

EVALUATION OF CASHEW NUT SHELL LIQUID (CNSL) AS WOOD PRESERVATIVE USING CRUSHING STRENGTH

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ABSTRACT

A laboratory evaluation of cashew nut shell liquid (CNSL) as wood preservative on sapwood of *Triplochiton scleroxylon* test blocks sawn into 20mm x 20mm x 300mm sizes against *Trametes cingulata* and *Lentinus lepideus* was studied using crushing method. The crude extract was diluted with n-hexane, volume for volume. Four levels of CNSL concentration were tested at 4%, 8%, 12% and 16%. The treated test blocks and control test blocks were exposed to the infection regions of the pathogens in Kolle-flasks for 2, 4, 6, 8, 10 or 12 weeks. After incubation, the test blocks were tested in radial compression and their modulus of elasticity (MOE) determined. Significant differences at  $P < 0.05$  were found among the fungi types, levels of crude extract concentration and interactions between the fungi, concentrations and duration. Fungi activity was at minimum after 2 weeks of inoculation for concentrations of 12% and 16%. The CNSL was found to be very effective as fungicide in preventing wood decay at these levels. The recommended killing point concentration (KPC) against the microorganisms as obtained in this study is 16%.

Key words: Cashewnut shell liquid (CNSL), *triplochiton scleroxylon*; *trametes cingulata*, *lentinus lepideus*, kolle-flasks, modulus of elasticity (MOE).

INTRODUCTION strength from a combination of highly oriented cellulose microfibrils and encrusting hemicellulose. Any change in these carbohydrates

Many changes occur in mechanical properties of wood as inhabiting microorganisms invade and colonize it (Eaton and Hale, 1993). These changes range from drastic effects on wood strength to subtle modifications in properties such as density, hygroscopicity, electrical conductance, acoustic and caloric values. These changes and their rate of development in wood vary with wood species, the environmental conditions, and the organisms involved (Zabel and Morrell, 1992). In many instances, these changes are hidden, poorly defined and may account in part for the high variability of many wood properties.

As fungi grow through the wood they alter its chemical structure and remove mass thereby altering its mechanical properties. According to Levi (1978), wood derives its

often cause sharp reduction in wood strength and properties, and since these properties drop much more rapidly than its weight, it is theoretically and practically possible to determine the effectiveness of a preservative more rapidly using strength rather than weight loss.

The strength properties most often used to measure the effect of decay and effectiveness of preservatives include modulus of rupture (MOR), work to maximal load in bending, tensile strength parallel to the grain, toughness, hardness and shear strength (Toole, 1969, 1971; Eaton and Hale, 1993). Of these, work to maximal load, toughness and impact bending are known to be the most sensitive in detecting early decay in wood (Wilcox, 1978).

Studies on the microbial effects on wood strength properties have used bending tests of small clear specimens that had been exposed to wood rotting basidiomycetes for varying periods (Toole, 1969, 1971). The data collected were then used to compute modulus of elasticity (MOE), modulus of rupture (MOR) and work to maximal load from stress-strain relationship. Levi (1978) observed that the major drawback of strength loss methods is the inherent variability in the strength properties of wood.

The need for great care in the selection of specimens and the use of large numbers of test specimen explain why strength tests have been more readily accepted for the screening of preservatives than for national standard tests such as weight loss. Consequently, the objective of this study is to determine the efficacy of CNSL as fungicide on the wood samples of *Triplochiton scleroxylon* K. schum using crushing strength method, while using *Trametes cingulata* fr and *Lentinus lepideus* fr as inoculum. According to Tyman (1979), the percentage compositions of the active ingredients of CNSL were anacardic acid, 73.3 %; cardol, 19.1 %; 2-methyl cardol, 2.8 % and cardanol, 4.8 %. Works carried out by Kubo *et al.* (1986, 1993); and Kubo and Muroi (1993) revealed that anacardic acid contain anti-microbial ingredients against schistosomiasis and Gram-positive bacteria.

## MATERIALS AND METHODS

### *Preparation Of extract*

Various solvents have been used to extract CNSL from the shells of cashew nuts. These include petroleum spirit (b.p 60-80 °C); diethyl ether; methanol and n-hexane (Tyman, 1979; Kubo *et al.*; 1986). This could either be by cold solvent extraction, which involved shaking of shell with the organic solvents or using soxhlet extractors placed on steam bath or electric furnace.

The cashew nuts were sliced into two equal halves using the hand-operated slicing machine. The kernels were removed with a pointed knife taking care to avoid contaminating them with the shell liquid.

