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Antifungal Effectiveness of Pyrolytic Oil Obtained from *Triplochiton scleroxylon* (De. Wild) Sawdust on Selected Wood Species

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Authors' contributions

This work was carried out in collaboration among all authors. Author OAA designed the study, performed the statistical analysis, wrote the first draft of the manuscript. Authors FBO and OAA wrote the second and last draft of the manuscript. Author FBO managed all the laboratory analyses of the study. Author OAO managed the fungi culturing. Authors OAA and JKA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out to investigate the effectiveness of pyrolytic oil obtained from *Triplochion scleroxylon* sawdust which used as a preservative against fungi attack on *Alstonia bonnei, Ceiba pentandra, Pterocarpus osun, Terminalia randii, Triplochiton scleroxylon* wood. The wood samples used for the experiment were dimensioned into 20 x 20 x 60 mm and soaked for 72 hours to obtain appreciable absorption. The percentage absorption after soaking and weight loss after exposure to termite were determined. Data were analyzed using simple statistics and analysis of variance at $\alpha_{0.05}$. The highest and lowest percentage absorption was recorded for *Terminalia randii* and *Alstonia bonnie with* 23.20 % and 13.10 % respectively. Analysis of variance result indicates the significant difference in wood species used. The result obtained for weight loss revealed significant differences in wood species as well as in fungi also. The result further showed that those are taken as control recorded the highest weight loss to white and brown rot fungi. Pyrolytic oil possesses a great potential in the prevention of fungi attack as it contained phenolic compound.

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1. INTRODUCTION

The wood preservation is an active part of forestry that engaged in protection of wood products from degradations and deterioration and thus playing a very important role in forestry conservation worldwide making headway towards meeting global wood demand [1].

Wood being a biological material is readily degraded by bacteria, fungi and termites [2-3]. However, some wood species are resistant to these degrading agents while others are very susceptible to the deterioration [4]. Hence, susceptible must be treated with preservatives to increase their service life. The process of reducing and/or preventing attack by wood deteriorating agents thereby increasing the service life of wood is called wood preservation [5]. Using natural products to enhance the service life of wood will minimize environmental pollution and also the injury to the workers caused by toxic wood preservative chemicals. Besides, the use of locally produced preservatives will lead to reduced importation of costly preservatives and save on foreign exchange. The availability of cheap but effective wood preservatives is likely to increase the percentage of wood treated before use. This will lead to less frequency of replacement of timber and a reduction in the rate of deforestation.

Recent studies suggest that the studies on the use of plant extracts have opened a new approach for the control of plant diseases and pathogens present [6-11]. Wood extracts are natural compounds and are rich in bioactive compounds such as tannins, polyphenols, and lignins which are toxic to wood degrading micro-organisms. On the other hand, pyrolytic oil is dark brown, free-flowing organic liquids that are comprised of highly oxygenated compounds from pyrolysed biomass [12]. The pyrolytic oil can also be called bio-oil, pyrolysis oils, pyrolysis liquids, liquefied wood, pyroligneous acid among others. Pyrolytic oil contains organic compounds like phenols, alcohols, ketones, esters, aldehydes, oxygenated hydrocarbons [13-15].

In recent time, pyrolytic oil obtained from many different sources of biomass are gaining more attention as a new safer wood preservative against biodeteriorating agents. Furthermore, the number of studies based on this new usage is constantly increasing [16-23]. Hence this study therefore aimed at evaluating the effect of pyrolytic oil against wood-decaying fungi using selected tropical wood species to promote environmentally friendly preservatives and increase its durability while in service.

2. MATERIALS AND METHODS

2.1 Pyrolysis Experiment

The pyrolysis of *Triplochiton scleroxylon* saw dust follows the previous work of [24].

2.2 Preparation and Treatment of Wood Sample

The wood samples (*Alstonia bonnei, Ceiba pentandra, Pterocarpus osun, Terminalia randii,* and *Triplochiton scleroxylon*) were obtained from wood workshop of the Department of Wood and Paper Technology, Federal College of Forestry, Ibadan, Nigeria. The wood samples were dimensioned into 20 x 20 x 60 mm (longitudinal x radial x tangential directions). They were properly labeled, weighed, and dried in an oven at a temperature of 103±2°C for 24 h until excess moisture content was removed. The wood samples were completely immersed (soaking method) in the pyrolytic oil for 72 h to obtain an appreciably amount of absorption.

