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BIODETERIORATION RESISTANCE OF NIGERIAN GROWN *Artocarpus altilis* (Parkinson) Fosberg WOOD TO *Xylaria polymorpha (Pers) Grev.*AND *Sclerotium rolfsii* Sacc (WHITE AND BROWN ROT FUNGUS) ATTACK

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ABSTRACT

In Nigeria wood-based industries are facing a severe shortage and scarcity of choice timber species. Consequently, the demand for wood products has led to the introduction of *Artocarpus altilis* into the timber market as an alternative wood species. However, it is very necessary to evaluate its natural durability with regard to length of service to curtail deterioration by the destructive agents. Four *A. altilis* trees from Southwest zones of Nigeria were purposively selected and felled based on maturity (45±0.5 years). Billets of 500cm were obtained from (10% base, 50% middle and 90%) top of merchantable height of each tree and thereafter partitioned into centrewood, innerwood and outerwood along the radial plane. In an accelerated durability test (ADT), wood samples were inoculated with *Xylaria polymorpha* and *Sclerotium rolfsii* for 20 weeks using standard procedure. The data obtained were subjected toanalysis of variance with a significance level of$_{a0.05}$was used for the analysis. The result shows that *A.altilis* wood species is resistant to fungus attack with an averagemass loss of4.70±2.12% and 5.47±2.89% for both white and brown rot fungi. Axially, white rot wood was degraded by 4.49±2.12%, 4.76±2.48% and 4.85±1.79% at the base, middle and top respectively while brown rot wood was degraded by 5.31±2.53%, 5.58±2.90% and 5.51±2.04% at the base, middle and top respectively. The highestonlymass lossof 6.58±2.97% was obtained from innerwood. Analysis of variance showed that the effect of interaction between sampling height, radial positions and fungi shows insignificant difference along and across the axis of the species. However, naturally, fungi will attack wood of *A.altilis* in service, hence, the wood of *A.altilis* is found to be resistant

Keywords: *Artocarpus altilis*, Fungi, fungal test, massloss assessment, *Xylaria polymorpha*

Introduction

Natural durability of wood could be defined as a measure of its resistance attack against insects and fungi (Faruwa,*et al.*,2016 and Ridout, 2001).Wood is a very important basic raw materials for major structural and non-structural constructional purposes (Katja *et al.,* 2018).Wood is an anisotropic natural material that is susceptible to bio-deterioration agents (Eaton and Hale, 1993). The vulnerability of wood to degradation microbes commonly found in packaging industries, storage facilities, and service facilities has resulted in enormous life, property, and economic loss (Areo,2020).Similarly, Ogunsanwo *et al*. (2002) observed that a large number of wood logs and timber are destroyed on an annual basis by bio-deterioration agents.Areo (2020) reported that the wood-based industry is capable of providing unique opportunities in the utilisation and applications of several timbers while the industry will eventually benefit from this subsquently improving national GDP and local economy.

Adi *et al*. (2014) and Istikowati *et al*. (2016) reported that utilization of wood resources from several fast-growing tree species is limited because little information is available regarding the properties and anatomical characteristics of the wood. As a result, there has been a dwindling availability of preferred

and durable larger diameter timber that has become scarce in our natural forests globally, and this is due to over-exploitation of species. Hence, there have been crucial changes in the nature and source of timber materials for the wood-based and product industries, resulting in a gradual shift in wood extraction processes and techniques around the world, leading to the introduction of fast-growing, lesser-used, and durable smaller-diameter timber species (Plaschkies *et al.* 2014; Owoyemi and Uchechukwu, 2018).

