

Termiticidal effect of cold-water extracts of *Erythrophleum suaveolens* (Guill. & Perr.) Brenan stem bark and sawdust on *Daniella oliveri* (Rolfe) and *Gmelina arborea* (Roxb) wood samples

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ABSTRACT

This study investigated termiticidal effect of *Erythrophleum suaveolens* stem bark and sawdust cold water extracts on *D. oliveri* and *G. arborea* wood. The wood samples were processed into 10 cm x 2 cm x 2 cm dimensions, while plant parts were air-dried to avoid damping before extraction. *E. suaveolens* stem bark and sawdust were screened for phytochemicals. Concentrations of extracts were made by dissolving 10g, 20g and 30g of *E. suaveolens* stem bark and sawdust each in 500 mL of cold water respectively, and the mixtures were allowed to macerate for 24 hours. Solignum and untreated wood samples were used as control. Treated wood samples were laid in 2 x 6 x 1 factorial in a Randomized Complete Block Design (RCBD) in termitarium and data taken for 8 weeks. Phytochemical screening showed that *E. suaveolens* stem bark extract had high presence (+++) of tannins, while saponins, flavonoids, carbohydrate, steroids and glycosides were moderately present (++) . The result also revealed that, *E. suaveolens* sawdust had moderate presence (++) of cardiac glycoside, while carbohydrate and terpenoids were slightly present (+). Incident of termite attack on treated wood reveals that, 30% *E. suaveolens* stem bark extract and solignum were not attacked throughout the period of the experiment. *G. arborea* treated with 30% *E. suaveolens* stem bark extract had the least (7.68 %) mean percentage weight loss followed by and solignum (7.60 %), while *D. oliveri*, control had the highest mean percentage weight loss of 44.28%. In conclusion, 30% *E. suaveolens* stem bark extract and solignum were the best of all the treatments and *G. arborea* wood was more resistant to termite attack than *D. oliveri*.

Keywords: *Erythrophleum. suaveolens*, extract, phytochemicals, solignum, termite.

INTRODUCTION

Termites, also known as white ants belong to an order from a small group of insects that are very destructive to wood and wood products (Grimaldi and Engel 2005). Their main food is cellulose found either in dead wood material or living plants. They also feed on almost any organic material. Termites are important to the forest as

foragers of dead and decaying wood and stumps. Termites are absolutely harmful when they transfer their feeding to finished wood or cellulose products of wood (Ibrahim and Adebote 2012). Termites degrade wood by feeding on its components, as a result reducing its strength ability and appearance.

Wood is known to be one of the oldest top-known structural materials and is a renewable natural resource. According to Jerrold (2005), wood is tremendously a multipurpose material with many physical and mechanical properties. It is a renewable resource with an excellent strength to weight ratio. Fabiyi *et al.*, (2010) reported that demand for wood and wood products is growing as it is useful in construction and bio-energy. Nevertheless, due to variety in nature, exploitation of tree for structural and construction purposes was selective and limited to strong and durable species

Woods that are naturally durable are used for variety of commercial uses Scheffer and Morrell (2008). Natural resistance to decay by wood has been evaluated in field and laboratory tests of wood from many species. Some wood species have grown to develop extractive compounds that protect wood. These are responsible resistance to decay in all wood species. These chemical compounds are usually produced when the living ray cells in the inner sapwood zone die and this forms the non-living heartwood. Sapwood of nearly all species does not have natural durability. Heartwood of many species has a characteristic darker colour, while in others it varies little in colour from the sapwood. The decay resistance among woods varies among tree species, individual trees, and within individual trees (Scheffer and Morrell (2008). Chemical extractives have long been recognized as key features that impart natural durability in the heartwood of certain wood species (Taylor *et al.*, 2002). Timbers of low natural durability often require treatments which deposit biocides and preservatives into the cell walls (Schultz and Nicholas, 2000).

Report from a review of the natural durability of 1500 marketable wood species worldwide shows that 191 of the

commercial species are very resistant to bio-deteriorating agents, 180 are resistant, 298 moderately resistant and 726 nonresistant (Scheffer and Morrell, 1998). Consequently, majority of commercial wood species required preservatives treatments to enhance their durability. *D. oliveri* and *G. arborea* are generally sorted as construction material in timber markets located in sudano-sahelian and guinea region with shortage timber supply (Sotannde *et al*, 2010). These species are classified among the non-resistant timber species.

Recent studies have been focused on some wood preservatives that are relatively cost-effective chemicals and have minimal toxicity to mammals and environment. Ability of wood and natural plant extractives to protect wood against wood degrading fungi and insects has been one possible approach for developing new wood conservatives (Kartal *et al*, 2005). The use of traditional plant materials in the management of insect pests such as termite control which is cheap, easily reached and assembled in the developing countries has been reported by Owusu, (2000). Though most of these traditional methods are of little use in the developed countries, they still play a significant role in pest control programs in the developing countries.

