Effects of plant extracts as preservative against wood decay fungus *Sclerotium rolfsii* (Sacc)

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ABSTRACT

The study was conducted to investigate the potentials of some selected plant extracts as preservatives against wood decay fungus (*Sclerotium rolfsii*).The wood samples of *Triplochiton scleroxylon* and *Ceiba pentandra* were used for the experiment. The samples were dimensioned into (20 x 20 x 60) mm. The experiment was laid in a Randomized Complete Block Design (RCBD), the data obtained were analyzed using analysis of variance (ANOVA) at 5% level of significant and Duncan Multiple Range Test (DMRT) was used to separate the mean difference. The plant extracts of *Zingiber officinale*, *Piper guinensis* and *Zanthoxylum zanthoxyloides* were used for the experiment. The extracts were obtained using ethanol and hot water extraction methods. The preservatives were applied on the wood samples using dipping method; the samples were dipped into the preservatives for seventy-two (72) hours. The wood samples were inoculated in Petri dishes containing sclerotia of fungus (*Sclerotium rolfsii*), while the weight loss was recorded. The result showed that retention levels of wood species were found to be higher in hot water extraction method (HWE) than ethanol extraction method (EE). The result indicated that retention level (kg/m^3) of *C. pentandra* ranged from 45.89-50.32 for hot water extraction across the extracts used. While it ranged from 42.56-47.09 for ethanol extraction method (EE). *T. scleroxylon* exhibited retention rate between 41.28-48.24 for HWE and 40.28-45.21 for EE method respectively. The mean weight loss exhibited by wood species indicated that the highest weight losses were found in control (no treatment) for both *C. pentandra* and *T. scleroxylon* with weight loss values of 27.40 ± 4.22 respectively. Since all the plant extracts responded well to the fungal decay, it is hereby concluded that all the plant extracts can be used to suppress fungal attacks thus reducing environmental pollution in the society.

Keywords: wood decay, fungi, preservatives, weight loss, extracts.

INTRODUCTION

Throughout the course of history, wood has remained one of the most important renewable natural resources available to man. However, as a natural organic material, wood is degraded by many organisms principally fungi and insects, (Schuttz and Nicolas, 2002).

Therefore, it is generally treated with a chemical preservative to prevent damage (Craig *et. al.*, 2001).These products are widely accepted by authorities around the world for permanent protection against fungal decay, termite, insect groups and borers. Recent restrictions, internationally are limiting the use of non-biodegradable chemicals for wood preservation, primarily due to increased disposal problems as treated wood is taken out of service (Nurudeen, *et. al.*, 2011). The demand for wood and wood products in Nigeria and the world over have continued to be on the increase, consumption of sawn wood and wood based panel was projected by FAO (1995) to have increase to 2.668million and 121milion for sawn wood and wood based panel respectively by the year 2010 (FAO,1995). Human health and environmental concerns have restricted the use of traditional wood preservative. Therefore, efforts have been concentrated on finding non-toxic eco-friendly alternative (Selim *et. al*., 2002)

Wood is a porous material and in many respects acts like a filter to liquids flowing through it. Due to the extremely small pore size, in most cases wood can be regarded as an ulter-filter. Thus, it is predicted that wood treatment solutions that contain particulate matter will be plugged during the impregnation process (Schuttz and Nicolas, 2002). For this reason, it is very difficult for the extractives to penetrate into the wood structure (Trak, 2006). The toxicity as well as the high cost of conventional agents, promoted the search for natural plant extractives (Extracts) fungicidal activities. These plants have been reported to possess anti-fungi activities against some species of fungi. This is the reason why this study has been carried out to report fungal activity and to know the potential of selected plant extract in wood preservation. Investigation of the synergistic interactions of mixed extract from eco – friendly plant sources on the durability timbers under long term field condition is a significant novelty. Antwi- Boastako (2004) achieved effective significant results due to application of plant extracts in treatment of wood products against deteriorating agents. In his findings, he discovered that plant extracts are more environmentally friendly compared to oil-borne and chemical types. The former lack odour, keep treated surfaces dry, and found to be best choice as much as human life is involved (De Groot *et. al.,* 1996).

METHODOLOGY

Study area

The study was carried out at Pathology laboratory of Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, located on Longitude 3.51^{0}E and Latitude 7.28^{0}N. The annual temperature ranges from minimum of 18.07^{0}C to an average maximum of 34.4^{0}C.

