

Effects of Hot and Cold Treatment Techniques on Preservative Absorption of *Triplochiton Scleroxylon* (Obeche) Against Fungi Attack

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ABSTRACT

The influence of different treatment techniques on the absorption of preservatives by Obeche wood against decay fungi was examined. The treatment techniques consisted of cold and hot dipping methods, while the preservatives included solignum, neem leaf extract and spent engine oil. The experimental design was 3 x 2 x 3 factorial experiment in Completely Randomized Design. Five sets of the wood samples were immersed in hot and cold preservatives for 6 and 24 hrs. respectively. The percentage preservative absorptions were recorded. The treated wood samples were inoculated with *Sclerotium rolfsii* and *Pleurotus sajorajau* fungi for 12 weeks after which the weight losses were recorded. Data obtained were subjected to Analysis of Variance (ANOVA). The results revealed that the hot treatment technique recorded the highest (50.98%) mean absorption. With 97.29% and 36.18% mean preservative absorption for both hot and cold treatment techniques respectively, Solignum preservative had the highest significant effects on Obeche wood. Hot treatment technique recorded the lowest (18.20%) and significant mean weight loss, while solignum and the control respectively recorded the lowest (9.67%) and highest (28.40%) mean weight loss of the Obeche wood. The hot treatment technique increased the penetration and absorption of preservative chemicals into Obeche wood, while solignum preservative had a better absorption and retention as well as the highest inhibition of the degree of attack of the fungi species on Obeche.

Keywords: Treatment Techniques; Preservative; Absorption; Obeche; Fungi; Weight loss

INTRODUCTION

In Nigeria, more than 80% of timber products are used for versatile purposes such as building, furniture, railway sleepers, transmission poles, pulp and paper, plywood, veneers, composites board, matches, fuel (coal industry) and fuel wood (Akanbi and Ashiru, 2002). The fact that wood can be used for both in-door and out-door services and exposed to different weather conditions is an indication that wood can be used for many years if properly preserved. Wood is treated to prevent its destruction by wood decaying organisms. Treating wood with the appropriate preservative increases its service life, and also helps to conserve our nation's timber resources.

Falemara *et al.*, (2012) and Grene (2001) opined that wood is one of the oldest best known structural material and one of the few renewable natural resources. The supply of wood is limited; as such it is necessary to protect the wood in service from biological deterioration. Impregnating wood by applying suitable chemicals is the most preferred preservation method and present a lot of economic gain, but some toxic chemicals used for wood preservation contain serious pollution risks to the environment (Iya and Kwaghe, 2007). According to Badshah, *et al.*, (2005), these man-made problems had further resulted in phytotoxicity, mammalian toxicity, pesticides residues, insect resistance, insect outbreaks and increased cost of production. The conventional wood preservatives although found to be very effective

against wood destroying organisms, are said to cause environmental pollution and a few of them are hazardous to animals and human beings (Onuorah, 2000).

Triplochiton scleroxylon (Obeche) which belongs to the family Sterculiaceae is an important indigenous wood species in the Nigeria timber market due to its versatility and huge volume supply. Unfortunately, the species has a low service life as a result of its susceptibility to attack by agents of bio deterioration. However, the wood would last longer when treated with suitable preservatives. Freshly felled logs are extremely prone to attack by pinhole borer beetles, while seasoned timber is often infested by powder-post beetles. The wood of the species is not durable, being liable to fungal attack (e.g. blue stain), and susceptible to termites, powder-post beetles and dry-wood borers. The heartwood is somewhat resistant to preservative treatment (Louppe, 2008).

Over the past few decades, there has been a substantial global quest to develop eco-friendly wood preservatives that are relatively cost-effective chemicals and have minimal toxicity to mammals and the environment. Ability of wood and natural plant extractives to protect wood against wood degrading fungi and insects have been one possible approach for developing new wood preservatives (Kartal *et al.*, 2004). Okigbo and Ogbonnaya (2006), stated that the use of extracts

from plants for plant disease management is economically viable and poses little environmental risk, and the plants are available to farmers in Nigeria that do not have ready access to other synthetic fungicides. On this basis, the research study therefore investigated the impacts of cold and hot treatment techniques on preservative absorption of *Triplochiton scleroxylon* (Obeche) against fungi attack of brown rot fungi (*Sclerotium rolfsii*) and white rot fungi (*Pleurotus sajorcaju*).