2.2.1 Absorption test

Absorption test was conducted after the treatment with pyrolytic oil by draining and reweighing the wood to determine the percentage and this was determined with the following formula.

$$\%AR = \frac{T_3 - T_2}{T_2} X\ 100 \tag{1}$$

%AR = Percentage Absorption, T_3= Weight after soaking, T_2 = Oven-dried weight.

2.3 Preparation of Culture Medium

The white-rot fungi (*Pleurotus ostreatus*) and Brown rot (*Sclerotium rolfsil*) were obtained from the Pathology Department, Forestry Research Institute of Nigeria. The fungi were cultured using Potato Dextrose Agar as the culturing medium at 25°C for 48 hours. 40 ml of PDA was poured into McCartney bottles and sterilized by autoclaving at 0.1 N/mm^2 (120°C) for 20 minutes. The medium was inoculated with the test fungi within 6 days after the preparation of the bottles [25].

2.4 Test Blocks Infected with Fungi

Wood samples treated with the pyrolytic oil were infected by placing them in the bottles in which there were actively growing cultures of the test fungi. The blocks were placed in the bottles containing each of the two test fungi such that they came in contact with the aerial mycelium of the fungus then incubated at room temperature (27 ± 2°C) in In vitro for 16 weeks. At the end of the incubation period, the blocks were removed from the culture bottles, cleaned off the adhering mycelium, and oven-dried at 103°C to constant weight.

2.5 Weight Loss of Wood Samples

Percentage weight loss to termite attack for each wood samples were calculated using the formula below:

$$\%WL = \frac{T_4 - T_3}{T_3} X\ 100 \quad (2)$$

%WL = Percentage weight loss, T_3 = Weight after conditioning, T_4 = Weight after exposure to fungi.

2.6 Data Analysis by ANOVA

Statistical analysis was conducted on data obtained. Analysis of variance (ANOVA) was adopted for significant differences between treatments (selected wood species). When the ANOVA indicated a significant difference among selected wood species, a comparison of the means was conducted, using the Duncan Multiple Range Test (DMRT) to identify which groups were significantly different at $\alpha_{0.05}$.

3. RESULTS AND DISCUSSION

3.1 Effect of Absorption of Pyrolytic Oil with Selected Wood Species

The absorption of pyrolytic oil by the selected wood species is significantly different shown in Table 1. The analysis of variance conducted showed that there is a significant difference ($p<0.05$) among selected wood species used. It could also be observed that there is variation in the rate at which each of these wood species absorbed the pyrolytic oil due to the fraction of pyrolytic oil in that pyrolytic oil contains a heavy oil with a viscous mostly oligomeric lignin-derived fraction settled at the bottom and the light oil contains water-soluble which are mostly carbohydrate derived compounds found on the top layer [23].

Using Duncan Multiple Range Test (DMRT), a comparison of the means was conducted to identify which wood species were significantly different shown in Table 2 that the most absorbed wood is *Terminalia randii*. The lowest and highest percentage absorption was recorded as 13.10 % and 23.20 % *for Alstonia bonneii* and *Terminalia randii.* The low and high absorption of these preservatives by wood can be attributed to the vessel arrangement in the wood [26]. The vessels constitute the main channel for flowing in of preservative solution into the wood in the longitudinal direction. Also, the viscosity of the pyrolytic oil and the structure of the wood used [23-24]. Absorptions are usually low for oil borne preservatives because of their high viscous nature.

Also, the absorption of preservatives by *Alstonia bonnei, Ceiba pentandra, Pterocarpus osun, Terminalia randii,* and *Triplochiton scleroxylon* differs and this can be too attributed to the wood structure. Beside, penetration ability, the viscosity of the preservative and chemical composition of the preservative can also contribute to the absorption of preservative.

