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Preservatve Potentials of *Datura metel* Seed Oil on *Triplochiton scleroxylon Wood (Schumann)*against Fungal Attack

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ABSTRACT: This experiment was carried out to evaluate the potential of extracted *Datura metel* seed oil as a bio wood preservative against fungi attack as reports have shown bio-preservatives to be toxic free and environmentally friendly. The oil was extracted from the seed by Soxhlet apparatus using N-Hexane and ethanol solvents and using volume-to-volume method of dilution kerosene (at 50%) was added to increase its quantity thereafter. The phytochemical screening of the seed of *Datura metel* revealed the presence of tannins, alkaloids, flavonoids, saponins and phenols. Wood samples of *Triplochiton sceleroxylon* were cut to 20 × 20 × 60mm and the dimensioned wood samples were soaked for 72 hours in the seed oil extract hence preservative absorption rate and percentage weight loss of wood was determined on exposure to a purely cultured *Sclerotium rolfsil* (brown rot fungi) and *Pleurotus ostreatus*(white rot fungi). Data obtained were subjected to analysis of variance at α0.05 and the results showed the highest value of mean weight loss of 18.29% while the samples exposed to brown rot fungi has a mean value of 14.12% and white rot a lowest mean value of 12.72%. The highest absorption was observed to be 92.73 kg/m at 100 % concentration level of *D,metel* extract. Based on the results obtained, the seed-oil extracts of *Datura metel* have the potential of being an effective wood preservative.

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Wood is a natural organic fibrous tissue comprising of cellulose embedded in a matrix of Lignin, materials which are a combination of simple sugars that can biodegrade. It has always been a pre- eminent construction material for both domestic and industrial uses as much as up to 80% in Nigeria(Ogbogu,1996), thus the need to preserve them. Notwithstanding, wood can be unusable due to fungal infestations, insect attacks, fire attacks and also mechanical failure (Areo, 2002). Some timbers have highly valued properties of excellent resistance to various agents of deterioration and are therefore termed highly durable, while many others have only moderate resistance or no resistance to insect and fungi attacks, hence, wood preservation becomes a necessity (FAO, 1986). Consequently, only durable wood species are being selected and exploited for structure and construction purposes (Oluwafemi and Adegbenga, 2007). However, some work of literatures have revealed that there are other wood species of low durability that can still be used for construction purposes if properly treated, thus corroborating. Makpa (1998) who stated that for wood can give optimum satisfaction in service if it must undergo preservation. Also, Falemara *et al.*, 2014 reported that wood treated with the appropriate preservative increases its service life. Wood

preservatives are pesticides that protect wood against the attack of bio-deteriorating agents like insects, fungi or bacteria. Many chemical preservatives have been found useful against fungal and insect attacks (Ahmed *et al.,* 2010), however, their toxic properties and poor degradability of have been reported to cause harmful effects to consumers and the environment (Adetogun, 1998;Onuorah, 2000). This therefore calls for a need to develop environmentally friendly biological preservatives that will serve as alternatives to the hazardous synthetic ones.

Datura metel is a shrub-like perennial herb which grows in the wild, it is commonly known as devil*s trumpet and known worldwide for its chemicals and ornamental use. The previous studies on the extracts of the leaves of D. *metel* showed that it contained bio-preservative agents. (Donatus and Ephraim, 2009), Hossain *et al.,* (2014) found many phytochemicals such as alkaloids, flavonoids, phenols, saponins, sterols and tannins in the leaf, and findings from (Alabri *et al.,* 2014; Roy *et al.,* 2016) and (Hossain *et al.,* 2014, suggests that *D. metel* extract possess antioxidant and antibacterial, respectively. Also, it was opined that it contained antifungal (Akharaiyi *et al.,*2011), anti-proliferative (Rajesh and Sharma, 2002;Dabur *et al.,*2005), and immunosuppressive properties (Bellila *et al.,* 2011; Yang *et al.,* 2014). However, little information is available about the bio-preservative agents in the seed oil of *Datura metel* and its efficacy for treating wood. Triplochiton scleroxylon commonly known as obeche belonging to the family of sterculiaceae, is a large deciduous forest tree and a well- known specie in the wood industry, and its wood is moderately durable. Therefore, objective of this study is to determine the preservative potential of Datura metel seed oil on Triplochiton scleroxylon wood against fungal attack.