MATERIALS AND METHOD

The experiment was carried out in Federal College of Forestry Jos, Plateau State Nigeria. The wood sample *Triplochiton scleroxylon* was sourced from a local timber market and processed into smaller samples using the circular saw. Ten liters of spent engine oil was procured from the automobile workshop in Jos, while ten liters of solignum was purchased from the market. Fresh leaves of matured *Azadirachta indica* tree were collected from the mother tree, washed with distill water and air dried at room temperature (22^oC) for 21days and pulverized into fine particles. Cultured brown rot fungus (*Sclerotium rolfsii*) and white rot fungus (*Pleurotus sajorcaju*) species were sourced from the Pathology Department at Forestry Institute of Nigeria, Ibadan, and Oyo State.

Samples Preparation

The wood species was cut to 105 test blocks (20mm x 20mm x 60mm) (Plate 1). The initial weight of the wood samples was taken and recorded as T₀. Thereafter, the samples were oven dried at 103^o C for 24hours until constant weight was attained to reduce the moisture and also to sterilize the wood. This weight was recorded as T₁. The extract preparation of *Azadirachta indica* was obtained according to the methods described by Owolade, (2000) and Achio, *et al.*, (2012), 300g of the powdered leaf was mixed with 1liters of distilled water, allowed to stand for 24 hours, sieved and further filtered using a filter paper. The extract was then transferred into a container and labeled for use. The spent engine oil and solignum were divided into two sets of 5 liters for hot and cold treatments respectively.



Plate 1: Wood Billet Samples

Treatment of Wood Samples and Fungi Exposure

Treatment and preservative impregnation of the wood samples was carried out according to the methods described by Owoyemi and Kayode, (2007). A set of five samples were immersed into hot solutions of solignum, spent engine oil and aqueous extract of *Azadirachta indica* preservatives heated in an open tank (Plates 2 – 9). Heating was discontinued after 6 hours, allowing the wood samples and the preservative to cool together for 24hours after which they were drained on wire mesh and the samples weighed and recorded as T_{2a}. The second set, comprising of five samples were cold dipped into each of the preservatives for 24 hours, weighed and recorded as T_{2b}. The samples were kept in the laboratory for 72 hours for conditioning before exposure to fungi attack. Pure cultures of the fungi (brown rot (*Sclerotium rolfsii*) and white rot (*Pleurotus sajorcaju*)) were grown on potato dextrose sugar agar (PDA). The treated wood samples were inoculated with the cultured fungi of white rot species, brown rot species and a combination of both fungi species in an enclosed transparent bottle for 12weeks. Untreated samples (control) were also exposed to fungi attack. After the 12 weeks exposure, the test blocks were removed, cleaned and then weighed. The final weight after exposure was obtained and recorded as T₃ (Perminderjit, 2014).



Plate 2: Extract Preparation



Plate 3: Pure Cultured Fungi



Plate 4: Solignum Treated Wood



Plate 5: Spent Engine oil treated wood



Plate 6: Neem leaf extract treated wood



Plate 7: Control (Untreated)



Plate 8: Hot Treated Wood Samples



Plate 9: Wood Inoculated in the fungi

Experimental Design

The experimental design adopted for this study was a 3 x 2 x 3 factorial experiment in a Completely Randomized Design (CRD), the combination of which gives 18 treatments replicated three times. The factors consist of three preservatives, two treatment techniques and three fungi species and a combination of both white rot and brown rot fungi).

Parameters Assessed

Assessment of test samples were carried out according to Owoyemi and Kayode (2007); Selim, *et al* (2009) and Perminderjit, (2014);

Preservative Absorption: This refers to the quantity of preservative chemical absorb by the wood samples. The percentage absorption was calculated by using equation 1:

$$\% \text{ Absorption} = \frac{T2-T1}{T1} \times 100 \dots\dots\dots (1)$$

Weight Loss: The weight of the wood samples after exposure to the fungi species was calculated using equation 2:

$$\% \text{ Weight loss} = \frac{T2-T3}{T2} \times 100 \dots\dots\dots (2)$$

Where;

- T1 = Oven dry weight of sample (g)
- T2 = Conditioned weight after preservative treatment (g)
- T3 = Final weight after fungi exposure (g)

Statistical Analysis

The data obtained were subjected two-way Analysis of Variance (ANOVA) to determine significant effects of treatment techniques and preservatives. Follow up test was carried out using Duncan Multiple Range Test (DMRT) where significant differences exist.

