MEDWELL PUBLISHING
Agricultural Journal 4 (1): 32-35, 2009
ISSN: 1816-9155

Evaluation of Cashewnut Shell Liquid (CNSL) as a Wood Preservative Using Weight Loss

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Abstract: Laboratory evaluation of Cashewnut Shell Liquid (CNSL) as a wood preservative by the weight loss method was studied. Test blocks of *Triplochiton scleroxylon* were treated at concentration levels of 4, 8, 12, 16, 20, 24, 28 and 32% using pressure impregnation method which resulted into substantial penetration and absorption of CNSL by the test blocks of *Triplochiton scleroxylon*. The treated test blocks were thereafter placed inside Kolle-flasks containing active growths of *Coriolopsis polyzona*, *Pycnoporus sangineus*, *Ganoderma lucidum* and *Lenzites palisoti* for 16 weeks. From the results obtained, the concentration levels at which the preservative was applied were highly significant at $p<0.01$. The CNSL was found to prevent weight loss at concentration above 8%. The recommended killing point concentration (KPC) against the micro-organisms as obtained in this study is 16%.

Key words: Cashewnut shell liquid, *Triplochiton scleroxylon*, test blocks, kolle-flask, *Coriolopsis polyzona*, *Pycnoporus sangineus*, *Ganoderma lucidum*, *Lenzites palisoti*, killing point concentration

INTRODUCTION

In recent years, research has focused on the search for alternatives to the propriety preservatives such as Pentachlorophenol; Lindane; Dieldrin and Copper, Chrome and Arsenate (CCA) in different countries (Awuah, 1989). This is due to the concern about the availability, cost, toxicity and detrimental environmental impacts of these conventional wood preservatives (Lee *et al*., 1990). Apart from the existing studies on the microbial effects of some plant extracts such as sisal (*Agave sislana* Perrine); Pyrethrum (*Chrysanthemum cinerariaefolium* Visiana) and fever plant (*Ociumum gratissimum* L.) on the pathogenic organisms that invade man (Awuah, 1989; Akinde, 1986; Sofowora, 1981), investigation also exist on the efficacy of such plant preparations against fungal organisms that invade wood (Adetogun and Adegeye, 2003; Adetogun *et al*., 2003). This study, which investigates the fungicidal activities of cashewnut extract against wood rotting basidiomycetes is a preliminary work on organic fungicide development from cashew plant.

The shell of the Cashewnut obtained from the fruit of the cashew tree (*Anacardium occidentale* Linn.), is the source of the liquid extract known as Cashewnut Shell Liquid (CNSL) used in the study. The liquid is mainly phenolic in nature (Hammonds, 1977). From laboratory analysis made by Tyman (1979), it contained anacardic acid, 73.3% cardol, 19.1%; 2-methyl cardol 2.8% and cardanol, 4.8%. Among these compounds, anacardic acid was found to curtail the activities of Schistosomiasis and Gram-positive bacterial (Kubo *et al*., 1986, 1993; Himejima and Kubo, 1991; Kubo and Muroi, 1993).

In view of the antimicrobial property of CSNL, this study was initiated as a practical approach for screening the potentials of the crude extract of CSNL as a fungicide against wood decay using the weight loss method.

MATERIALS AND METHODS

Heartwood and sapwood of *Triplochiton scleroxylon* (Obeche) Schumann are not clearly differentiated and the latter is reported to be up to 15 cm wide (Salim *et al*., 2002). *Triplochiton scleroxylon* blocks were prepared from the sapwood of good quality and straight grained of sawn planks purchased from the local market. In line with similar studies (Greaves, 1985), the cutting was arranged in such a manner that the grains of the wood followed the long axis. The test blocks were serially cut into 25×15 mm cross section and cross cut into

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engths of 50 mm. Two hundred and forty test blocks were selected for the test. The blocks were sterilized in the oven for 18 h at a temperature of 103°C. The weight obtained after oven drying was taken as the initial dry weight of the individual specimen.

Extraction of CSNL: The cashewnut were sliced into 2 equal halves using hand-operated slicing machine. The kernels were removed with a pointed knife. The sliced shells were milled with hammer mill into fine particles. Hundred grams of the milled sample was put in the soxhlet extractor using n-hexane as the solvent. The extract was then different concentrations until all the n-hexane had been removed. Eight different concentrations of CSNL were prepared using absolute ethanol as the solvent (4, 8, 12, 16, 20, 24, 28 and 32%) applying the volume to volume method.