MATERIALS AND METHODS

Preparation of Datura metel Seed Oil: Ripe fruits of *Datura metel* were sourced in large quantities and de-pulped to separate the seeds, it was later dried within shade and then oven dried at 40 C for about 48 to 72 hrs and ground into powder in a blender. The oil was extracted chemically from the ground and sieved (1mm mesh) seeds with N- hexane and ethanol in Soxhlet apparatus using about 32g of the powdered seed and 350 mL of solvent over a period of 8hrs. Subsequently, the solvent was kept off using rotary evaporator at 40 C under reduced pressure. Seed oil was then collected in capped tubes and refrigerated at 4 C for further study. The procedure was replicated and the extracted oil was stored in a covered bottle prior its use.

Phytochemical Screening of Datura metel Seed: The Phytochemical screening of was done following the standard procedure by (Brain and Turner, 1976) on the seeds for the presence and amount of tannins, alkaloids, flavanoids, saponins and phenols.

Preparation of test fungi: The brown and white fungi used for this study was obtained from International Institute of Tropical Agriculture laboratory, Ibadan using potato dextrose agar as a culture medium.

Preparation of Test Fungicide: The volume-to-volume method was used for the preparation of different concentration levels of the oil extract using kerosene as the diluent (Ajala *et al*., 2014). This implies that, 0mL of *D.metel* seed oil in 100 mL of Kerosene (diluent) is equivalent to 0% dilution and 100 mL *D.metel* seed oil in 0 mL kerosene is equivalent to 100 % respectively while the untreated sample is represented as control. For each concentration, ten replicates were used for each oil treatment which was thereafter separated into five replicates for the fungi.

Preparation of Culture Medium: A nutrient medium of Potato Dextrose Agar (PDA) in distilled water was prepared. 40 mL of the PDA was poured into McCartney bottles and sterilized by autoclaving at 0.1 N/mm2 (120 °C) for a period of 20 minutes. The medium was inoculated with the test fungi 6 days after preparation of the bottles (Sarker *et al.,* 2006).

Innoculation of Test Blocks: The wood blocks were infected by placing them in the bottles in which there were actively growing cultures of the test fungi such that they came in contact with the aerial mycelium of the fungus. The control test blocks were wrapped in aluminum foil and sterilized in the oven before introduction to the test fungi, it was then incubated at room temperature (27 ± 2 o C) in the laboratory for 14 weeks.

Treatment of Test Blocks: The properly identified and tagged wood samples were cut to into standard sizes (20 x 20 x 60 mm) dried in the oven at 103^0C for 24hrs to remove the moisture and weighed. Soaking method (FAO, 1986) was used to treat the wood test blocks with the preservatives. They were completely immersed in the bio-preservative for 72 hours. The wood blocks were conditioned and treated with various concentrations of castor oil (0 mL, 20 mL, 40mL, 60 mL, 80ml and 100 mL) so as to obtain maximum absorption, while the others were left un-soaked to serve as control for both treatments. They were removed and air dried for three days and then

weighed (W3).The absorption rate was calculated using equation (1) according to Adetogun (2009).

Absorption Rate

The rate of absorption of the wood samples when soaked in the preservative was calculated using the formula below

$$A = \frac{TA \times Conc. \times 10}{VW \times PN} \qquad (1)$$

Where: A=Absorption (Kg/m^3); TA= Total Absoprtion; Conc.=Concentration; VW=Volume of Wood; NP=Number of Piece

Percentage Weight Loss: At the end of incubation period, the blocks were removed from the culture bottles, cleaned of the adhering mycelium and oven dried at 103 ^oC to constant weight (Sarker *et al.*, 2006)to determine the weight loss of the wood. The percentage weight loss for individual test pieces was determined according to ASTM, 1999.

$$\text{Percentage weight loss} = 100 \times \frac{W1 - W2}{W1} \qquad (2)$$

Where W_1 = Weight after absorption; W_2 = Weight after exposure to fungi

Data Analysis: Data obtained were subjected to analysis of variance (ANOVA) for the significant difference that exist between treatments on the wood samples based on the absorption rate and weight loss used while comparison of means was conducted, while comparison of means was conducted using Duncan Multiple Range Test (DMRT) to identify which groups were significantly different at α 0.05.The experimental design adopted for this study was a completely randomized design (CRD).

