

Full Length Research Paper

## Biodegrading effects of some rot fungi on *Pinus caribaea* wood

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Wood samples were collected from a ten-year old plantation of *Pinus caribaea* (morelet) in Ijaiye Forest Reserve, 38 km northwest of Ibadan, Nigeria. The wood samples were inoculated separately with two species of white-rot fungi; *Corioliopsis polyzona* and *Pleurotus squarrosulus*, and two species of brown-rot fungi; *Lentinus lepideus* and *Gleophyllum striatum*. Wood weight loss due to biodegradation varied from 1.5 – 48.1% for *Corioliopsis polyzona*, 9.6 – 58.0% for *Pleurotus squarrosulus*, 40.4 – 78.1% for *Lentinus lepideus* and 6.8 – 49.2% for *Gleophyllum striatum* degrading activities. The mode of wood degradation was peculiar with each fungus. Wood decay varied along the tree bole but was not related to height above the ground. The results indicated that biodegradation by rot fungi differs in intensity according to the fungus species and this suggested that preservative impregnation and retention may be the best way to control the rots to make *P. caribaea* a utility wood.

**Key words:** *Pinus caribaea*, wood decay, wood preservation.

### INTRODUCTION

Wood and wood products in use are often attacked by various organisms in many conditions especially if its natural resistance is low. The warm and humid climate condition in Nigeria is conducive for the development and activities of these organisms. The most important agents of wood deterioration are fungi, insects and fire.

Wood decay fungi belong mainly to the group of *Basidiomycetes* (Cartwright and Findlay, 1958; Odeyinde, 1980). The type and severity of fungal attack depends on the fungi involved and the period of attack. For example, in a freshly felled timber, the earliest fungal colonizers are largely *Ascomycetes* and *Dueteromycetes*, although some *Phycomycetes* may be present. When a log is abandoned in the forest for a considerable length of time, the early colonizers are replaced by wood-rotting *Ascomycetes* and *Basidiomycetes* (Mommoh, 1972). De Groot (1975) observed that wood moisture content increase considerably with intensity of wood degradation by white-rot fungi in *Pinus radiata*; brown rot fungi were less influenced by moisture in their attack on the wood of the same s that the rate of wood degradation appeared to be higher pecies. Blankenhorn et al. (1980) observed for

white-rot than brown-rot fungi.

In studies of wood decay using the wood of aspen *Populus* species, Messner et al. (1985) reported that when pine wood is degraded by brown-rot fungi, the osmophilic particles are densely distributed in all cell layers, correlating with the rapid depolymerization of carbohydrates over the entire cell wall. While with rotted pine wood, the particles are found on the surfaces of the cell wall but never within the cell walls. They also observed that contrary to common belief, brown-rot fungi are capable of lignin metabolism, causing complete disintegration of wood cell walls, middle lamella and cell corners.

Clark and Scheffer (1983) indicated that wood decay resistance varied within individual trees to *Seouoia sempervirens*. This might be in response to genetic, environmental and internal factors of trees. Results of several studies reported by Wilcox (1983) indicate that when brown rot fungi reduce wood weight by as low as 1 – 2% there is over 50% reduction in strength properties. Kraft pull yield of wood deteriorate by white rot and rot fungi are low and uneconomic while their strength yield substantially is lower than those of sound wood (Hunt, 1978a, b).

*Pinus caribaea*, a native of Central America has been introduced into Nigeria as a plantation species. Initially it was confined to high altitudes of northern savannah

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areas to check desertification (Iyamabo et al., 1972). It is now being widely planted in Nigeria because it has long fibres suitable for the manufacture of high quality paper. It also provides soft white wood suitable for other purposes. The main objective of this study was to evaluate the relationship between two species of white rot fungi (*Corioliopsis polyzona* and *Pleurotus squarrosinus*) and two species of brown-rot fungi (*Lentinus lepideus* and *Gleophyllum striatum*) on *P. caribaea*. The investigation also examined the between and within tree variation in *P. caribaea* as caused by each of the four fungi. The possibility of controlling the fungi with a chemical preservative was also investigated.

## MATERIALS AND METHODS

### Study area

Wood samples were collected from a 10 year old *Pinus caribaea* plantation in Ijaiye Forest Reserve, 38 km north Ibadan, Nigeria, lying between 7° 34'N and 7° 45'N and 3° 34'E and 3° 45' E. The reserve consists of two distinct types of vegetation, forest and savannah. The total annual rainfall ranges from 100 – 125 mm. the average relative humidity is 70%. The mean monthly temperature is 28°C. There are two main seasons in the year, a dry season with dry northeast trade wind-harmattan predominating from November to march, and a rainy season characterized by the south-west monsoon wind bringing rains from April to October. The plantation was established at an espacement of 2 m x 2 m, and received no specific silvicultural treatment from the time of its establishment to the time of sample collection for the study.

### Field sampling

30 trees were selected at random for wood sample collection and the following parameters were measured: diameter at breast height over bark (DBH), total height and crown diameter. Wood bolts were cut from each sample tree at 5, 25, 45, 55 and 65% of its total height. The samples were used for the study of between-tree variation in wood decay and the effect of a preservative.