3.2 Effect of Fungi Attack on Preserved Wood with Pyrolytic Oil

Table 3 showed the percentage weight loss of wood samples as a result of fungi attack on five wood species *Alstonia bonnei, Ceiba pentandra, Pterocarpus osun, Terminalia randii,* and *Triplochiton scleroxylon*. Through Table 4 it is revealed significant difference in the wood species as attacked by fungi regarding treated and untreated while no significant exist in the

Table 1. Analysis of variance show percentage absorption of selected wood species

Source of variation	Df	Sum of squares	Mean square	F	Sig.
Wood Species (*Ab, Cp, Po, Tr, Tc*)	4	163.33	40.83	10.43	0.00*
Error Difference	10	39.17	3.92		
Total	14	202.49			

**- significant (p<0.05)*

Ab - Alstonia bonnei, Cp - Ceiba pentandra, Po - Pterocarpus osun, Tr - Terminalia randii, Ts -Triplochiton scleroxylon.

Table 2. Absorption of pyrolytic oil by wood species

Wood species	Percentage absorption (%)
Alstonia bonneii	13.10(0.15)a
Ceiba pentandra	16.00(0.59)ab
Pterocarpus osun	18.10(0.17)b
Terminalia randii	23.20(0.85)c
Triplochiton scleroxylon	17.77(2.32)b

Mean; Standard error in parenthesis. Values having the same alphabet in the column are not significantly different (p≤0.05) using Duncan Multiple Range Test

fungi used for this study. It can be shown that the untreated samples which are taken as control recorded the highest weight loss to white and brown rot fungi with the mean value of 39.35 and 35.21; 42.82 and 45.47; 37.92 and 39.15; 35.78 and 33.55; 36.84 and 37.52% for *Triplochiton scleroxylon*, *Pterocarpus osun, Alstonia bonnei, Ceiba pentandra* and *Terminalia randii* respectively. Moreover, *Triplochiton scleroxylon* shows the least weight loss to white and brown rot fungi with a mean value of 4.46 and 5.90 % respectively.

The result of the weight loss obtained can be attracted to the effectiveness of the pyrolytic oil [23] Thus pyrolytic oil contained organic compounds such as phenols, esters, ketones, aldehydes, alcohols, and oxygenated hydrocarbons [15]. This gives it the quality for preserving wood against the fungi attack.

Table 3. Influence of period of soaking on percentage weight loss of selected wood species

Wood species	Conditions of treatment	Weight loss to fungi attack (%)	
		Pleurotus ostreatus	***Sclerotium rolfsil***
Triplochiton scleroxylon	Treated	11.22(1.10)	11.15(3.97)
	Not Treated	39.35(4.27)	35.21(2.24)
Pterocarpus osun	Treated	4.46(1.03)	5.90(0.49)
	Not Treated	42.82(3.39)	45.47(4.46)
Alstonia bonneii	Treated	10.43(5.19)	10.61(1.92)
	Not Treated	37.92(4.72)	39.15(4.61)
Ceiba pentandra	Treated	13.72(5.50)	13.01(8.62)
	Not Treated	35.70(9.81)	33.55(13.02)
Terminalia randii	Treated	10.07(3.28)	7.47(5.22)
	Not Treated	36.84(1.00)	37.52(3.86)

Mean and standard error in parenthesis. Values having the same alphabet in the rows are not significantly different (p≤0.05) using Duncan Multiple Range Test.

Table 4. Analysis of variance (ANOVA) for percentage weight loss

Source of variation	Df	Sum of squares	Mean square	F	Sig.
Wood species (WS)	4	21.48	5.37	0.19	0.94ns
Condition (CO)	1	12224.25	12224.25	428.09	0.00*
Fungi (FUG)	1	1.82	1.82	0.06	0.80ns
WS * APA	4	503.55	125.89	4.41	0.01*
WS * FUG	4	34.52	8.63	0.30	0.88ns
APA * FUG	1	0.00	0.00	0.00	1.00ns
WS * APA * FUG	4	24.00	6.00	0.21	0.93ns
Error	40	1142.21	28.56		
Total	59	13951.84			

**-significant (p≤0.05), ns-not significant (p>0.05)*

4. CONCLUSION

This research concluded that pyrolytic oil obtained from wood sawdust possesses great potential to resist fungi attack as it contained phenolic compounds. The research has been able to establish that the weight loss obtained can be attracted to the effectiveness of the pyrolytic oil hence proven it to have the quality for preserving wood against the fungi attack.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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