RESULTS AND DISCUSSION

Phytochemical Screening: Table 1 represents the results obtained from the phytochemical screening of Datura metel seed oil and it indicates the presence of alkanoids, terpenoids, tannins flavonoids saponins and phenols but no steroids were found in the oil sample, this indicates that most phytochemicals are present in *D. metel* seed oil. The results obtained from this study indicates the presence of tannins, alkaloids, flavonoids, saponins, terpenoids and phenols which agrees with the findings of Dooh *et al.* (2014), who reported the same results for the qualitative analysis of methanol extract of Thevetia peruviana. Tannins which is present in the oil have been reported to possess anti-fungal properties (Barbehenn and Constabel, 2011). Alkaloids as reported by Macel, (2011) attracts and deters insects and have also been reported to have antimicrobial properties which are effective against fungal growth (Carson and Hammer, 2010) are also present in the oil. Flavonoids which are phenolic structures found abundantly in photosynthesizing cells and are so important a plant component due to their active hydroxyl groups and anti-oxidative and antimicrobial properties (Güder *et al*., 2014) are also found to be present in the oil.

Table 1; Phytochemical Screening Results of *Datura metel* seed oil

Phytochemical constituents	Presence/absence
Alkanoids	+
Terpenoids	+
Tannins	+
Flavonoids	+
Saponins	+
Steroids	-
phenols	+

Where: + Indicates the presence of phytochemical constituents; - Indicates the absence of phytochemical constituents

They are also known to have anti-inflammatory and antitumor activity and have also been reported to inhibit wood decay fungi (Onuorah 2000; Yen *et al*., 2008; Tumen *et al*., 2013; Li *et al*., 2014), previous studies have reported that quantification of phenolic compounds in plant extract is influenced by the chemical nature of the extraction solvent (Kumaran *et al.* 2007). Saponins which are also a major family of secondary metabolites that occur in a wide range of plant species (Osbourn 1996) produced by plants as a defensive mechanism to stop attacks by foreign pathogens, which makes them natural antibiotics (Okwu and Emenike, 2006) have also been reported to be present in the oil. They are also responsible for biological activity against insects hence they are involved in plant disease resistance because of their well-known antimicrobial activity (Papadopoulou *et. al*, 1999; Bouarab *et.al*, 2002; Wittstock and Gershenzon, 2002, Elisa *et.al*, 2007). Terpenoids used as flavoring agents, insect repellents, fungicides and medicinal purposes (Johnson and Morgan, 1997) are also found to be present in the seed oil. Several other research works (Singh and Sushilkumar 2008; Sotannde *et al.* 2011; Djenontin *et al.* 2012; Addisu *et al.* 2014; Faruwa *et al.* 2015) have also reported the efficacy of plants extractsas bio-preservative against fungi and termite attacks. Mazhar *et al*., (2013) affirmed that the seed extracts of medicinal plant offers a source of naturally occurring chemicals that could be used because of the repellent, anti-feedant or toxic effects on micro-organisms in feeding assays (Ahmed *et al.* 2007.

