.) Gaertn. and *Celtis milbraedii* Engl.) impregnated with natural and inorganic preservatives. Journal of Science and Technology 30(1):18-29.

Asamoah A, Frimpong-Mensah K, Antwi-Boasiako C (2014) Efficacy of *Erythropleum suaveolens* (potrodom) and *Distemonanthus benthamianus* (bonsamdua) water extractives on the durability of five Ghanaian less used timber species of varying perviousness and retentiveness. Journal of the Indian Academy of Wood Science 11(1):72-81.

Banjo TA, Kasim LS, Iwalokun BA, Mutiu WB, Olooto WE, Mba NG, James ES, Shorunmu TO (2013) Effects of different extraction methods on in-vitro antimicrobial properties of *Lagenaria breviflora* whole fruit. N. Y. Sci. J. 6(10):60-65.

Eludoyin OS, Oladele AT, Iyanda OM (2015) Mapping and Assessment of Ethno-Medicinal Trees in Built Up Areas - University of Port Harcourt, Nigeria. South-east Eur. For. 6(1):129-140. DOI: http://dx.doi.org/10.15177/seefor.15-10

Elujoba AA, Fell AF, Linley AF (1991) Chromatographic and spectroscopic analysis of bound and unbound phenolic acids in Lagenaria breviflora fruit. Journal of Pharmaceutical & Biomedical Analysis 9(9):711-715. DOI: 10.1016/0731-7085(91)80211-Q

Elujoba AA, Fell AF, Linley PA, Maitland D (1990) Triterpenoid saponins from the fruits of *Laganaria breviflora* Robert. Phytochemistry 29:3281-3285.

Emerhi EA, Adedeji GA, Ogunsanwo OY (2015) Termites' resistance of wood treated with *Lagenaria breviflora* B. Robert fruit pulp extract. Nature and Science 13(5):105-109.

Eyitayo BM, Abiola FM, Enoh BE, Olatunde JS (2014) Effect of Ethanolic Fruit Extract of *Adenopus Breviflorus* (*Lagenaria Breviflora* Robert) on Hematological Indices in Male Albino Wistar Rats. J. Phys. Pharm. Adv. 4(11):501-508. DOI:10.5455/jppa.20141117043323

Hien NTT, Li J, Li S (2012) Effects of water-borne rosin on the fixation and decay resistance of copper-based treated wood. BioResources 7(3):3573-3784.

Lenz M, Creffield JW, Evans TA, Kard BM, Vongkaluang C, Sornnuwat Y, Preston AF (2003) International comparison of three field methods for assessing the in-ground resistance of preservative-treated and untreated wood to termites and fungal decay - Summary of observations after five years. IRG/WP 03-20261. International Research Group on Wood Protection, Stockholm, 19pp.

Maoz M, Karchesy JJ, Morell JJ (2012) Ability of natural extracts to limit mold growth on Douglas-Fir sapwood. BioResources 7(4):5415-5421.

Ogundeko OT, Ramyil MS, Idyu CV, Idyu II (2014) Comparative Effect of Cold Hydro Stem-Bark Extract of *Erythrophleum suaveolens* on Gastrointestinal Muscle of Rabbit Jejunum (*Oryctolagus cuniculus*). American Journal of Pharmacological Sciences, 2(3):52-55. DOI: 10.12691/ajps-2-3-2

Ogunsanwo OY, Adedeji GA (2010) Effect of bark extract of *Erythrophleum suaveolens* (Guillemin & Perrottet) Brenan on fungal activities in wood of *Triplochiton scleroxylon* k. schum. Journal of Environmental Extension 9:56-62.

Olajuyigbe SO, Ogunsanwo OY, Adegeye AO (2010) Compressive strength in heartwood extract of teak (HWE) treated hardwoods after exposure to white rot attack. International Journal of Biological and Chemical Sciences 4(3):571-578.

Omole AO, Onilude MA (2000) Study on use of engine oil as wood preservative. Journal of Tropical Forest Resources 16(1):66-71.

Yildiz S, Yildiz U, Dizman E, Temiz A, Gezer E (2010) The effects of pre-acid treatment on preservative retention and compression strength of refractory spruce wood impregnated with CCA and ACQ. Wood Research 55(3):93-104