Treatment of test blocks: Twenty four test blocks were tested at each concentration, using vacuum pressure applied at 0.7 kg cm^{-2} for 10 min. Another set of 24 blocks were treated with solvent only without the addition of the extract. This was applied to serve as 0% concentration level. After this the blocks were wiped lightly with filter paper to remove excess solution and reweighed to determine uptake of preservative. Individual absorption of blocks was calculated using the formula below:

$$\text{Absorption} = \frac{\text{Total absorption} \times \text{concentration} \times 10\,\text{kg m}^{-3}}{\text{Volume of wood} \times \text{number of pieces}}$$

The treated and control blocks were conditioned in a dessicator for 2 months prior to the decay test. Four pairs of test blocks of the same preservative concentration treatment were aseptically placed in each Kolle-flask containing 40 mL of Cassava Dextrose Agar (CDA) (peeled cassava 200 g; dextrose 12 g; agar 17 g; distilled water 1000 mL) (Adetogun and Adegeye, 2003) with fully growing mycelia of a monoculture of the test fungi [*Coriolopsis polyzona* (Pers) Ryv; *Pycnoporus sanguineus* (Lex fr) Murid; *Ganoderma lucidum* (Leysex) Karsten and *Lenzites palisoti* (fr). The test blocks were incubated at a temperature of 25±2°C for a period of 16 weeks. At the end of the incubation period, they were cleaned with dry cotton wool in order to remove adherent mycelia and were thereafter oven-dried. Their weights were then taken so as to calculate percentage losses arising from the fungi decay of the specimen. The efficiency of CSNL at the various concentrations in protecting the test blocks against biodegradation by the test was evaluated from the following formula:

$$\frac{\text{Dw1} - \text{Dw2}}{\text{Dw1}} \times \frac{100}{1}$$

where:

Dw1 = Weight of test blocks before incubation.
Dw2 = Weight of test blocks after incubation.

In examining, the test blocks after the incubation period, colour changes and degree of softening were used as parameters of decay assessment based on this visual method, ratings were allotted to indicate the protective ability of each treatment level; on the wood. Four ratings exist; these are 6, 4, 2 and 0. Rating 6 denotes badly decayed wood, a destruction condition of the wood sample. Rating 4 indicates fairly decayed wood, that is, a situation of market colour changes and easily recognizable softening. Rating 2 denotes slightly decayed sound wood, indicating depletion of the colour of the wood. Rating 0 denotes sound wood, a situation whereby there is a complete suppression of the test fungi by the CSNL. Data collected from the experiment were transformed using Arc sin transformation procedure. The transformed data were subsequently analyzed using 2-way analysis of variance and LSD test for mean separation (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The mean absorption of the CNSL and solvent by the test blocks which is expressed in kilogrammes per cubic meters was between 0.07 and 7.19 kg m^{-3}. The broad range in absorption by the test blocks was largely accounted for by differences in the concentration levels of the CNSL. The least absorption was recorded in the blocks treated with the solvent only which was 0.07 kg m^{-3}. However, the result revealed that the wood species was easily impregnated without difficulty thereby supporting the permeability coding of the wood-*Triplochiton scleroxylon* (FAO, 1986).

The satisfactory and impressive penetration of the extract into the oven dried test blocks is attributed to the low viscosity of this solvent which consequently lowered the extract viscosity. Therefore, the treatment adopted in this study (Vacuum pressure process) allowed for substantial penetration and absorption of CNSL, thereby providing more effective protection to the test blocks. Furthermore, the treating conditions were controlled so that retention and penetration was varied to meet the requirements of service, thus, unlike brushing and dipping, resulting in more economical use of the preservative. This method could be used in the treatment of different tropical building timbers (Adetogun *et al*., 2003).

Result from the visual examination of the test blocks after 16 weeks of incubation are presented in Table 1. The Table 1 revealed that there was total inhibition of the 4 types of fungi at higher concentrations of CNSL at levels of 16-32%. No growth of the test fungi was found on the test blocks at these concentrations, though, the blocks were wet. At the concentration level of 12%, three of the fungi were completely inhibited except those treated with the fungus *C. polyzona* which showed an evidence of slight decay. At the lower concentration levels of 0 and 4%, the blocks were completely covered by the mycelial mat, while some grew at the base end where rotting of the wooden components took place. There were varying degrees of attack at 8% concentration level for 3 out of the 4 types of fungi except for the fungus *L. palisoti* which provided complete inhibition on the wood samples. The results obtained is in consonance with the previous work of Adetogun and Adegeye (2003).