Artocarpus altilis is categorised as a lesser-used species that belongs to the genus *Artocarpus* (Moraceae). It comprises of approximately 50 species and is widely distributed in tropical and subtropical regions. The generic name of the species comes from the Greek words' artos' (bread) and 'karpos' (fruit), and the fruits eaten are commonly called breadfruit. It was therefore chosen for evaluation because of its large size of up to 25m (82f) or more in height (Ragone, 2011). The species is popular as an agroforestry species, planted as a fruit tree and, more recently as good construction timber. Moreover, recent surveys of the timber market in the southwest zone of Nigeria show a good representation of this emerging species Areo, (2020). From an economic point-view, available information has shown that, despite the abundance of this species, it remained unattended to in terms of property evaluation, especially its natural durability, and very little research has been carried out on *A. altilis*wood in the country.

This is why the study intends to investigate the decay resistance of the wood to white and brown rot fungi attacks to determine its suitability for various uses to complement the commercial wood in Nigeria. Meanwhile, it has been observed that the deterioration of wood in service is the major hindrance to the effective utilisation of any wooden products. Therefore, in wood processing and utilisation of *A. altilis*, an understanding of the level of resistance to deterioration is critical, while knowledge of its resistance to attack is also crucial as it affects its uses and in-service life. In the present study, the natural decay resistance of *A. altilis* wood to fungi attack was examined using two fungi strains. The research findings from the study will be important for the effective and efficient preservation of this species against infestation by biodegradating organisms.

Materials and Methods

Four matured trees of *Artocarpus altilis* were purposively selected based on the absence of reaction tendencies, fairly straight and free from natural defects as well as excessive knot areharvested at Longe village, Gambari Forest Reserve, Oyo State. It lies within latitude 7°10'37" N to 7°10'34" N and longitude 3°52'50" E and 3°50'59" E. Three billets of 500cm were obtained from base, middle and top (10, 50 and 90%) of the merchantable height of each selected tree making a total of 12 bolts.

Sample preparation

Test sample representatives were taking from the Central planks obtained from all the bolts to give 12 planks from where test samples were obtained. The central planks were further partitioned into corewood, innerwood and outerwood along the radial planes following the method used by Ogunsanwo and Onilude (2001) and Shupe *et al*, (1995). Test samples for the test were cut radially from the wood sections approximately 40 mm from the pith and to the bark,i.e bark to bark, and this was further processed into standard dimensions for the tangential, radial and longitudinal plane of the test samples measured 19 × 19 × 19 mm respectively,given 6 sampling replicates from each radial direction, according to ASTM D-2017-05.

The accelerated biological test also known as fungi test was carried out with the use of Brown

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Rot Fungi (*Sclerotium rolfsii*) and White Rot Fungi (*Xylaria polymorpha*) and the procedure of the experimentation is given below:

Procedure for Isolation of *Xylaria polymorpha* and *Sclerotium rolfsii* (White and Brown Rot Fungi)

Preparation of Test Culture Bottles

The *Xylaria polymorpha* and *Sclerotium rolfsii* inocula were collected and carried out at Forestry Research Institute of Nigeria, Ibadan, in Pathology Section. Potato Dextrose Agar (PDA) as a nutrient medium was prepared in distilled water. 39g of PDA was mixed with 1 litre of water in conical flask and then homogenized. After thorough homogenization, 40ml of PDA was thereafter poured into bottles and sterilized by autoclaving at 1.05kg/cm^2 for 15 minutes. Then, the PDA was mixed with streptomycin to avoid contamination from bacterial. After sterilization, the flasks were laid sideways so that the medium is retained in the neck of the bottle. Moreover, the medium were then inoculated with the test fungi between two to six days for complete growth after preparation of the bottles. The bottles were then incubated at room temperature (27±2^{o}C) in the laboratory. This follows the procedure of (Arun 2006 and Sarker *et al.* 2006)