RESULTS

Preservative Chemicals and Treatment Techniques

The effect of preservative chemicals and treatment techniques on preservative absorption by *Triplochiton scleroxylon* wood

showed that hot solignum treatment technique had 97.29% mean preservative absorption while 36.18% was recorded for cold treatment technique. For spent engine oil, the hot treatment technique had 29.98% while the cold treatment

recorded 22.02% absorption. Neem leaf aqueous extract had 25.67% and 19.42% mean preservative absorption for hot and cold treatment techniques respectively. It can thus be inferred that the wood sample absorbed and retained more of the

solignum preservative chemical followed by the spent engine oil, while neem leaf aqueous extract had the least mean percentage preservative absorption (Figure 1).

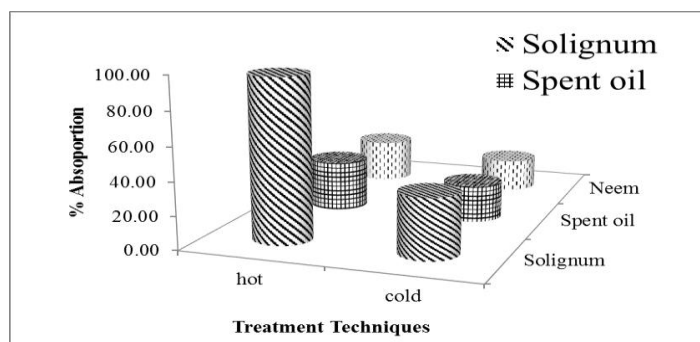


Figure 1: Effect of preservative chemicals and treatment techniques on absorption by *Triplochiton scleroxylon* wood.

Table 1: Effect of treatment techniques on preservative absorption by *Triplochiton scleroxylon*

Treatment Techniques	% Absorption
Hot Treatment	50.98 ^a
Cold Treatment	25.87 ^b
SE±	1.79

Means having the same letters are not significantly different ($p > 0.05$)

The result of analysis of the mean effect of treatment techniques on percentage preservative absorption of *Triplochiton scleroxylon* in Table 1 revealed that hot treatment technique exhibited the highest significant effect of 50.98% at 5% probability level.

Table 2: Mean effect of preservative chemicals and treatment techniques on percentage preservative absorption of *Triplochiton scleroxylon*

Preservatives	Hot Treatment	Cold Treatment
Solignum	97.29 ^a	36.18 ^a
Spent oil	29.98 ^b	22.02 ^b
Neem extract	25.67 ^b	19.42 ^b
SE±	4.063	1.612

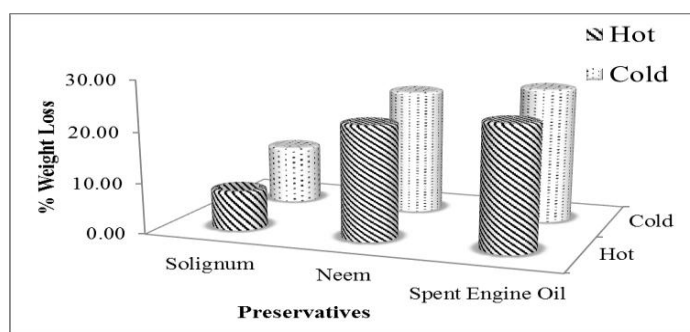
Means having the same superscripts are not significantly different ($p > 0.05$)

Solignum preservative had the highest significant effects of 97.29% and 36.18% on mean percentage preservative absorption on the treated *Triplochiton scleroxylon* wood for hot and cold treatment techniques respectively. The other preservative chemicals (spent engine oil and neem leaf aqueous extract) were not significantly different from each other. (Table 2).

Percentage Weight Loss

Effect of preservative chemicals and treatment techniques on percentage weight loss of *Triplochiton scleroxylon* (Figure 2)

gave a clear indication that hot treatment techniques of all the preservative chemicals yielded the lowest percentage mean weight loss of the *Triplochiton scleroxylon* wood due higher absorption of preservative and greater resistance to decay fungi, while the cold treatment techniques had that highest percentage mean weight loss. Solignum preservative treatment produced the lowest percentage mean weight loss for both hot and cold treatment techniques, followed by aqueous neem leaf extract and lastly spent engine oil.