E. suaveolens is a perennial tree of about 30 m in height, often low branching and producing a dense spreading crown. It belongs to the family of Caesalpiniaceae (Leguminosae-Caesalpinioideae). It is referred to by various names by natives, these include *obo* and *erun* (Yoruba), *inyi* (Igbo), *goska* (Hausa), *aba* (Akan-Asante, Ghana), *digpende* (Bassari-ogo), *teli* (Koranko-Sierra leone) etc. It is often referred to in English as sassy, sasswood, red water tree and ordeal tree (Burkill, 1985). It occurs in moist semi – deciduous

forest, gallery forest and wooded grasslands, from sea – level up to 1100m altitude. Studies have revealed that *E. suaveolens* plant is very toxic to livestock especially goat, cow, pigs and sheep. In grassland regions, the cattle rearers are always very cautious to allow their animal graze on the plant for its poisonous nature (Nwude and Chineme, 1981).

Extracts from *E. suaveolens* are also known to be used in cases of gangrenous wound, rheumatism, skin disease, arthritis and oedemas. The extracts are also used as poison or repellent against rodent, insects and some aquatic animals and also in tanning hides and as dye (Neuwinger, 1996). However, no research has been conducted on the efficacy of its sawdust extracts. Therefore, this work aimed at adopting local, cheap method, eco-friendly method of wood preservation of cold-water extraction of stem bark and sawdust of *E. suaveolens* in the treatment of *D. oliveri* and *G. arborea wood* against termites.

MATERIAL AND METHODS

Study Area

The study was carried out at the termitarium at Federal University of Agriculture, Makurdi (FUAM). FUAM is located in Agan Council Ward, North-Bank in Makurdi LGA. FUAM is located at latitude 7° 44" N and Longitude 8° 35" E of the Middle Belt region of Nigeria and covers a land mass of 7,978 km² (Gyang 1997). It is surrounded on the North East by Guma LGA and by River Benue in the South. Dry season lasts from November to March while the monthly temperature ranges between 28.5 °C – 36 °C in March to April. The mean annual rainfall value is 1200mm to 1500mm; the relative humidity is between 60% and 80% but decreases in the early months of the dry season. The vegetation of

FUAM has been described as Northern Guinea savannah. The three soils types found in the area are namely: sandy soils, clayey loam and alluvial (Tyowua *et al.*, 2013). The environment of the FUAM is open savannah woodland that is relatively rich with high variety tree of species comprising of a wide diversity of woody trees, dominantly fewer trees, with more shrubs, and a collection of palms, herbs, climbers and abundant tall grasses up to 2 m tall. Forest formations are located in river banks and low-land areas (Yager *et al.*, 2017). Some of the species found in the area include: *Prosopis africana*, *Vitellaria paradoxa*, *Vitex doniana*, *Parkia biglobosa*, *Burkia africana*, *Khaya senegalensis*, *Hymenocordia acida*, and *Daniella oliverri*.

Collection and preparation of plant materials

Stem bark and sawdust of *E. suaveolens* were obtained at Bakin Kogi Chawai Timber Shed, in Kaduna. The stem bark was air-dried ensuring sufficient air flow to avoid damping according to Ahmed, et al., (2011) before extraction and then pulverized. *D. oliveri* and *G. arborea* wood were purchased from Timber shed at New Bridge, Makurdi and processed into (10 x 2 x 2) cm (length x width x breadth) dimension as test samples.

Cold water extraction method (polar)

Three levels of concentration of water extract was made by dissolving each of 10 g, 20 g and 30 g of stem bark and sawdust powder in 500 mL of cold water respectively, for a period of 24 hours to allow for extraction.

Preparation of Solignum treatment

Non-diluted Solignum was measured (900 mL) in a glass bottle and used as one of the treatments for the soaking of the wood samples.

Treatment of Wood samples

The test wood samples were correctly labeled, weighed (W_1) and soaked in the different treatments for 24 hours. After soaking, the treated wood blocks were removed from the treatment solutions, drained, and reweighed (W_2) to determine the levels of gross absorption and retention of the extracts.

Absorption and retention of extracts is calculated and expressed volumetrically using formulae (Eqns. 1 and 2) adopted by Yildiz *et al.* (2010), Hien *et al.* (2012) as:

$$\text{Absorption (kgm}^{-3}\text{)} = 1000(G) / V \dots 1$$

$$\text{Retention (kgm}^{-3}\text{)} = [(G \times C) / V] \times 10 \dots 2$$

Where:

$G = (W_2 - W_1)$ = amount of the treating solution absorbed by the test wood blocks (g),

W_1 = is the oven dried weight of the conditioned wood blocks before treatment (g),

W_2 = is the weight after treatment,

V = volume of wood test block (cm^3).