Preparation of extracts and wood specimens

The plant extracts of *Zingiber officinale* (Ginger), *Piper guinensis* and *Zanthoxylum zanthoxyloides* used for the experiment were collected at FRIN orchard Ibadan. The specimens were taken into FRIN Herbarium for identification. The collected samples were air dried and blended into particles with the aid of blending machine. The particle was sieved with mesh 1 – 2 mm and dissolved with 100 ml ethanol and 100 ml of hot water respectively. Subsequently, it was allowed to settle at room temperature, 27°C for 5h. The resultant extract solution was filtered through a glass wool filter and then rinsed with a small quantity (about 30 ml) of ethanol and same quantity of distilled water for hot water extraction. The extract solutions were evaporated to constant weight under reduced pressure at 40°C. Subsequently, the extracts were diluted with distilled water and stored in the refrigerator for later use. For impregnation process, wood specimens [20 (tangential) x 20 (radial) x 60 (longitudinal) mm] were prepared from air-dried sapwood of *Triplochiton scleroxylon* and *Ceiba pentandra* while *Sclerotium rolfsii* (Brown rot) was used as wood-decaying fungi.

Treatment method

Air-dried wood specimens were impregnated in vacuum desiccators with the extracts for 72hours. The total number of treated specimens was eighty (80) comprised of 4 treatments replicated 4 times with 2 methods of extraction, 2 different sapwood specimens and 1 fungus. The impregnated wood specimens were weighed (T2), air dried for one week at ambient temperatures, and then dried in an oven at 60°C for 3 days. Calculation of the amount of preservative absorbed by wood specimen in kg/m^3 is as follows:

Retention level (kg/m^3) = (G x C/V) x 10

Where G= (T2 – T1) = amount in grams of treated solution absorbed by the wood specimen (g), T1 = initial weight of the conditioned wood specimen before impregnation (g), T2 = weight of the wood specimen immediately after impregnation and wiping (g), C = grams of preservative in 100 g of treating solution, and V = volume of wood specimens (cm^3).

Specimens were weighed after impregnation to determine level of absorption and then spread on trays at room temperature for 72 h. They were later placed in the conditioning chamber for 21 days to enable them to attain equilibrium moisture content (EMC). After which final weights of the specimens were measured (T3).

Decay test

The treated and untreated wood specimens used for decay test were spread on trays at room temperature for 72 h. They were later placed in the conditioning chamber for 21 days to enable them to attain equilibrium moisture content (EMC). The wood samples were inoculated with a wood decay fungus (*Sclerotium rolfsii*) in Petri dishes. The inoculated plates were then incubated at room temperature (28 ± 2^0C) and observations on weight loss were made at the end of three month in a modified test according to ASTM D 1413-76 test method for solid wood. At the end of the incubation, blocks were removed from the test Petri-dishes and the mycelium was carefully brushed off the samples. Tested specimens were weighed again after 4th week and mass loss was calculated from the conditioned weight of the wood specimen immediately, before and after testing, as follows:

Weight Loss (%) = (100 (T3 – T4) / T3)

Where T3 = weight of wood specimen plus remaining preservative after conditioning and before exposure to the test fungi (g), and T4 = weight of the wood specimen after test and after final conditioning (g).

RESULTS AND DISCUSSION

Table 1: Retention level of wood species in plant extracts.

Wood species	Extract	Retention level (Kg/m3) HWE	EE
Ceiba pentandra	*Z. officinale*	50.32	46.51
	P. guinensis	49.01	47.09
	Z. zanthoxyloides	45.89	42.56
T. scleroxylon	*Z. officinale*	48.24	45.21
	P. guinensis	44.56	43.25
	Z. zanthozyloides	41.28	40.28

HWE- Hot water extraction method

EE- Ethanol extraction method

Table 1 shows the retention level of wood species in plant extracts. The result indicated that for *C. pentandra* species *Z. officinale* were able to penetrate more, followed by *P. guinensis* and *Z. zanthoxyloides* for hot water extraction with retention values of 50.32, 49.01 and 45.89 respectively. Considering the ethanol extraction (EE) method for *C. pentandra*, the highest retention found in *P. guinensis* followed by *Z. officinale* and *Z. zanthoxyloides* with values of 47.09, 46.51 and 42.56 respectively. Consequently, the retention rate obtained for *Triplochiton scleroxylon* indicated that *Z. officinale* penetrated more into the wood samples followed by *P. guinensis* and *Z. zanthoxyloides* for HWE with values of 48.24, 44.56 and 41.28 respectively. For ethanol extraction method, the highest retention rates were found in *Z. officinale, P. guinensis* and *Z. zanthoxyloides* with values of 45.21, 43.25 and 40.28 respectively. The highest retention rate exhibited by wood species under hot water extraction might be attributed to the fact that temperature aids the rate of reaction and thus induced the absorption rate of the wood samples. Comparing the retention rate among the wood species used, *C. pentandra* were found to have the highest retention capacity. The highest retention capacity exhibited by *C. pentandra* could be attributed to the fact that *C. pentandra* is of a large lumen which gives room for moisture absorption.

Table 2: Mean weight loss exhibited by wood species after exposure to fungal attack.