Absorption Rate Of Datura Metel Seed Oil: Table 2 represents the mean values obtained for the absorption rate of *Triplochiton scleroxylon* wood sample based on the treatments at (0, 20, 40, 60, 80 and 100 %)

concentration level of preservatives, it ranged from 0.57 to 75.45. The mean absorption rate values were observed to be significantly different from each other as it increases with increase in concentration level except for the 80 mL and 100 mL which were not significantly different from one another. The least absorption (0.57 kg/m) was observed in the test blocks treated with kerosene alone i.e. 0 ml concentration level. The result obtained agrees with the findings of Amoo-Onidundu *et al.*, 2011, Adebawo (2019), Okanlawon et al.,2020 who reported that absorption depends on the method of application, viscosity, soaking period and the level of concentration of the preservative. The highest value obtained for absorption rate in this study (75.45 kg/m) is a bit lower than what was obtained for *C. pentandra* (94.48 kg/m) at 100 % concentration level of *O.basilicum* leaf extract (Okanlawon *et al.,* 2020) which could also be attributed to variations in physical and anatomical characteristics of *Triplochiton scleroxylon* wood specie and also probably due to the wood of *C. petandra being* lighter, softer in texture and lower in strength and coarser (Gibbs and Semir, 2003). The wood samples were easily impregnated with *D.metel* seed oil extract without difficulty due to low viscosity of the extract influenced by viscosity of the diluents which agrees with the work of Adetogun (2011).

Table 2: Mean values of percentage absorption of Datura metel seed oil by T. scleroxylon wood

Concentration level (ML)	Mean absorption rate (kg/m3)
0	0.57[a]
20	19.50[b]
40	32.60[c]
60	68.02[d]
80	73.25[e]
100	75.45[e]

Mean values followed by the same alphabet are not significantly different

Percentage Weight Loss Of Triplochiton Sceleroxylon Wood Specie: Table 3 represents the weight loss of *T. scleroxylon* due to fungal attack which ranged from 10.04 - 38.48 and 11.92 – 42.58 for white rot fungi and brown rot fungi respectively. The table also shows the untreated wood samples (control) of *T. scleroxylon* had the highest value for weight loss (42.58) brown rot and (38.48) white rot respectively which is an indication that the level of attack of untreated wood samples by the fungi is significantly different (higher) to that of the treated samples. The results obtained in this study is in line with the report of Wong and Cheok (2001) who reported that unprotected wood can be attacked by wood deteriorating agents and if this is not controlled can lead to deterioration, loss of structure, extra cost of replacement and even the loss of lives in severe cases. The significant difference in the values obtained for treated and untreated wood samples (control) showcased a reduction in the deterioration of the treated samples thus indicating the effectiveness of the seed oil extract on the treated samples as against the untreated samples (control) and this can be attributed to some varying array of chemical compounds in the seed oil as reported earlier in this study and several other studies (Lukmandaru, 2011; Namujehe and Orikiriza, 2013. Quite a number of studies have also proved the effectiveness of seed oils originated from plants as bio preservatives (Okanlawon *et al*., 2020a, Okanlawon *et al*., 2020b, Adegoke *et al.*2015, Osman *et al*., 2007). Though there is no significant difference in the weight loss of the wood blocks at 100 mL concentration level for both fungi, the result shows the brown rot to be more virulent in their attack than the white rot fungi which does not agree with the findings of Ajala *et al*. (2014) who reported that white rot fungi were more virulent than brown rot fungi. The results further shows that level of attack was minimal at higher concentration level of the seed oil extract (80mL and 100 mL) for both fungi which may be due to higher concentration of the oil having a higher quantity of phytoch emicals.

Table 3: The mean value for weight loss, Standard error and Duncan test of *Triplochiton scleroxylon* wood specie (P>0.05)

Treatment (ml)	Fungi	
	Pleurotus ostreatus	*Sclerotium rolfsii*
	Mean ± Sdv	Mean ± Sdv
Control	38.48±1.03[a]	42.58±1.44[a]
0	34.73±0.63[b]	40.96±1.58[a]
20	30.45±0.25[b]	34.63±1.25[b]
40	23.64±1.28[c]	29.67±1.17[c]
60	18.29 ±1.45[c]	20.23±0.95[d]
80	9.05±1.05[d]	11.12±1.25[e]
100	10.04±1.20[e]	11.92±0.80[e]

Mean values followed by the same alphabet are not significantly different

*Conclussions***:** Based on the results obtained from this study, it can be concluded that *Datura metel* seed oil has the potential of being a good bio-preservative especially for *Triplochiton scleroxylon* wood specie and as an alternative to the non- ecofriendly synthetic wood preservatives .This helps in increasing the service life span of the wood specie, though other methods of application can be further be investigated upon.