Eight wood blocks each measuring 2.3 cm x 2.3 cm x 1.3 cm were machined from the bolt cut from base of each tree. The wood blocks were cut from similar positions from different trees to make comparisons among trees valid. This gave a total of 240 blocks, 120 out of these were inoculated with the four fungi, one base having one fungus. The remaining 120 wood blocks were first treated with a preservative with a trade name: "cuprinol-clar", and later inoculated with the four fungi, one wood block for one fungus.

### Variation in wood decay along the bole

5 out of the 30 trees were selected at random for the study of variation in wood decay along the bole. 5 bolts (height levels) were treated per tree, blocks per bolt were cut from the growth rings near the bark on the eastern side of the tree; one block was used for each fungus.

### Variation in wood decay with age

Bolts from 5 largest trees were used for this aspect of the study. 5 trees were randomly selected and 1 bolt was cut from each tree near the base so that each bolt had 10 wide growth rings. From

each bolt 5 blocks were cut radially from the pith to the outermost ring. 1 block was cut from every 2 rings from the pith. It is important to note that wide rings are essential if a block is to be cut from every 2 rings, from the 5 largest trees sampled.

### Preservative treatment of wood

The wood blocks to be given preservative treatment were first oven dried and impregnated with "cuprinol-clar" by the full pressure method. The blocks were dried and weighed again to determine their net retention of the preservative.

### Inoculation of wood with fungi

Each fungus was isolated and separately inoculated into each block. The procedure used was the agar method specified in British standard 838 and German DIN 52176. The method involved isolating and culturing each fungus on a sterile malt agar in a flask until the medium was well covered with the mycelia of the fungus.

Stock cultures of isolated fungi were sub cultured by transferring bits of them onto sterile plates containing sterile malt agar and incubated at 27°C for 5 days in an incubator. The wood blocks were oven-dried at 110°C for 24 h, weighed and saturated in an autoclave for 2 h and aseptically transferred to a flask containing fungi mycelium for inoculation and incubated at 27°C for 12 weeks.

### Determination of wood decay (weight loss)

The initial oven-dried weight of each sound wood ( $w_1$ ) before inoculation was recorded. After inoculation and incubation for 12 weeks, the fungus covering each wood block was carefully removed and block was again oven dried at 110°C for 24 h to get the final weight ( $w_2$ ).

$$\text{Wood decay or weight loss} = \frac{[(w_1 - w_2) / w_1] \times 100}{}$$

## RESULTS AND DISCUSSION

### Between-tree variation in wood decay

The magnitude of wood decay caused by each of the 2 white-rot fungi; *Corioliopsis polyzona* (first fungus) and *Pleurotus squarrosulus* (second fungus) and each of the 2 brown-rot fungi; *Lentinus lepideus* (third fungus) and *Gleophyllum striatum* (fourth fungus) varied between *P. caribaea* trees. The percentage weight loss in the 30 trees varied from 1.5 – 48.1% for the first fungus, 9.6 – 58.0% for the second fungus, 40.4 – 78.1% for the third fungus and 6.8 – 49.2% for the fourth fungus (Table 1). The percentage wood weight loss of individual trees did not show regular correlation with the wood total height, height over bark (DBH) and crown diameter (Table 2). It is therefore clear that tree bole sizes and crown diameter are not good indicators of its resistance or susceptibility to the attack of the four fungi.

Since the trees were of the same age, planted at the same espacement and sampled from two homogenous hectares of the plantation, the between-tree variation in wood decay or resistance to decay was largely genetic. It is therefore possible to select large individual tree with high resistance to wood decay fungi and desirable wood

**Table 1.** Percentage wood loss by fungi and tree parameters of *Pinus caribaea*.

Parameter	N	Mean $\pm$ S.E
<b>Percentage wood by fungi (%)</b>		
<i>Corioliopsis</i> sp.	30	33.24 $\pm$ 1.75 <sup>a</sup>
<i>Pleurotus</i> sp.	30	29.51 $\pm$ 1.69 <sup>a</sup>
<i>Lentinus</i> sp.	30	60.46 $\pm$ 2.17 <sup>b</sup>
<i>Gleophyllum</i> sp.	30	29.87 $\pm$ 1.52 <sup>a</sup>
<b>Tree parameters</b>		
Crown diameter (m)	30	3.52 $\pm$ 0.26 <sup>a</sup>
Height (m)	30	10.23 $\pm$ 0.49 <sup>b</sup>
Height over bark (DBH) (cm)	30	16.64 $\pm$ 0.04 <sup>c</sup>

Means with the same superscript in the same column are not significantly different ( $P < 0.05$ ).