C = grams of preservative in 100g of treating solution/concentration of extract

Phytochemical Analysis

Test for alkaloids, anthraquinones, alycosides, tannins, flavonoids, saponin, terpenoids, cardiac glycoside, carbohydrate, steroids were carried out according to standard procedures as adopted by Dominguez (1973); Tona *et al.*, (2000); Firdouse and Alam (2011); Rathore *et al.*, (2012); Fawehinmi *et al.*, (2013).

Experimental Design

The treated wood samples were laid down in a Randomized Complete Block Design (RCBD) with 7 treatments, with a control and 2 wood samples in the termitarium

located along student village, opposite staff multipurpose cooperative society at South core Federal University of Agriculture, Makurdi.

Seven treatments which included two plant extracts of 10%, 20% and 30% each of *E. suaveolens* sawdust and bark, one pesticide and one control were used. The experiment was replicated three times. Five samples each of the wood species were used for each treatment giving a total of twenty-four test samples for a replicate. A total of forty-eight test samples were used for the three replicates. The treated samples were buried for eight weeks. Samples were checked and assessed weekly by visual observation of wood samples on the field for the rate of termite attack.

Data collection procedure

Inspection and evaluation of the specimens were done by visual assessment after every two weeks for any sign of termite attack for a period of eight weeks. In every inspection, the specimen was removed from the ground, cleaned and damage was assessed and recorded.

Experimental layout

A plot of 6 by 21 meters was mapped in termite infested area. Twenty-one holes of 10cm depth were dug along the length of the mapped-out area at every 1m. This is done in three places as three replicates. 5 wood samples were laid for each wood species in one replicate, and 6 wood samples for each treatment in a replicate. Figure 1 shows the layout of field experiment, Figure 2 shows the filled crude extracts before treatment while Figure 3 are the labelled wood samples before treatment and figure 4 indicate wood samples soaked in crude extracts for treatment



Figure 1. Field layout of the experiment

The treatments are labelled as: 10% *E. suaveolens* stem bark extract, 20% *E. suaveolens* stem bark extract, 30% *E. suaveolens* stem bark extract, 0% *E. suaveolens* stem bark extract, Solignum (synthetic chemical) and Control. 10% *E. suaveolens* sawdust extract, 20% *E. suaveolens* sawdust extract, 30% *E. suaveolens* sawdust extract, 0% *E. suaveolens* sawdust extract, Solignum (synthetic chemical) and Control.



Figure 2. Crude extracts before treatment



Figure 3: Labelled wood samples before treatment,



Figure 4: Wood samples soaked in crude extracts for treatment

Incidence of Termite Attack

The incidence of termite attack was recorded as follows:

- + = attack and
- ✓ = no attack

Severity of termite attack

The severity of termite attack was determined by percentage weight loss calculated mathematically as:

$$\text{Percentage weight loss} = \frac{w_1 - w_2}{w_1} \times 100 \dots\dots 3$$

Where:

w_1 = Conditioned weight after preservative treatment (g)

w_2 = Final weight after exposure to termite (g)

Efficacy of treatments was assessed by observing decrease in mean weight of treated wood samples from week 1 – week 8 of the experiment.

Statistical Analysis

Analysis of Variance (ANOVA) was used to determine significant effects of treatment on wood samples. Follow up test was carried out using Duncan Multiple Range Test (DMRT) where significant differences exist.

RESULTS

Table 1 shows the result of phytochemical screening of *E. suaveolens* stem bark and sawdust. The results of *E. suaveolens* stem bark indicated high presence (+++) of

tannins, moderate presence (++) of saponins, flavonoids, carbohydrate, steroids and glycosides, and slight presence (+) of alkaloids and anthraquinones while, terpenoids and cardiac glycoside were absent (-). Results of *E. suaveolens* sawdust revealed that cardiac glycoside was moderately present (++) while, carbohydrate and terpenoids slightly present (+). Flavonoids, and terpenoids were least present (\pm) while, alkaloids, saponins, tannins, anthraquinones and cardiac glycoside were absent (-). The results show that *E. suaveolens* stem bark had more phytochemical than *E. suaveolens* sawdust. Table 2 shows results of incidence of termite attack on wood samples. The results revealed that wood samples treated with 30% *E. suaveolens* stem bark extract and solignum were not attacked (-) throughout the period of the experiment. In the second week of the experiment, only *D. oliveri* wood treated with 20% *E. suaveolens* sawdust extracts was attacked (✓). For *G. arborea* wood, there was no attack (-) up to 6th week except for 20% *E. suaveolens* sawdust extract treated sample that was attacked in the 2nd week and 10% *E. suaveolens* sawdust extract treated sample attached in the 6th week. In the 8th week, wood with all treatments (except 30% *E. suaveolens* stem bark extract and solignum) were attached (✓).