The sliced shells were milled with the hammer mill into fine particles. 100 g of the milled sample were weighed on the top loading weighing machine (Gallenkamp type). The weighed sample was put in the soxhlet extractor using n-hexane as the solvent. The extractor was placed on a steam bath for 24 h to ensure complete extraction. The n-hexane - oil mixture was collected in the round bottom flask of the extractor.

### *Evaporation in vacuo*

In order to separate the CNSL from the solvent, the mixture was evaporated in vacuo using a rotary evaporator. The mixture of the n-hexane and the oily liquid in the 500 ml round bottom flask was connected to a rotary evaporator. The temperature regulator was set at 70 °C being the boiling point of n-hexane. The rotavapour was set at 7 rpm. The n-hexane portion was collected in the 1000 ml round bottom flask while the oily extract remained in the 500 ml round bottom flask.

### *Preparation Of test fungicide*

The oily extract from cashew nuts was dissolved in chloroform and aqueous

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solutions of varying concentrations of 4 %, 8 %, 12 % and 16 % were prepared applying volume-to-volume method. 1 ml of CNSL was dissolved in 99 ml of chloroform to give 1 % solution strength of the fungicide.

*Preparation of test blocks*

Heartwood and sapwood of *Triplochiton scleroxylon* K. Schum are not clearly differentiated and the latter is reported to be up to 15 cm wide (Howland and Bowen, 1977). Sapwood of good quality and straight-grained stock was taken from the bole of *T. scleroxylon* obtained from the utilization unit of Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria. The wood species was sawn into sizes of 6 cm x 2 cm x 2 cm and the cutting was so arranged that the grains of the wood followed the long axis. One hundred and eighty blocks were prepared for the test. The test blocks were dried to constant weight in the Gallenkamp (UK) oven for 18 h at 103 °C. The weight obtained was taken as the initial dry weight.

*Isolation of pathogen*

The nutrient used, as substrate to culture the test fungi was malt extract agar (MEA)(sigma). 50g of the MEA was added to 1 litre of distilled water and soaked for 15 min. The resultant solution was sterilized in the autoclave for 10 min at 115 °C at 1.06 kg/sq. cm. Two drops of lactic acid was added to the solution to prevent bacteria contamination. After cooling down, the agar was poured into sterilized Kolle-flasks. 15 ml of MEA was poured into each flask. They were left in the culture room to solidify.

Inocula *TT cingulata* and *L. lepideus* were obtained from the pure culture in the pathology unit of FRIN and cultured immediately on the MEA in the Kolleflask. They were left in the culture room until appreciable growth was formed.

*Treatment of test blocks*

Dipping impregnation method (Odeyinde, 1986, FAO, 1986) was used to treat the test blocks. The blocks were completely immersed in the fungicide for 4 min. Thirty-six blocks were treated at each concentration level of 4 %, 8 %, 12 % and 16 % while another set of thirty-six blocks received no treatment (control). The treated blocks were allowed to drain for 2 minutes, and then weighed to determine the rate of absorption using the formula below (BSI, 1961).

Absorption =

$$\frac{\text{Total absorption} \times \text{concentration} \times \text{loin kg/rn}'}{\text{Volume of wood} \times \text{number of pieces}}$$

The test blocks were transferred to the culture tray with sterilized forceps. A 15ml beaker full of propylene oxide was placed inside the tray and covered with another tray and left overnight. This was done in order to remove any spores that might be present and therefore to sterilize the test blocks. Three test blocks treated at each dilution level of CNSL were placed in the Kolle-flasks containing each of the two test fungi. The control test blocks were wrapped in aluminum foil and sterilized in the autoclave before introduction into the Kolle-flasks containing the test fungi. The test blocks were incubated in the Gallenkamp incubator for 2, 4, 6, 8, 10 or 12 weeks at 25 ± 2 °C. There were six replicates.

Compression test

At the end of each incubation period, the test blocks were removed from the infection region, the surface mycelium was wiped off. The wet weight of the test blocks were determined by weighing on the top loading weighing machine (Gallenkamp) before they were oven-dried for 18 h at 103 °C. The weight obtained was taken as the final dry weight. The test blocks were tested in radial compression with Hounsfield Tensometer and their modulus of elasticity were determined. All the test blocks were brought to a moisture content above the fibre saturation point before conducting the compression test. The test blocks were put in the compression cage and loaded at machine speed of 0.01 mm per second until failure occurred. The corresponding reading of the mercury level was then recorded in kg.