Wood species	**Extracts**	**Mean weight loss ± SE**	
		HWE	EE
Ceiba pentandra	*Z. officinale*	9.61±1.71^{c}	9.01±1.63^{c}
	P. guinensis	14.51±2.14^{b}	15.43±3.04^{b}
	Z. zanthoxyloides	11.02±2.03^{b}	9.20±2.07^{c}
	Control	27.40±6.25^{a}	27.40± 6.25^{a}
T. scleroxylon	*Z. officinale*	11.32±2.01^{d}	10.21±2.61^{c}
	P. guinensis	15.63±2.55^{b}	14.04±2.78^{b}
	Z. zanthoxyloides	13.19±1.97^{c}	13.01±2.41^{b}
	Control	22.16±4.22^{a}	22.16 ± 4.22^{a}

Mean of five replicates.

HWE- Hot water Extraction

EE- Ethanol extraction method

The analysis of variance conducted showed significant difference ($P \leq 0.05$) in the weight loss exhibited by wood samples. The mean weight loss exhibited by wood species after exposure to fungal attack (table 2) indicated that weight loss encountered were statistically significant ($P \leq 0.05$) thus necessitated for follow up test to separate the mean difference. Hence, the highest weight loss (%) for *C. pentandra* and *T.*

scleroxylon were found in control wood samples (no treatment) with value of 27.40± 6.25 and 22.16 ± 4.22 for *C. pentandra* and *T. scleroxylon* respectively.

Considering the weight loss by *C. pentandra* in hot water extraction *Z. officinale* caused the least weight loss followed by *Z. zanthozyloides* and *P. guinensis* with values of 9.61 ± 1.71, 11.02 ± 2.03, 14.51 ± 2.14 respectively. However, the weight loss exhibited by *C. petandra* in EE method indicated the least weight loss in *Z. officinale* followed by *Z. zanthoxyloides* and *P. guinensis* with their weight loss values of 9.01±1.63, 9.20±2.07, 15.43±3.04 respectively. Consequently, *T. scleroxylon* had its least weight loss with hot water extraction in *Z. officinale* followed by *Z. zanthoxyloides* and *P. guinensis* with value of 11.32±2.01, 13.19±1.97 and 15.63±2.55 respectively. The ethanol extraction on the other hand indicated the least weight loss in extract of *Z. officinale* followed by *Z. zanthoxyloides* and *P. guinensis* with value of 10.21±2.61, 13.01±2.41 and 14.04±2.78 respectively.

The least weight loss exhibited by extract of *Z. officinale* in both *C. petandra* and *T. scleroxylon* could be attributed to its high phytochemical contents such as alkaloid, tannin which in turn have toxic effects against bioagent, thus could be preferred for protection of wood or wood based objects against destroying organisms (Schltz and Nichollas, 2000).

The impact of *P. guinensis* and *Z. zanthozyloides* in suppressing the fungal attack were also note worthy. The weight loss was found to be much lower compared to the control wood samples for both *C. petandra* and *T. sclerenxylon*. Ability of natural plant extracts to protect wood against degrading fungi and insects have one possible approach for developing new wood preservatives (Selim *et al*., 2002; Kartal *et al*., 2004). Similar findings were observed by Chang *et al*., (1998) who reported that α– cardinal obtained from Taiwania heart-wood possess high antifungal effectiveness. Digrak *et al*, (1999) investigated the antimicrobial activities of extracts of Mimosa bark; they reported that extracts had anti bacteria activity. This result is in accordance with the findings of Usman *et al.*, (2007) who reported that *Nerium olender* extract reduces the fungi attack on wood as a result of poisonous additives present in it. However, similar research was observed by Nurudeen e*t al.*, (2011) who reported that application of extract of Z. *zanthoxyloides* proved effective in suppressing termite attack.

CONCLUSION AND RECOMMENDATIONS

This study has established the potential of *Z.officinale*, Z. *zanthoxyloides* and *P. guinensis* extracts in controlling fungal growth on wood. Chemical preservatives are greatly toxic to the environment. Since plant extract were found to be good alternative for wood treatment and also characterized low cost, low mammalian toxicity, ease of handing and treatments, thus the study is of great benefit. Based on this regard, the extract of Ginger will greatly reduce fungi attack due to significant reduction in weight loss of treated wood samples compared to untreated samples. Based on the findings from the experiments, the extract used in this study are non toxic, biodegradable and renewable sources. It is hereby recommended for the preservation of wood and use. Government should endeavor to fund the research so as to discover more of valuable species that can be suitable for wood treatment and still compete with the conventional wood preservatives. One of the major environmental threats and hazard at alarming rate posed to the global community is pollution and the release of enormous poisonous substances into the environment causing menace to natural balance, human health, depletion of soil layer, water body e.t.c. The need for environmental protection should arouse the interest of modern scientist and researchers, through the use of eco friendly preservatives rather than synthetic chemicals that will always leave residue which in turn leads to environmental pollution.

Consequently, more research should still be conducted by scientist on natural sources of preservatives with potent chemicals for wood treatment which will enhance longevity of wood in service. This can lead to the utilization of the lesser known wood species which are not commonly used in building structures.

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