Preparation of Test Culture BottlesandInfection of Test Blocks

The bottles containing the test blocks of 19 x 19 x19 mm were incubated at 27±2^{o}C for 20 weeks. At the end of the incubation period, the blocks were removed from the culture bottles, cleaned of the adhering mycelium, taking care not to remove the splinters of wood and weighed immediately to determine moisture absorbed. Then, weighed samples were oven-dried at 103^{o}C to constant dry wet in accordance with (Arora, 2006 and Sarker *et al.*, 2006). 90 test blocks were used for the test for brown and white rot fungi. After the incubation period, the percentage moisture absorbed by the wood blocks was measured on the sensitive weighing balance. The wet weights of the blocks were determined after been oven-dried at 103^{o}C for 15hours. Thereafter, test blocks were picked gently and allowed to cool before final weight was carried out. The percentage weight loss in the individual test blocks was determined toprovide a measure of the relative decay resistance of the *A. altilis* wood samples using equation 1 below in accordance with ASTM D 2017-05.

$$W = \frac{W_1 - W_2}{W_1} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Where: W = Weight loss

W1= Initial weight of wood samples before exposure to decay fungi.

W2 = Final weight of wood samples after exposure to decay fungi (at the end of the testing period)

Experimental Design

The experimental design adopted was a 3 factor factorial experiment in a Completely Randomized Design.

Results

Classification of the resistance of timbers based on their Natural Durability

The test samples of *A. altilis* collected from the sampling height (the base, middle and top positions) were classified according to their resistance attack to the two fungi stains according to ASTM D-2017-05 standard and as shown in the Table 1 below;

Table 1: ASTM D-2017-05 Standard criteria for categorizing the resistance of wood species to decay fungi

Average Weight Loss (%)	Average Residual Weight (%)	Indicated Class of Resistance
0 to 10	90 to 100	Highly resistant
11 to 24	76 to 89	Resistant
25 to 44	56 to 75	Moderately resistant
45 or above	55 or less	Slightly resistant or non-resistant

Table 2: Mean values of percentage weight loss of fungi attack of *A. altilis* wood on sampling height and radial position

Sampling direction	Radial Position	Fungi attack after 20 weeks White Rot	Severity of attack	Fungi attack after 20 weeks Brown Rot	Severity of attack
Base	Corewood	4.84±2.92a		5.12±2.25b	
	Innerwood	4.32±1.76b		6.58±2.97a	
	Outerwood	4.29±1.33c		4.23±2.01c	
Pooled Mean		4.49±2.12	Highly resistant, 0-10%	5.31±2.53	Highly resistant, 0-10%
Middle	Corewood	5.59±3.57a		6.01±6.15c	
	Innerwood	4.13±1.71c		6.11±3.96b	
	Outerwood	4.57±1.56b		4.62±1.79a	
Pooled Mean		4.76±2.48	Highly resistant, 0-10%	5.58±2.90	Highly resistant, 0-10%
Top	Corewood	4.68±2.07b		5.70±1.81ab	
	Innerwood	4.28±1.47c		4.96±1.87b	
	Outerwood	5.58±1.86a		5.97±1.64a	
Pooled Mean		4.85±1.79	Highly resistant, 0-10%	5.51±2.04	Highly resistant, 0-10%
Mean		4.70±2.12		5.47±2.89	

Means±Standard mean error for 5 samples repeated. Values in and column of the similar alphabet at a = 0.05 are not significantly different

Table 3: Analysis of Variance for resistance to fungi attack of *A. altilis*

SV	Df	SS	MS	F-cal	P-value
SH	2	2.473	1.237	0.2078	0.8127^{ns}
RP	5	11.627	2.325	0.3908	0.8542^{ns}
Fungi	1	21.311	21.311	3.5820	0.0611^{ns}
SH*RP	10	40.668	4.067	0.6835	0.7377^{ns}
SH*Fungi	2	0.182	0.091	0.0153	0.9849^{ns}

RP*Fungi	5	37.807	7.561	1.2709	0.2818 ns
SH*RP*Fungi	10	23.782	2.378	0.3997	0.9442 ns
Error	108	642.553	5.950		
Total	143	780.402			

ns = not significant at (p value >0.05)

Discussions

The result shows that the average mean percentage mass loss of fungi resistance in *A. altilis* for White rot and Brown rot was 4.702.12 % and 5.472.89 %, respectively. Axially, white rot mean values range from 4.492.12 % (the base), 4.762.48 % (middle) to 4.851.79 % (stem-top). This implies that percentage weight loss rises from the base toward the stem-top. The radial range for white rot fungi is 4.842.92% to 4.291.33% at corewood through outerwood at the base, 5.593.57% to 4.571.56% corewood to outerwood in the middle, and 4.682.07% to 5.581.86% corewood to outerwood toward the stem-top, as shown in Table 2.The outcome demonstrates that *A. altilis*' proportion of weight loss clearly reveals that it's resistant to fungal attack across and along the bole.