Figure 2: Effect of preservative chemicals and treatment techniques on weight loss of *Triplochiton scleroxylon*Table 3: Effect of preservative chemicals on weight loss of *Triplochiton scleroxylon*

Preservative Chemical	Percentage Weight Loss
Solignum	9.67±4.08 ^c
Spent Engine Oil	25.57±2.41 ^b
Neem	23.63±6.66 ^b
Control	28.40±2.22 ^a

Means having the same superscripts are not significantly different ($p>0.05$)

As observed from the result, spent engine oil and aqueous neem leaf extract were not significantly different for mean weight loss of *Triplochiton scleroxylon* wood based on the degree of decay caused by the fungi species. Conversely, Solignum preservative chemical recorded the lowest (9.67%) significant effect on percentage mean weight loss, while the control (28.40%) was significantly from the other treatments on *Triplochiton scleroxylon* wood (Table 3).

Table 4: Effect of treatment techniques on weight loss of *Triplochiton scleroxylon*

Treatment Technique	Percentage Weight Loss
Hot	18.20±8.73 ^c
Cold	21.04±8.15 ^b
Control	28.40±2.23 ^a

Means in having the same superscripts are not significantly different ($p>0.05$)

The treatment techniques as well as the control were significantly effective on the mean percentage weight loss of the *Triplochiton scleroxylon* wood as a result of the rate of fungi decay on the wood. However, the control (in which no treatment was applied) recorded that highest (28.40%) mean significant, while hot treatment technique recorded the lowest (18.20%) significant effects on the percentage mean weight loss of *Triplochiton scleroxylon* wood at 5% probability level (Table 4).

Table 5: Effect of Fungi Species on weight loss of *Triplochiton scleroxylon*

Fungi Species	Percentage Mean Weight Loss
<i>Sclerotium rolfsii</i>	19.77±8.88 ^b
<i>Pleurotus sajorcaju</i>	22.27±9.52 ^{ab}
Combination	20.60±6.94 ^a

Means having the same superscripts are not significantly different ($p>0.05$)

The effect of fungi species on the rate of decay caused by *Sclerotium rolfsii*, *Pleurotus sajorcaju* and combination of *Sclerotium rolfsii* and *Pleurotus sajorcaju* (Table 5) indicated that the effects of *Sclerotium rolfsii* and *Pleurotus sajorcaju* were not significantly different from each other. This insignificant difference is also the same for *Pleurotus sajorcaju* and the combination of *Sclerotium rolfsii* and *Pleurotus sajorcaju* on the percentage mean weight loss of the *Triplochiton scleroxylon* wood. The implication of these is that the fungi species types statistically had no significant effects on the percentage mean weight loss of *Triplochiton scleroxylon* wood.

DISCUSSION

Preservative Absorption

Absorption is the quantum of preservative uptake by the wood during treatment which also determines the protection coverage. The result of this study revealed that the percentage preservative absorption ranged from 19.42% to 97.29%. The maximum value as obtained is less than the maximum preservative absorption reported by Faruwa *et al.*, (2015) which stated that *Ceiba pentandra* had a maximum preservative absorption of 113% while obeche had 128% when treated with tar oil, *Tridax procumbens* and *Parkia biglobosa* extracts. The result revealed significant increase in the quantity of preservative absorbed by *Triplochiton scleroxylon* for hot treatment compared to the cold treatment techniques. This assertion differs to the works of Adejoba *et al.*, (2011) that no significant difference existed between the three methods of application of preservatives on *Gmelina arborea* wood. The effect of preservative chemicals on weight loss of obeche wood showed that significant difference existed between solignum and spent engine oil, solignum and neem leaf aqueous extract, but the effects of spent engine oil and neem leaf aqueous extract was not significantly different. This in line with similar study by Owoyemi and Kayode (2007) implies that the nature of the preservative chemicals affected the quantity absorbed by the wood. Conversely, the study disagrees with his findings that absorptions are higher for water soluble preservatives than for oily types. It was revealed from this study that two oily preservatives (solignum and spent engine oil) had the highest preservatives absorption than the water borne preservative (Neem leaf aqueous extract). This can be attributed to the fact

that the oily preservatives had better permanence in the wood than the water-borne preservative after treatment, most especially after heating to increase their temperature and simultaneously reducing their viscosity, consequently enhancing better flow of preservative absorption into the wood. The finding also corroborates with the discoveries of Olaniran, *et al.* (2010) that the methods adopted for preservative application has significant effect on the quantity of spent engine oil absorbed by wood.