Table 1. Phytochemical screenings of *E. suaveolens* stem bark and sawdust

Phytochemicals	Stem Bark	Sawdust
Alkaloids	+	-
Saponins	++	-
Tannins	+++	-
Flavonoids	++	±
Carbohydrate	++	+
Terpenoids	-	+
Steroids	++	±
Anthraquinones	+	-
Glycosides	++	-
Cardiac glycoside	-	++

Key: – negative; ± least present; + slightly present; ++ moderately present; +++ highly present

Table 2. Incidence of termite attack on *D. oliveri* and *G. arborea* wood samples

Treatments	Con.	<i>D. oliveri</i>				<i>G. arborea</i>			
		Wk2	Wk4	Wk6	Wk8	Wk2	Wk4	Wk6	Wk8
<i>E. suaveolens</i> sawdust extract	10%	-	✓	✓	✓	-	-	✓	✓
	20%	✓	✓	✓	✓	✓	✓	✓	✓
	30%	-	✓	✓	✓	-	-	-	✓
<i>E. suaveolens</i> stem bark extract	10%	-	✓	✓	✓	-	-	-	✓
	20%	-	✓	✓	+	-	-	-	✓
	30%	-	-	-	-	-	-	-	-
Solignum treatment		-	-	-	-	-	-	-	-
Untreated wood (– control)		-	✓	✓	✓	-	✓	✓	✓

Key: ✓ = attack and – = no attack

The results of percentage absorption of *E. suaveolens* stem bark and sawdust extracts treated *D. oliveri* and *G. arborea* wood samples are presented in presented in Table 3. *D. oliveri* test wood treated with 30% *E. suaveolens* stem bark extract had the highest (214.5 kgm⁻³) percentage absorption while Solignum treated samples had the least (69.00 kgm⁻³). *G. arborea* treated with 30% *E. suaveolens* sawdust extract had the

highest absorption of 71.50 kgm⁻³, while Solignum treated samples had the lowest value (38 kgm⁻³). The mean percentage absorption of *E. suaveolens* extracts in both treated wood samples were not significant, but differ significantly from solignum treated samples for two wood species. Generally, mean percentage absorption was higher in *D. oliveri* than in *G. arborea* samples

Table 3. Mean percentage absorption of *E. suaveolens* extracts and Solignum in *D. oliveri* and *G. arborea* wood samples

S/No.	Treatments	N	<i>G. arborea</i> Mean ± SDV	<i>D. oliveri</i> Mean ± SDV
1	10% <i>E. suaveolens</i> sawdust extract	5	71.00±10.55 ^b	204.50±26.30 ^b
2	20% <i>E. suaveolens</i> sawdust extract	5	64.50±6.94 ^b	192.50±33.49 ^b
3	30% <i>E. suaveolens</i> sawdust extract	5	71.50±5.76 ^b	210.50±37.60 ^b
4	10% <i>E. suaveolens</i> stem bark extract	5	70.00±3.062 ^b	201.00±38.91 ^b
5	20% <i>E. suaveolens</i> stem bark extract	5	62.50±28.06 ^b	211.00±48.67 ^b
6	30% <i>E. suaveolens</i> stem bark extract	5	60.50±10.23 ^b	214.50±31.04 ^b
7	Solignum (synthetic chemical)	5	38.00±16.05 ^a	69.00±58.25 ^a

The results of mean percentage retention of *E. suaveolens* stem bark and sawdust extracts, and Solignum treated *D. oliveri* and *G. arborea* wood samples are presented in Table 4. Mean percentage retention in *D. oliveri* wood was maximum (64.36 kgm⁻³) in 30% stem bark *E. suaveolens* extract treated samples while, solignum treated samples had the least (0.68 kgm⁻³). For *G. arborea* wood

samples, 30% *E. suaveolens* sawdust extract treated samples had the highest (21.48 kgm⁻³) retention while, solignum treated samples had the least value (0.40 kgm⁻³). The percentage retention of *E. suaveolens* extracts and solignum treated wood samples were significant. However, mean percentage retention was higher in *D. oliveri* than in *G. arborea* wood samples.

Table 4. Mean values of percentage retention by *G. arborea* and *D. oliveri* wood samples

S/No.	Treatments	N	<i>G. arborea</i> (kgm ⁻³) Mean ± SDV	<i>D. oliveri</i> (kgm ⁻³) Mean ± SDV
1	10% <i>E. suaveolens</i> sawdust extract	5	7.14±1.07 ^b	21.98±4.61 ^b
2	20% <i>E. suaveolens</i> sawdust extract	5	12.90±1.39 ^c	38.50±6.70 ^c
3	30% <i>E. suaveolens</i> sawdust extract	5	21.48±1.72 ^e	63.16±11.27 ^d
4	10% <i>E. suaveolens</i> stem bark extract	5	7.02±0.29 ^b	20.12±3.87 ^b
5	20% <i>E. suaveolens</i> stem bark extract	5	12.50±5.61 ^c	42.20±9.73 ^c
6	30% <i>E. suaveolens</i> stem bark extract	5	18.04±3.35 ^d	64.36±9.32 ^d
7	Solignum (synthetic chemical)	5	0.40±0.16 ^a	0.68±0.58 ^a