REFERENCES

Adebawo F.G (2019). Fungal resistance of obeche (*Triplochiton Scleroxylon* k. schum*)* wood treated with neem (*azadirachta indica*, a. juss) seed oil

extract. *Journal of research in forestry, wildlife & environment vol. 11(3).*

Adegeye, A.O., Ogunsanwo, O.Y. and Olajuyigbe, S.O. (2009). Antifungal activities of heartwood extract (HWE) of Teak *Tectona grandis* against two white rots in woods of *Gmelina arborea* and *Triplochiton scleroxylon*. *Academic Journal of Plant Sciences,* 2(4): 279-285.

Adegoke OA;Ajala OO;Alamu AJ (2015).Anti termite effectiveness of *Calophylum inophyllum Linn.*seed oil on selected tropical wood species. *XIV World Forestry congress*, Durban, South Africa. September 2015.pp7-11

Adetogun A.C. (2009). Investigating the fungicidal activities of cashew nut extract against wood. *Ph. D thesis*, University of Ibadan, Nigeria.

Adetogun A.C. (2011). Evaluation of Cashew nut Shell Liquid Incorporated with Sodium Chloride (Table Salt) as Fungicide against Wood Decay. *Innovations in Science and Engineering* 1: 74-78.

Addisu, S., Mohamed, D. and Waktole, S. (2014).Efficacy of Botanical Extracts against Termites, *Macrotermes spp*,(Isoptera: Termitidae) under Laboratory Conditions. *International Journal of Agricultural Resources*, 9(2): 60-73.

Ahmed, S. Riaz, M.A., Malik, A.H. and Shahid, M. (2007). Effect of Seed Extracts of *Withanias omnifera*, *Croton tiglium*and *Hygrophila auriculata* on Behavior and Physiology of *Odontoter mesobesus* (Isoptera, Termitidae).*Biologia*. 62(6):770-773.

Ajala O. O., Adebawo F.G., Yekeen O.M, and Owoade O. D. (2014). Potentials of seed oil extract of *Azadirachta indica* (A. JUSS) as preservative against wood-decaying fungi of *Aningeria robusta* (A. CHEV.) *In: Sudano-sahelian landscape and renewable natural resources development in Nigeria*.

Akanbi,T.L (2010). Assessment of preservative effect of *Pakkia biglobosa* seed extract on Ceiba pentandra on exposure to different wood destroying agent. *Ph. D thesis*, University of Ibadan, Nigeria.

Akharaiyi, F.C. Antibacterial, phytochemical and antioxidant activities of *Datura metel. Int. J Chem.Tech. Res*.,3, 478-483 (2011)

Alabri, T.H.A., A.H.S. Al Musalami, M.A. Hossain, A.M. Weli and Q. Al-Riyami: Comparative study of phytochemical screening, antioxidant and antimicrobial capacities of fresh and dry leaves crude plant extracts of *Datura metel* L. ,237 (2014).

Amoo-Onidundu,O.M.,Areghan,O.J.and Ehijator,S.E.(2011); Preliminary study on preservative absorption of *Gmelina arborea* (Roxb) and *Triplochiton scleroxylon* (K.Schum) wood pretreated with hot water. *Term paper*, Forestry research institute of Nigeria .Jericho, Ibadan ,Oyo state,Nigeria

Areo,O.O (2002);Preservation of small round logs of Tectonia grandis exposed to termite attack using Chromate Copper Arsenate(CCA). *An HND project* submitted to the Federal College of Forestry, .Jericho, Ibadan , Oyo state,Nigeria.

Atanasov, A.G., B. Waltenberger, E.M. Pferschy-Wenzig T. Linder, C.Wawrosch, P. Uhrin, V. Temml, L.Wang, S. Schwaiger, E.H. Heiss and J.M. Rollinger: Discovery and resupply of pharmacologically active plant-derived natural products: A review. *Biotechnol Adv*, 33, 1582-1614 (2015)

Barbehenn, R.V, and Constabel, P.C. (2011). Effect of the plant alkaloid plant-herbivore interactions. *Phytochemistry*, 72:1551–1565.