The percentage changes in mass, which occurred during the 16 weeks of incubation periods, are presented in Table 2. The table revealed that the mean weight loss of the test blocks subjected to solvent (ethanol) treatment only was between 20.32 and 43.25% , while the percentage weight loss in the control experiment was between 21.52 and 49.99%. At 4% concentration of CNSL, the weight loss of the test blocks was between 8.0 and 40.15%. The trend was not the same at the same 8% concentration of CNSL. At each of these three treatment conditions (Control, 0 and 4%), the trend showed that the test blocks were most prone to attack by the fungus *C. polyzona* and were the least attacked by the fungus *L. palisoti*. This trend was maintained at 8% concentration of the extract as the test blocks exposed to attack by the fungus *C. polyzona*, recorded 25.07% weight loss while those blocks exposed to attack by the fungus *L. palisoti* recorded weight loss of 0.00%. At 12% concentration, the test bocks were to attack by the three of the fungi- *P. sanguineus*, *G. lucidium* and *L. palisoti*.

The fungus, *C. polyzona* however, still damages the wood blocks recording 7.90% weight loss. At concentration levels of 16, 20, 24, 28 and 32% the CNSL satisfactorily and effectively shielded the test blocks against attacks by the 4 types of fungi.

At lower concentration levels of CNSL, the test blocks were either badly, fairly, or slightly decayed, but at higher concentrations the wooden specimens were sound at the end of the incubation period. This showed that no decay occurred in the test blocks treated at these concentration levels.

There was no significant difference between the rate of decay caused by the fungi on the test blocks in the control and solvent experiments, respectively. Test blocks

Table 1: Visual rating of wood blocks of *Triplochiton scleroxylon* exposed to different concentrations of CNSL after 16 weeks of incubation in *C. polyzona*, *P. sanguineus*, *G.lucidium* and *L. palisoti*

	Rating of wood decay/concentration of CNSL (%)									
Fungus	TC	0	4	8	12	16	20	24	28	32
Coriolopsis polyzona	6	6	6	4	2	0	0	0	0	0
Pycnoporus sangineus	4	4	4	2	0	0	0	0	0	0
Ganoderma lucidum	4	4	4	2	0	0	0	0	0	0
Lenzites palisoti	4	4	2	0	0	0	0	0	0	0

Table 2: Percentage weight loss of wood blocks of *Triplochiton scleroxylon* exposed to different concentrations of CNSL after 16 weeks of incubation in *C. polyzona*, *P. sanguineus*, *G. lucidium* and *L. palisoti* (mean of 6 replicates)

Concentration (%)	*Coriolopsis polyzona*	*Pycnoporus sangineus*	*Ganoderma lucidum*	*Lenzites palisoti*
Control	49.99	25.92	31.73	21.52
0	42.25	24.93	21.43	20.32
4	40.15	21.30	16.53	8.09
8	25.07	2.47	5.37	0.00
12	7.90	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00

Test of means for wood decay/CNSL threshold standard error of each mean at $p<0.01 = 0.946$; Mean distances 2, 3, 4 and 5; Significant ranges 3.44, 3.59, 3.69 and 3.37

exposed to both treatments were either badly or fairly decayed. Similar patterns of decay were observed on the test blocks treated at 4% concentration level of CNSL.

At 12% concentration level of the CNSL, the degree of decay for the fungus *C. polyzona* was significantly reduced while the decay activity of the rest fungi- *P. sanguineus*, *G. lucidium* and *L. palisoti* were completely and effectively controlled. At higher concentration levels of 16, 20, 24, 28 and 32%, the extract was too toxic for the growth and decay activities of the four types of fungi applied in the study experiment. At these concentration levels, the test blocks remained sound at the end of the incubation period indicating the inhibitory effect of the CNSL against these basidiomycetes. The result also showed that the solvent alone cannot control fungal attack on the wood as it contained no fungicidal ingredient. It could only be used as a solvent medium. From the trend of the results obtained in this study, it can be inferred that the resistance to decay attack observed in the treated test blocks was due to the concentration of application of the CNSL. Hence, the preservative action depends solely upon the toxic deposit of the CNSL in the wood cavity and not the ethanol used as organic solvent. The study therefore, showed that CNSL possess toxic properties, which establish it as a potential wood preservative for treatment of tropical hardwood timbers. The effect of the CNSL on treatment of wood against *C. polyzona*,

P. sanguineus, *G. lucidum* and *L. palisoti* fungi types provided very significant results. This suggests that CNSL can effectively control the basidiomycetes used in this study. The failure of the treated blocks to completely resist the attack of the test fungi at concentration levels of 4 and 8% can be attributed to insufficient toxicity. Even at 12%, *C. polyzona* slightly destroyed the test blocks. This suggests that this stubborn fungus should be reckoned with and employed when determining the threshold value of any new preservative.

The study revealed the complete inhibition of the most tolerant fungus, *C. polyzona*. By the CNSL at 16% concentration, thereby suggesting the possible broad-spectrum and medium efficacy of the crude extract.

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