Table 5 presents mean percentage weight loss of *G. arborea* and *D. oliveri* treated wood samples. *G. arborea* results show that 10% *E. suaveolens* stem bark extract treated samples had highest mean percentage weight loss of 10.86 % while, solignum treated samples had the least (7.60 %). However, 30% *E. suaveolens* stem bark extract had 7.68 % which is slightly similar to solignum treated samples (7.60 %). Mean

values of the treated and untreated wood samples were not significant at p<0.05.

For *D. oliveri*, untreated (control) samples had the highest mean percentage weight loss of 44.28% while, 30% *E. suaveolens* stem bark extract treated wood samples had the lowest (8.84 %) closely followed by solignum treated samples (9.56 %). Mean percentage weight loss of the control is significantly different from mean values of

all treated wood samples at $p>0.05$. The pictures of treated wood samples after the

expiration of experiment period are shown in Figure 5.

Table 5. Percentage Weight loss of *G. arborea* and *D. oliveri* treated wood Samples

S/No.	Treatments	N	<i>G. arborea</i> Mean \pm SDV	<i>D. oliveri</i> Mean \pm SDV
1	10% <i>E. suaveolens</i> sawdust extract	15	9.53 \pm 3.81 ^a	15.30 \pm 11.77 ^b
2	20% <i>E. suaveolens</i> sawdust extract	15	8.24 \pm 3.71 ^a	26.34 \pm 16.70 ^b
3	30% <i>E. suaveolens</i> sawdust extract	15	10.15 \pm 3.72 ^a	20.54 \pm 21.15 ^b
4	10% <i>E. suaveolens</i> stem bark extract	15	10.86 \pm 3.00 ^a	10.88 \pm 6.91 ^a
5	20% <i>E. suaveolens</i> stem bark extract	15	9.68 \pm 4.42 ^a	12.88 \pm 7.49 ^a
6	30% <i>E. suaveolens</i> stem bark extract	15	7.68 \pm 3.61 ^a	8.84 \pm 7.30 ^a
7	Solignum (synthetic chemical)	15	7.60 \pm 9.56 ^a	9.56 \pm 7.77 ^a
	Control	15	12.56 \pm 5.74 ^a	44.28 \pm 31.2 ^c

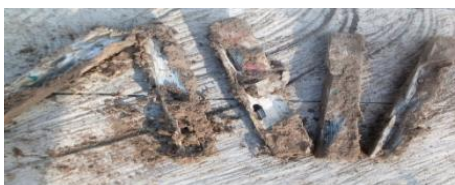
***D. oliveri* Treated wood samples**



10% *E. suaveolens* Sawdust Extract



20% *E. suaveolens* Sawdust Extract



30% *E. suaveolens* Sawdust Extract



D. oliveri Control

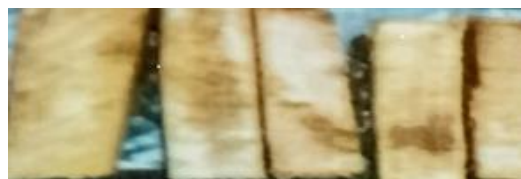
***G. arborea* Treated wood samples**



10 % *E. suaveolens* Stem bark Extract



20 % *E. suaveolens* Stem bark Extract



30% *E. suaveolens* stem bark Extract



Control

Figure 5. Treated wood samples after expiration of experiment

DISCUSSION

These phytochemicals are agents of antimicrobial activities, based on laboratory tests. This study revealed that tannins was highly present stem bark of *E. suaveolens* and absent in the sawdust. Kirker *et al.*, (2013) reported that tannins, phenols, and other resin acid extracts from some wood species have been discovered to have fungitoxic and are thought to be accountable for imparting natural durability to certain wood species. Saponins, flavonoids glycosides, steroids and carbohydrate were also moderately present in *E. suaveolens*

stem bark in this study. Several important biological characteristics such as anti-inflammatory, antimicrobial, spermicidal, antipyretic, pesticidal, immunostimulant, antiviral, anticancer, antifeedant, and analgesic activities have been attributed to saponins by Price *et al.*, (1987). Harborne and Baxter, (1993) reported that stem-bark extracts of *E. suaveolens* have anesthetic and convulsing effects. Procyanidins from the stem was said to have potent anti-inflammatory and analgesic properties (Dongomo *et al.*, 2001). Alkaloidal fractions as reported by Adeoye and Oyedapo, (2004)