Bellila, A., C. Tremblay, A. Pichette, B. Marzouk, V. Mshvildadze, S.Lavoie and J. Legault: Cytotoxic activity of withanolides isolated from Tunisian *Datura metel*, L. *Phytochemistry* ,72 3031 (2011).

Bouarab K., Melton R., Peart J., Baulcombe D, Osbourn A.E. (2002). A saponins-detoxifying enzyme mediates suppression of plant defense. *Nature*, 418: 889–892.

Brain, K. R. and Turner T. D. (1975). The practical evaluation of Phytopharmaceutical, *Book chapter*, Ist edition, Britol Wright Scientechnia. 105.

Carson C. F., and Hammer K. A., (2010). Chemistry and Bioactivity of Essential Oils. *In: Lipids and Essential Oils* as Antimicrobial Agents, Thormar, H. (Ed.). John Wiley & Sons, New York, USA. pp 203-238.

Dabur, R., A.K. Chhillar, V.Yadav, P.K. Kamal, J. Gupta and G.L. Sharma (2005). antifungal activity of 2-(3,4-dimethyl-2,5-dihydro-1H-pyrrol-2-Yl)-1-methylethyl pentanoate, a dihydropyrrole derivative. *J.Med.Microbiol*.54, 549–52

Djenontin, T.S., Amusant, N., Dangov, J.,Wotto,D.V., Avlessi, F., Dahouenon-Ahoussi, E.,

Donatus, E.O. and C.I. Ephraim (2009). Isolation, characterization and antibacterial activity of alkaloid from L. leaves. *Afr. J.* 277–281.

Dooh J.P.N., Ambang Z., Ewola A.T, Heu A., Kosma P., Yalen E.J.M., and Goghomu R.T. (2014). Screening and the effect of extracts of *Thevetia peruviana* on the development of *Colletotrichum gloeosporioides*, causal agent of cassava anthracnose disease. *J. Agric. Res. Develop.* 4(4):054-065.

Falemara, B.C., Obidike-Ugwu, E.O.,Ukanyirioha, C.J. and Mus'ab, S.M. (2014). Evaluation of different Treatment Techniques on Preservative Absorption of *Triplochiton scleroxylon*(Obeche) against Fungi Attack. In the book of proceedings; Sudano-Sahelian Landscape and Renewable Natural Resources Development in Nigeria. *37th Annual conference of Forestry Association of Nigeria*.Pp 525-537.

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: *Environ. Appl. Sci. Manage. Changing Global Climat.* 4(3- 1): 59-63.

Food and Agriculture Organization of the United Nations. (1986). Wood preservation manual. *FAO Forestry Paper* 76, pp: 152.

Gibbs P and Semir J(2003).A taxonomic revision of genius Ceiba Mill(Bombacaceae). *anales jardfn botanico de madrid*, 60(2).

Güder A, Engin M. S, Yolcu M, and Gür M. (2014). "Effect of processing temperature on the chemical composition and antioxidant activity of *Vaccinium arctostaphylos* fruit and their jam," *J. Food Processing and Preservation*, 38(4): 1696-1704.

Hossain, M.A., M.S.A.A. Kalbani, S.A.J.A.F. Farsi, A.M. Weli and Q. Al-Riyami: Comparative study of total phenolics, flavonoids contents and evaluation of antioxidant and antimicrobial activities of different polarities fruits crude extracts of *Datura mete*L. *Asian Pac. J.Trop. Dis*,4 , 378–383 (2014).

Johnson S, and Morgan ED. (1997). Supercritical fluid extraction of oil and triterpenoids. Neem seeds *Phytochemical Analysis*, 8: 228-232.