Brown rot values ranged between 5.312.53 % at the base, 5.582.90 % at the middle, and 5.512.04 % at the top. This shows that percentage weight loss increased from the base to the middle and slightly decreased to the top (Table 2). For brown rot, the percentage weight loss ranged from 5.122.25% to 4.232.01% from corewood to outerwood at the base, 6.016.15% to 4.621.79% from corewood to outerwood in the middle, and 5.701.81% to 5.971.64% from corewood to outerwood at the top.

The inconsistent trend of decreasing from corewood to wood-inner and then increasing toward the outer-wood was observed in the percentage mass loss for brown rot fungi in radial position. Analysis of variance presented in Table 3 shows an insignificant difference between the sampling position *(p = 0.813)*, radial plane *(p = 0.854)*, and fungi *(p = 0.061)* on the white rot and brown rot of *A. altilis* wood. Hence, the effect of interaction between sampling height, radial position, and fungi shows an insignificant influence on the white rot and brown rot of *A. altilis*.

The multiple comparison test in Table 3 reveals significant (p 0.05) differences in white rot and brown rot at the base, middle, and top of the radial position for *A. altilis* white rot and brown rot. The result obtained is similar to Ogunsanwo and Ojo, (2018) on *Borassus aethiopum* wood but slightly different from the report of Owoyemi andUchechukwu (2018) on *Mitrigyna ciliata* and *Hevea brasiliensis* species.

Wood decay can be characterized as either wet-rot or dry-rot, but in damp wood, both can occur together or when wood is permitted to remain permanently or regularly damp. According to Nair, (2017), wood decay is activated during the digestive process by enzymes secreted by the fungal hyphae. Large quality losses are caused by fungi in both timber manufacturing and wood utilisation.

Meanwhile, the variations in the nature of the injury are typically due to the presence of various fungal species and the type of damage caused (Sadiku *et al.*, 2018). Protection must be given during processing, merchandising, and use in conditions that enable wood-degrading species to grow. Fungi, insects, bacteria, and marine borers are among the species that can degrade wood. Insects can also cause damage to wood, so they must be considered in many cases.

Natural resistance is the inherent ability of some wood species to resist the attack of bio-deteriorating agents without treatment with chemical preservatives (Owoyemi and Olaniran, 2014). Hence, both white and brown rot develop on susceptible wood when the moisture content of the wood remains above about 22% consistently for a prolonged period. Ohagwu and Uchechukwu (2011) and Owoyemi *et al.* (2008) reported that brown rot fungi possess a unique ability to attack the cellulose fraction of wood while avoiding the surrounding lignin. However, white rot fungi have the ability to degrade lignin up to 100% of timber weight. Cellulose and hemicelluloses are also degraded and become whitish. This study provides evidence that brown rot fungi could not accomplish this due to the high extractive in *A. altilis* wood.

Conclusion

From this research study, it was observed that the wood of *A.altilis* wood is resistant to both strains of fungi. However, the corewood appears to be more resistant to fungi attack while the outerwood is moderately resistant to fungi attack. Knowledge of wood property variations, therefore, is important in order to make appropriate and adequate utilization of *A. altilis* wood. Consequently, this present investigation presented basic data about specific fungal resistance of *A. altilis* wood, which serves as a basis for its wood quality assessment for efficient and better utilization. Therefore, it is recommended that sawn logs of *A. altilis* wood species could also be allowed for wood protection processes, especially for external applications to further enhance and prolong their service life.

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