**Table 2.** Relationship between wood decay and external parameters.

	<i>Corioliopsis</i> sp.	<i>Pleurotus</i> sp.	<i>Lentinus</i> sp.	<i>Gleophyllum</i> sp.	Height	DBH	Crown diameter
<i>Corioliopsis</i> sp.	1						
<i>Pleurotus</i> sp.	0.202374	1					
<i>Lentinus</i> sp.	0.136904	0.107901	1				
<i>Gleophyllum</i> sp.	0.130295	-0.0735	0.013944	1			
Height	0.020239	-0.11126	-0.09188	0.233082	1		
DBH	0.03997	0.062216	0.069168	0.036578	0.174422	1	
Crown diameter	-0.02995	0.15593	-0.21888	0.084001	0.09852	-0.08777	1

properties for genetic improvement of the traits (Table 1).

### Wood decay along the free bole

Although the variation in wood decay along the bole caused by each of the 4 fungi was significant (Table 1) there was neither a consistent decrease nor increase in wood decay up the bole (Figure 1). That wood decay resistance varies along the bole suggests that preservative penetration was irregular. It is therefore necessary to determine the optimum levels of preservative retention that is enough to render the most susceptible part of the bole decay resistant.

### Radial variation in wood decay

There was the tendency for wood decay to decrease (that is, for decay resistance to decrease) with age of the growth ring (Figure 2). This indicates that the younger growth rings (sapwood) permitted more impregnation and retention of the preservatives than the older growth rings, the heartwood.

### Relative importance of the fungi

On the average, *Lentinus lepidous* caused the greatest decay in the wood of *P. caribaea* (over 50% weight loss). The effects of the other three fungi were close when average values were considered (Table 1). However, each fungus appeared to decay the wood in a way peculiar to the fungus. With the declining availability of good timber in the national forests of Nigeria, it is very likely that attention may be shifted to tropical softwood plantation such as *P. caribaea* for timber supply. Under the tropical environmental conditions, such softwoods are prone to easy biodegradation by fungi. Results of this study indicate that the use of the traditional wood preservative "Cuprinol-Clar has very limited reliability. However, as the results indicate good penetration and retention of the preservative are vital for effective protection of the wood from rot fungi.

### Conclusion

The results indicate that *P. caribaea* wood can be attacked by a variety of root fungi. Both white-rot and brown-rot fungi effect considerable wood deterioration in

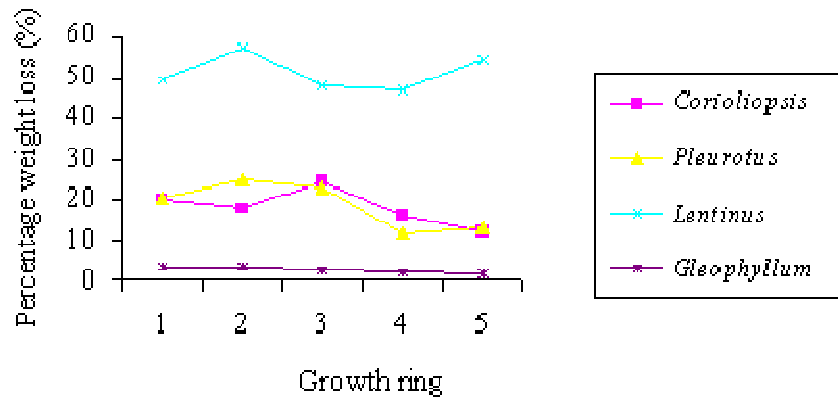


Figure 1. Total height variation in wood decay along the tree bole.

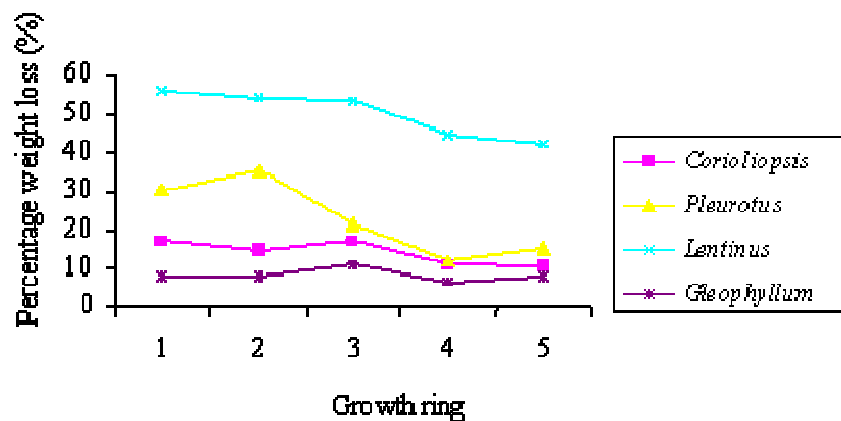


Figure 2. Weight loss variation in wood decay across the growth ring

*P. caribaea* wood. The rate of wood decay varied with the fungus and individual trees. Wood decay by the 4 fungi did not depend on bole size and crown diameter. The rates of wood decay by the 4 fungi were peculiar to each fungus. As the results indicated, *P. caribaea* can only be used as such if the tree has been adequately by preservative impregnation and retention for the control of a variety of rot fungi.

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