Kumar S, Chashoo G, Saxena AK, Pandey AK. Parthenium hysterophorus: A probable source of anticancer, antioxidant and anti-hiv agents. *BioMed Res Int.*; 2013:11

Kumaran A, Joel Karunakaran R (2007). In vitro antioxidant activities of methanol extracts of five Phyllanthus species from India. LWT - *Food Science and Technology*. 40(2):344–52

Li Q., Wang X. X., Lin J.G, Liu J., Jiang M. S, and Chu L. X. (2014). Chemical composition and antifungal activity of extracts from the xylem of *Cinnamomum camphora*. *BioResources* 9(2): 2560-2571

Lozano, P., Pioch, D. and Sohounhloue, K.C.D. (2012). Screening of Repellent, Termiticidal and Preventive Activities on Wood of *Azadirachta indica* and *Carapa procera* (Meliaceae) Seeds oils. *ISCA J. Biol. Sci.* 1(3): 25-29.

Lukmandaru, G. (2011). Variability in the Natural Termite Resistance of Plantation Teak Wood and its Relations with Wood Extractive Content and Colour Properties. *Journal of Forestry Research*, 8: 17– 31.

Macel, M. (2011). Attract and Deter: A dual role for pyrrolizidine alkaloids in plant-insect interactions. *Phytochemistry Reviews*, 10(1): 75-82.

Maoz, M., Weitz, I., Blumenfeil, M., Freitag, C. and Morrell, J. J. (2007). Antifungal activity of plant derived extracts against *G.trabeum*. The Inter. Res. Group on Wood Preservation, Sweden.

Makpa,D.T.(1988). The effect of wood moisture content on the absorption, penetration and retention of water borne wood preservative of two (2) Nigerian grown hardwood species. Pp118

Mazhar, A., Muhammad S., Munawar, I., Fozia,A., Sumaira, S., Sohail, A. and Tajnees, P.(2013). Antitermitic Activity and Phytochemical Analysis of FifteenMedicinal Plant Seeds. *J. Medicinal Plants Res.* 7(22): 1608-1617.

Namujehe, G. and Orikiriza, L.J.B. (2013). Natural Durability of Eucalyptus Clones against Termite Attack. *Inter. J. Sci. Basic. Appl. Res.* 10(1): 176 – 183.

Ogbogu,G.U (1996). The state of wood treatment technology in Nigeria. *A seminar paper presentation* in Forestry Research Institute of Nigeria, pg 12.

Ogunsanwo, O.Y., Adegeye, A. O. and Olajuyigbe, S. O. (2008). Effects of Heartwood Extract (HWE) of Teak and Cuprinol clear on Weight loss and Compressive Strength of Two Hardwood species from Nigeria. *Proceedings of International Conference on Environmentally Compatible Forest Products*. Fernado Pessoa University, Oporto, Portugal. September 10-12, 2008.

Okanlawon .F.B, *Olaoye K .O (a)* Bio Preservative Potential of *Ocimum Basilicum* L. Leaf Extract on *Triplochiton Scleroxylon* (K. Schum) and *Ceiba*

Pentandra (L.) Gaertn.Wood against Termite Attack *European Sci. J.* 16 (9) ;76-81.

Okanlawon F.B, Adegoke O.A, Olatunji OA, Okon Akan OA, Akala AO (b) Effectiveness of *Azadirachta indica A.*Juss (Neem) seed oil in controlling wood Termite. *J .Appl. Sci. Environ .Manage.* 24(9) 1541-1544.

Okwu, D.E. and Emenike, I.N. (2006). Evaluation of the Phytonutrients and Vitamin Contents of Citrus Fruits. *International Journal of Molecular Medicine and Advanced Sciences,* 2(1): 1-6.

Olajuyigbe, S. O., Ogunsanwo, O. Y. and Adegeye, A. O. (2010). Compressive Strength in Heartwood Extract of Teak (HWE) Treated Hardwoods after Exposure to White Rot Attack. *Inter. J. Biol. Chem. Sci.* 4(3): 571-578.

Oluwafemi,O.A., and Adegbenga,S.O.(2007). Preliminary report on utilization potential of Gliricida sepium(Jacq) steud for timber. *Res. J. Forest* 1;80-85.

Onuorah E. (2000). The wood preservative of extract of teak (*Tectonia grandis* Lim. F) as a fungicidal against wood decays. *M.Sc. Thesis*, University of Ibadan pp 163.

Osbourn A.E. 1996. Saponins and plant defense – a soap story. Trends in Plant Science. 1: 4–9.