markedly alter the serum metabolites and activities of the hepatic enzymes. Diterpenoid alkaloids (amide norcassaide and norery throsua-veolide) showed potent antimicrobial activities against bacteria and yeasts. The alkaloids have a stimulant effect on heart similar to that of cardenolides digitoxine (from digitalis) and ouabain (from strophanthus gratus) but the effect is very short-lasting, as the alkaloids are rapidly metabolized in the organism. Ajayi, et al., (2012) noted that flavonoids possess a wide range of biological features that include insecticidal, antimicrobial, and oestrogenic activities. Upasani, et al., (2003) reported insecticidal activities of flavonoids isolated in aqueous leaf extract of *Ricinus communis* used against *Callosobruchus chinensis*. Flavonoids obtained from aqueous foliar extract of *Annona squamosa* was reported to have 80% insecticidal activity against *C. chinensis* (Kotkar *et al.*, 2002). Ajayi, et al., (2012) also revealed that all the parts of *D. stramonium* usually known as Devil's trumpet or thorn apple had been described to comprise toxic substances due to high level of alkaloids.

E. suaveolens sawdust extract had moderate presence of cardiac glycosides. Cardiac glycosides are available in a varied species of plants. They are organic molecules containing a genin or aglycone with one or more sugars attached. Patel, (2016) reported that some people have used cardiac-glycoside-containing plants and their crude extracts as arrow coatings, homicidal or suicidal aids, rat poisons, diuretics, heart tonics, and emetics, principally due to the toxic nature of these compounds. In this study however, *E. suaveolens* sawdust extract with moderate presence of cardiac glycosides was not effective against the activities of termites.

The absorption of *E. suaveolens* extracts and Solignum obtained in this study ranged from $38.00 \pm 16.05 \text{ Kgm}^{-3}$ to $71.50 \pm 5.76 \text{ Kgm}^{-3}$ for *G. arborea*, and 69 Kgm^{-3} to 211 Kgm^{-3} in *D. oliveri*. These values are lower than the valued obtained by Emerhi, et al., (2017) which ranged between 210.41 and 255.20 Kgm^{-3} for *E. suaveolens stem bark extract* and 205.72 ± 27.16 and $227.60 \pm 49.78 \text{ Kgm}^{-3}$ for *E. suaveolens stem bark* and *Lagenaria breviflora* fruit pulp juice extract.

It was observed that the higher the concentration of extract, the higher the percentage absorption by treated wood samples. However, *D. oliveri* test samples had the highest percentage absorption as compared to *G. arborea* treated samples. Solignum treated wood samples had the lowest percentage preservative absorption in comparison with *E. suaveolens* extracts. The variation between *E. suaveolens* extracts and Solignum could likely be credited to the increased viscosity and reduced diffusivity additive impacts. 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 Emerhi, et al., (2017).

In this study, percentage retention in *G. arborea* ranged between 0.4 kgm^{-3} – 12.5 kgm^{-3} and 0.6 kgm^{-3} – 64.36 kgm^{-3} in *D. oliveri*. These values are below 25.55 kgm^{-3} and 125.11 kgm^{-3} obtained by Janfa *et al.*, (2015). Faruwa *et al.*, (2015) reported retention values of 0.13- 156.25 kg/m^3 for *G. arborea*; 0.26 – 385 kg/m^3 for *Ceiba pentandra* and 0.37 – 228 kg/m^3 for *Triplichiton scleroxylon*. Retention of the extracts was higher in *D. oliveri* wood than *G. arborea*. The cause for this low range of values in this study could be ascribed to low

thickness of the bio-preservatives *E. suaveolens* extracts. This agrees with the findings of Owoyemi and Kayode, (2007) that the nature of preservative chemicals affects the quantity absorbed by wood.

The degree of attack of termite on treated wood samples was measured in terms of weight loss. The weight loss was highest in untreated samples. This confirmed effectiveness of plant extract solutions in enhancing decay resistance of wood to termite attack (Goktas et al, 2007). Although *D. oliveri* absorbed more extract than *G. arborea*, yet it had a higher percentage of termite attack compared to *G. arborea*. This agrees with (Schaffer and Morrell, 1998) resistance of wood to termite attack varies from one species to another. *D. oliveri* is naturally a non-resistant wood while, *G. arborea* is a moderately resistant wood as classified by Sotannde, et al., (2010). This implies that *D. oliveri* requires adequate to treatment protect it before utilization. Solignum and 30% *E. suaveolens* stem bark extract we better as wood preservative in terms percentage weight of treated samples. The variation in termiticidal properties of *E. suaveolens* extracts with respect to different concentration can be attributed to the assertion of Abbas et al, (2013) that all the crude extracts showed antitermitic activity in a dose-dependent manner.