Modulus of elasticity (MOE) was determined mathematically as:

$$MOE \text{ in kg force/cm}^2 = \frac{PL^3}{4Abh^3}$$

Where P is load in Newton

(N) or Kg

L is span in (mm) or cm

b is width in (mm) or cm

d is depth in (mm) or cm

A is the deflection in (mm) or (cm)

at beam center at proportional limit

or corresponding to load P

1tonne=1000 kg.

CNSL concentration and crushing strength (modulus of elasticity)

RESULTS AND DISCUSSION

Results of the effect of time on the compression strength of *T scleroxylon* treated at the various concentrations of CNSL are presented in Table 1. In Table 1, the maximum load in kg was between 540 kg

Table 1: Modulus of Elasticity (MOE) of test blocks of *Triplochiton scleroxylon* exposed to different concentrations of CNSL after 2,4,6,8,10 or 12 weeks of incubation in *Trametes cingulata* and *Lentinus lepideus*

and 1768 kg for *T. cingulata* while it was between 825 kg and 1660 kg for *L.*

Fungi/Incubation Period (week)	Concentrations of CNSL* (%)				
	0	4	8	12	16
<i>TT cingulata</i>					
2	1370	1360	1450	1550	1770
4	330	1350	1440	1540	1768
6	1020	1300	1440	1540	1768
8	640	1280	1440	1540	1768
10	600	1120	1440	1540	1768
12	540	1010	1440	1540	1768
<i>L. lepideus</i>					
2	1385	1340	1390	1420	1680

4	1325	1325	1395	1410	1660
6	1250	1220	1395	1410	1660
8	1044	1122	1387	1410	1660
10	950	1075	1387	1410	1660
12	825	847	1387	1410	1660

\* Diluted volume/volume in n-hexane

*lepideus*. Table 2 revealed that at 0.05 1010 kg during the same incubation period. probability level the various sources of The strength properties increased with variation are significantly different. The increase in concentration of CNSL fungi, the concentration and duration are all regardler" of period of incubation of the significantly different. The fungi and treated samples.

Table 2. Result of analysis of variance for Modulus of Elasticity (MOE) of test blocks of *Triplochiton scleroxylon* exposed to different concentrations of CNSL after 2,4,6,8,10 or 12 weeks of incubation in

Source	DF	SS	MS	F-value	Pr>F
Fungi	1	44368.20	44368.20	8050.68	0.0001
Concentration	4	10195093.83	2548773.46	99999.99	0.0001
Duration		1253873.11	250774.62	45503.46	
Fun x Con	4	702413.08	175603.27	31863.50	
Con x Dur	20	2172895.17	108644.76	19713.77	0.0001
FunxConxDur	1 25	252547.39	10101.90	1833.01	0.0001
Error	120	661.33			
Corrected	179	14621852.11			

Total

concentrations are significantly different; the concentration and duration significantly different; while the interactions between the fungi, concentrations and duration shows significant difference. The postmortem analysis was carried out using Duncan multiple range test. The dependent variable used was strength. The results revealed that *T. cingulata* was more destructive in nature than *L. lepideus*.

The patterns of variation in the strength properties of these blocks treated at different concentrations of CNSL and inoculated with the two test fungi are illustrated in figures 1 and 2. The crushing strength of the test blocks varies from one concentration of CNSL to another. Test blocks treated at 0 % and 4 concentrations were the most susceptible to the two test fungi. It was 540 kg at 12 weeks after inoculation for *T. cingulata* while in 4 % concentration of CNSL, it was

The compression strength of the test blocks

treated at the same concentrations and inoculated with *L. lepideus* exhibited a similar pattern. The least maximum load in kg (825 kg and 847 kg) was obtained at 0 and 4 % concentrations of CNSL. All other concentrations tested were inhibitory to fungal growth, hence improvement in strength property of the test blocks.

As the level of concentration increased, the compression strength values progressively increased indicating the effectiveness of the CNSL in controlling the activities of the test fungi which otherwise would have affected the strength property of the test block. This observation is in consonance with studies earlier published in literature (Toole, 1969, 1971; Eaton and Hale, 1993; Adetogun and Adegeye, 2000, 2001). Himejima and Kubo (1991) also revealed that CNSL exhibited strong anti-fungal activity against *P. chrysogenum*, *M.*