Chemical penetration and retention has been the index to measure the treatability of wood species. According to Kamdem and Chow (1999), the challenge encountered with the preservative treatment of hardwoods is the inability to obtain even distribution of the chemicals and the difficulty in achieving the desired chemical retention. The effectiveness of preservative treatment depends on chemical formulation selected, method of application, wood species, moisture content before and after treatment, pretreatment methods, amount of preservative retained, depth of penetration and distribution, viscosity and temperature of the treating solution, vacuum and/ or pressure regimes and their durations are some of the parameters that influence wood treatability (Oteng – Amoako, 2006; Islam *et al.*, 2008). The difference in anatomical structure of wood has a lot of influence on the absorption and retention of wood preservatives (Akpan, 2007) which is an indication according to Olaniran *et al.* (2010), that the higher the density of the wood species the lower the rate of absorption and vice versa.

Weight Loss Due to Fungi Infestation

The weight loss after 12 weeks' fungal infestation ranged from 19.42% to 97.29%. This range of values is in consonance with similar study as reported by Faruwa *et al.*, (2015) in which obeche wood had a maximum weight loss of obeche of 100%. Hot preheated treatment technique proved to be significantly effective on the weight loss of obeche caused by the rate of fungi attack on the wood due to higher penetration and retention of the preservative solution as a result of reduction in viscosity. The implication of this is that, the treatment technique engaged in the application of preservatives can greatly affect the level of protection given to wood in-service as confirmed by Rebecca (1999) and reaffirmed by Olaniran *et al.* (2010) that the level of protection given to wood in service is not only determined by the potency of the preservative but also on the method of application. The significantly high degree of attack caused by the fungi species on the untreated (control) wood sample justified the reason why the wood of obeche wood was classified among the non-durable wood species which further proved its susceptibility nature to fungi attack. This is similar to the findings of Owoyemi *et al.*, (2012) on *Ceiba pentandra* which revealed high vulnerability and fungal infection indicating that the wood is not durable, and as such requires preservative treatment to prolong its serviceable life or longevity.

The effect of neem leaf extract collaborates with the findings of Olufemi *et al.*, (2011), who reported that the level of protection offered by neem oil and bark extract was considered low, but the neem leaf extract was effective when

compared to some plant extracts. Dhyani *et al.* (2005) in his study showed that neem leaves are very effective against some wood decay fungi. As opined by Nurudeen *et al.*, (2012), chemical preservatives are greatly toxic to the environment as such plant extracts which are environmentally friendly bio preservatives could serve as good alternative for wood treatment coupled with their characterized low cost, low mammalian toxicity, ease of handling and treatment. The significant but low effect of spent engine oil revealed that spent engine oil inhibited to some extent the degree of attack of the fungi species on the wood. As such, as an alternative to solignum and neem leaf extract, spent engine oil can also be utilized as a preservative chemical at a high temperature to reduce its viscosity and enhance better penetration into the wood.

The insignificant degree of decay caused by the fungi species (*Sclerotium rolfsii* (brown rot), *Pleurotus sajorcaju* (white rot)) and combination of *Sclerotium rolfsii* and *Pleurotus sajorcaju* on the percentage mean weight loss of *Triplochiton scleroxylon* wood as revealed in this findings lent credence to the report Ajala *et al.*, (2013) that the degree of decay caused by the two fungi species of *Pleurotus florida* and *Pleurotus sajor-caju* on weight loss was not significantly different on the tested wood sample.

CONCLUSION AND RECOMMENDATION

The degree of protection afforded by a wood preservative depends upon the quantity of preservative retained by the wood, the depth of penetration and retentiveness, and mostly importantly the permanence of the preservative in the wood. The hot treatment technique increased the penetration and absorption of preservative chemicals into *Triplochiton scleroxylon*. This research study has confirmed that the wood is non-durable and as such susceptible to fungi attack, nonetheless requires preservative treatment to lengthen its service life. Preservative treatment of the wood with the solignum gave adequate protection against fungi attack in terms of better penetration and retention. The degree of protection offered is a function of its penetrability. The presence of the active ingredient of neem (Azadirachtin) was responsible for the high level of effectiveness against fungi attack as compared with the lower effect on the degree of fungi attack on the wood exhibited by spent engine oil. The spent engine oil can still be utilized as preservative against fungi attack. Hot treatment immersion technique enhanced good penetration and treatability of wood compared to cold treatment.

Based on the findings of this research study, Neem leaf extracts, which is an environmentally friendly bio preservative agent, can serve as alternative preservative in treating *Triplochiton scleroxylon* wood. Further research should also be conducted to incorporate toxic organic substance into the spent engine oil to test for its efficacy to fungi attack.

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