CONCLUSION

In this study, *E. suaveolens* stem bark extract was more effective in mitigating attack of termite compare to *E. suaveolens* sawdust extract because its high presence of tannins and moderate presence of saponins, flavonoids, carbohydrate, steroids and glycosides. *E. suaveolens* sawdust extract had moderate presence of cardiac glycoside with slight presence of carbohydrate and terpenoids. Wood samples treated with 30% *E. suaveolens* stem bark cold water extract

and solignum were not attacked throughout the period of the experiment. Correspondingly, wood samples treated with these two treatments had the least percentage weight loss. *D. oliveri* had higher percentage absorption and retention than *G. arborea* wood. To achieve more effective wood preservative from *E. suaveolens*, higher concentrations of *E. suaveolens* stem bark extracts should be used.

REFERENCES

- Abbas, M., Shahid, M., Iqbal, M., Anjum, F., Sharif, S., Ahmed, S. and Pirzada, T., 2013. Antitermitic activity and phytochemical analysis of fifteen medicinal plant seeds. *Journal of Medicinal Plants Research*. 7(22): 1608-1617.
- Adeboye. B. A, and Oyedapo O. O. 2004. Toxicity of *Erythrophleum suaveolens* guineese stem, bark: Role of alkaloidal fraction. *African journal of traditional, complementary and Alternative medicines*,1,45-54.
- Ahmed S., Mazhar Iqbal Zafar, M.I., and Hussain, A. 2011. Evaluation of Plant Extracts on Mortality and Tunneling Activities of Subterranean Termites in Pakistan. *Pesticides in the Modern World - Pests Control and Pesticides Exposure and Toxicity Assessment*, Dr. Margarita Stoytcheva (Ed.), ISBN: 978-953-307-457-3, InTech.
- Ajayi O.E., Adedire C.O. and Lajide L. 2012. Evaluation of partially purified fractions of crude extracts of the leaves of *Morinda lucida* (Benth.) and *Datura stramonium* (L.) for suppression of wood damage by subterranean termites. *Journal of Agricultural Science*, 4 (5): 152-130.
- Burkill, H.M., 1995 *The useful plants of West Tropical Africa*. 2nd Edition. Volume 3, Families J–L. Royal

- Botanic Gardens, Kew, Richmond, United Kingdom. Pp 857.
- Dominguez X. A. 1973. Methods in Research Fitok imica, LIMUSA.
- Dongmo A.B., Kamanji A., Achang M.S., Chungag-Anye N.B., Njaman D., Nguelefack T.B., Nole T., and Wagner H. 2001. Anti-inflammatory and Analgesic properties of the stem-bark of *Erythrophleum suaveolens* (Caesalpinaceae), Guillemain and Perrottel. *J. Ethnopharmacol.*, 77.
- Fabiyi, J.S; Fuwape, J.A; and McDonald, A.G 2010. Sustainable production and utilization of engineered wood products (Pp. 365-388). In: Ijeomah, H.M. and Aiyeloja (eds.). Practical Issues in Forest and Wildlife Resources Management. Green Canopy Consultants, Port Harcourt, Rivers State.
- Faruwa F.A., Egbuche C.T., Umeojiakor A. O., and Ulocha O. B. 2015. Investigation into the Effectiveness of Selected Bio-Based Preservatives on Control of Termite and Fungi of Wood in Service. Agriculture, Forestry and Fisheries. Special Issue: *Environment and Applied Science Management in a Changing Global Climate*. 4 (3-1): 2015, 59-63.
- Fawehinmi A.B, Lawal H, Etatuvie S.O., and Oyedeji F.O. 2013. Preliminary phytochemical screening and antimicrobial evaluation of four medicinal plants traditionally used in Nigeria for skin infection. *African Journal of Pure and Applied Chemistry*, 7(2): 44-49.
- Firdouse S., and Alam P. 2011. Phytochemical investigation of extract of *Amorphophallus campanulatus* tubers. *International Journal of Phytomedicine*, 3 (1): 32–35.
- Goktas, O.R. Mammadov, E. Duru, M. Ozen, E. Colak, M.A. and Yilmaz, F. 2007. Introduction and evaluation of the wood preservative potentials of the poisonous *Sternbergia candidum* extracts. *African Journal of Biotechnology*. 6, 982 – 986.
- Grimaldi, D. and Engel, M.S. (2005). Evolution of the Insects. Cambridge University Press. 145pp.
- Gyang, E.O. 1997. Students information handbook (1997). University of Agriculture, Makurdi. 1-3.
- Harborne J.B., Baxter H. 1993. Phytochemical Dictionary, Taylor and Francis, London, UK, PP 791.
- Hien N.T.T, 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.
- Ibrahim, B. U., and Adebote, D. A. 2012. Appraisal of the economic activities of termites: A Review. *Bayero Journal of Pure and Applied Sciences*, 5(1): 84 – 89.
<http://dx.doi.org/10.4314/bajopas.v5i1.16>
- Jerrold, E.W. 2005. Wood Properties In: Arntzen, Charles J., ed. Encyclopaedia of Agricultural Science. Orlando, FL: Academic Press: 4: 549-561.
- Kartal S.N., and Ayrilmis N. 2005. Blockboard with boron-treated veneers: Laboratory decay and termite resistance tests. *International biodeterioration and biodegradation*, 55:93–98.
- Kirker, Grant T.; Clausen, Carol A.; Blodgett, A.B.; Lebow, Stan T. 2013. Evaluating naturally durable wood species for repair and rehabilitation of above-ground components of covered bridges. General Technical Report FPL-GTR-224. Madison, WI: U.S.