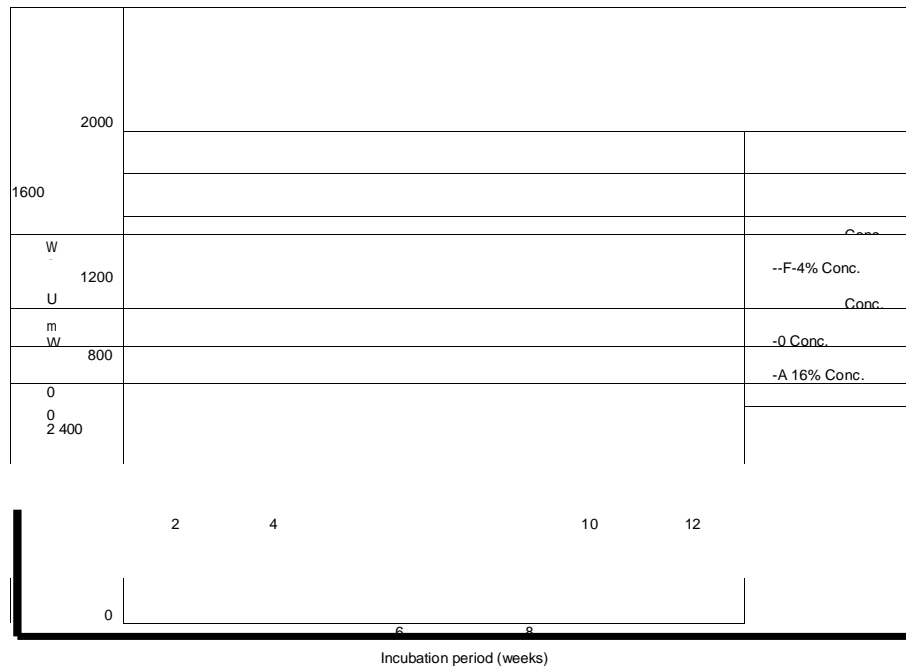


Fig. 1: Effects of *Trametea cingulata* on the strength properties of test blocks of *Triplochiton scleroxylon* treated at different concentrations of CNSL

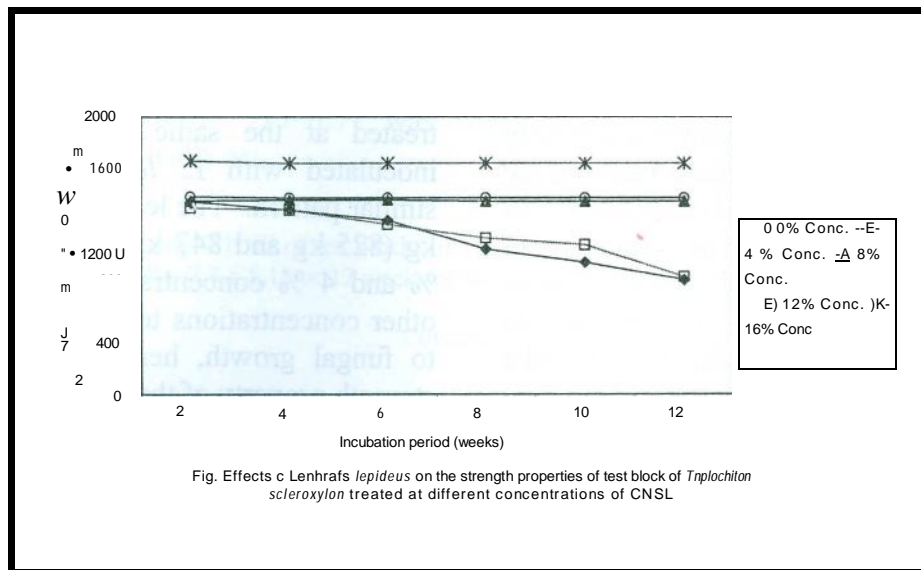


Fig. Effects of *Lenhrafts lepideus* on the strength properties of test block of *Triplochiton scleroxylon* treated at different concentrations of CNSL

*mucedo*, *R. stolonifer* and *A. niger*. The high reduction in the activities of *T. cingulata* and *L. lepideus* on *T. scleroxylon* by CNSL as investigated in this study makes this organic fungicide obtained from the shells of cashew nut a candidate preservative in preventing

wood decay and also in improving the strength properties of

*T scleroxylon* which in the building industry is classified as perishable wood.

The result of this study indicate that reduction in crushing strength is as good an indicator for evaluating the preservative properties of CNSL as a loss in weight of the test blocks treated with CNSL and



exposed to fungal attack (Adetogun, 1990 and 1998).

With CNSL, it may be possible to extend the life span of perishable wood species and protect them against fungi that incite serious decay on woody components. Since wood treatment can furnish protection against incipient decay and improve the mechanical properties of wood, a combination of factors that will not favour decay and wood treatment may give better results in reducing frequent replacement of woody structures due to decay.

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