Osman G; Ramazan M ; Emin MD; Ertan O;Melda C; Ferah Y(2007). Introduction and evaluation of wood preservative potentials of the poisonous *Sternbergia candidum* extracts. *Afr. J. Biotechnol.* 6(8);982-986.

Ozcan, B., M. Esen, M.K. Sangun, A. Coleri and M. Caliskan: Effective antibacterial and antioxidant properties of methanolic extract of seed oil. , 637–641, (2010).

Papadopoulou K, Melton R. E, Leggett M, Daniels M.J, and Osbourn A. E. (1999). Compromised disease resistance in saponin-deficient plants. *Proceedings of the National Academy of Science,* 96:1292–1292.

Pawar, H.A., A.V. Shenoy, P.D. Narawade, P.Y. Soni, P.P. Shanbhag and V.A. Rajal (2017). Preservatives from nature: A review. *Int. J. Pharm, Phytopharm. Res.*, 1, 78-88.

Preissel, Ulrike; Hans-Georg Preissel, (2002). Brugmansia and Datura Angels Trumpet and thorn apples . *Buffalo* , New York, firefly books,pp120-123.

Rajesh, G.L. (2002). Sharma: Studies on anti - mycotic properties of *Datura metel J. Ethnopharmacol* **80,** 193

Roy, S., S. Pawar and A. Chowdhary: Evaluation of cytotoxic and antioxidant activity of *Datura metel* L. and *Cynodon dactylon* L.extracts. *Pharmaco. Res*.,8 , 123–127 (2016)

Sarker, P.K, Rahman M.A, Bulbul M.R, Das T, Ilias G.N.M (2006). Standard test Methods for wood preservatives by laboratory Agar-Block test. The International Research Group On Wood Preservation, *(Paper for the 37th Annual Meeting, Tromso, Norway, 18-22, June, 2006).*

Singh, N. and Sushilkumar, A. (2008). Anti -termite Activity of *Jatropha curcas* Linn. Biochemicals. *J. Appl. Sci. Environ. Manage.* 12 (3):67-69

Sotannde, O.A., Yager, G. O., Zira, B. D. and Usman, A. (2011). Termiticidal Effect of Neem Extracts on the Wood of *Khaya senegalensis. Research Journal of Forestry*, 5(3): 128-138

Tumen I, Eller F.J, Clausen C.A, and Teel J.A. (2013). "Antifungal activity of heartwood extracts from three Juniperus species," *Bioresources* 8(1):12-20.

Vanneste, J.L., Hill, R.A., Kay, S.J., Farrell, R.L.and Holland, P. T. (2002). Biological control of sapstain fungi with natural products and biological control agents: A review of the work carried out in New Zealand. *Mycological Research,*106 (2):228-232.

Wittstock U, and Gershenzon J. (2002). Constitutive plant toxins and their role in defense against herbivores and pathogens. *Curr. Opinion. Plant Biol.* 5: 1–8

Wong, A. H. H. and Cheok, K.S. (2001).Observations of Termite-Fungus Interaction of Potential Significance to Wood Bio-deterioration Protection:*Timber Technology Bulletin* No. 24,Timber Technology Centre Kuala-Lumpur.

Yang, B.Y., Y.G. Xia, Y. Liu, L. Li, H. Jiang, L. Yang, Q.H. Wang and H.X. Kuang: New antiproliferative and immunosuppressive withanolides from the seeds of *Datura metel Phytochem. Lett*.., 8,92 (2014).

Yen T.B, Chang H.T, Hsieh C.C, and Chang S.T. (2008). Antifungal properties of ethanolic extract and its active compounds from *Calocedrus macrolepis* var. formosana (Florin) heartwood. *Bioresource*, 99 (11): 4871 - 4877.

Zito, M. Sajeva, M. Bruno, S. Rosselli, A. Maggio, and F.Senatore (2013), "Essential oils composition of two Sicilian cultivars of *Opuntia ficus-indica* (L.)Mill. (Cactaceae) fruits (prickly pear),"*Natural Product Research* 27(14):1305–1314