- Department of Agriculture, Forest Service, Forest Products Laboratory. 40 p.
- Kothar, H. M., Mendki, P. S., Sadan, S. V. G. S., Jha, S. R., Upasani, S. M. & Maheshwari, V. L. (2002). Antimicrobial and pesticidal activity of partially purified flavonoids of *Annona squamosa*. *Pest Management Science*, 58(1), 33-37. <http://dx.doi.org/10.1002/ps.414>.
- Neuwinger H.D. 1996. Poisons and Drugs-chemistry, pharmacology and toxicology In: African Ethnobotany. Chapman and Hall, London. pp 1941.
- Nwude N., Chineme C.N. 1981. Toxic effects of the leaves of *E. africanum* (Harms) in sheep. *Bull. Anim. Health Product. Afr.*, 299: 3499 -3500.
- Owoyemi, J.M. and Kayode, J.O. 2007. The Effects Chromated Copper Arsenate and Solignum Oil on the Resistance of *Gmelina arborea* (Roxb) to Termites' Attack. *Nigeria Journal of Forestry*. 37 (1): 30 – 37.
- Owusu, E.O., 2000. Effect of some Ghanaian plant components on control of two stored-product insect pests of cereals. *Journal of Stored Products Research*, 37: 85-91.
- Patel, S. (2016). Plant-derived cardiac glycosides: Role in heart ailments and cancer management. *Biomedicine and Pharmacotherapy*, 84, 1036–1041. doi: 10.1016/j.biopha.2016.10.030
- Price, K. R., Johnson, I. T., Fenwick, G. R., and Malinow, M. R. 1987. The chemistry and biological significance of saponins in foods and feeding stuffs. *C R C Critical Reviews in Food Science and Nutrition*, 26(1): 27–135. doi:10.1080/10408398709527461
- Rathore S, Bhatt S, Dhyani S and Jain A. 2012. Preliminary phytochemical screening of medicinal plant *Ziziphus mauritiana* Lam fruits. *International Journal of Current Pharmaceutical Research*, 4 (3): 160-162.
- Scheffer, T. C., and Morrell, J.J. 1998. Natural durability of wood: A worldwide checklist of species. *Res. Contribution*, 22:1-58.
- Schultz, T. P., and Nicholas, D. D. 2000. Naturally durable heartwood: evidence for a proposed dual defensive function of the extractives. *Phytochemistry*, 54(1), 47-52. doi: 10.1016/s0031-9422(99)00622-6.
- Sotannde O. A., Oluyeye, A. O. Adeogun P.F., and Maina, S.B. 2010. Variation in wood density, grain orientation and anisotropic shrinkage of plantation grown *Azadirachta indica*. *Journal of Applied Science Resources*, 6:1855-1861.
- Taylor, A.M.; Gartner, B.L.; Morrell, J.J. 2002. Heartwood formation and natural durability—a review. *Wood and Fiber Science*, 34 (4): 587–611.
- Tona L, Kambu K, Ngimbi N, Mesia K, Penge O, Lusakibanza M, Cimanga K, De Bruyne T, Apers S, Totte J., and Pieters L. 2000. Anti-amoebic and spasmolytic activities of extracts from some antidiarrhoeal traditional preparations used in Kinshasa, Congo. *Phytomedicine*, 7(1): 31-8.
- Tyowua B.T., Agbelusi E.A., and Dera B.A. 2013. Evaluation of Vegetation Types and Utilization in Wildlife Park of the University of Agriculture Makurdi, Nigeria. *Greener Journal of Agricultural Sciences*, 3 (1): 001-005.
- Upasani, S. M., Kotkar, H. M., Mendki, P. S. and Maheshwari, V. L. (2003). Partial characterization and insecticidal properties of *Ricinus communis* (L.) foliage flavonoids. *Pest Management Science*, 59(12), 1349-1354. <http://dx.doi.org/10.1002/ps.767>

Yager G. O. Agbidye F. S. and Adma E. S. 2017. Insect Species Diversity and Abundance in and around Federal University of Agriculture, Makurdi Forestry Nursery, Benue State, Nigeria. *Asian Journal of Biology*, 4(4): 1-11.

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