FUNGICIDAL EFFECT OF CHROMATED COPPER ARSENATE AND CASHEW NUT SHELL EXTRACT ON THE TREATMENT OF CEIBA PENTANDRA WOOD.

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ABSTRACT
The fungicidal effect of Chromated Copper Arsenate (CCA) and Cashew Nut Shell Extract (CNSE) on the treatment of Ceiba pentandra wood against fungal infestation was investigated. Ceiba pentandra wood samples dimensioned 20mm x 20mm x 60mm were treated with CCA and CNSE preservatives using cold dipping method. Absorption and retention of the preservatives were determined with CCA at 4% concentration having 65.75 % and 10.23 kg/m³ for absorption and retention respectively while undiluted CNSE recorded 31.4% and 0.79 kg/m³. The result of fungal exposure test for 12 weeks by soil block method revealed the efficacy of CCA in suppressing the activities of Serpula lacryman, Aspergillus wentii and Penicillium brevi – comatum on C. pentandra wood while CNSE could not provide the needed protection as there was no significant difference between CNSE treated samples and the control.

Keywords: Chromated Copper Arsenate, Cashew Nut Shell Extract, Ceiba pentandra, Decay fungi, Soil block culture.

INTRODUCTION
Wood is a major material for construction that has continued to maintain its prime position in the building industry. In spite of its numerous advantages as an important renewable resource material available to mankind, an excellent strength to- weight ratio properties, relatively low price and ease of fabrication among others, wood is prone to the attack of biodegrading agents like insects and fungi. The exposure of wood to moisture during use increases its likelihood of fungal infestation. One of the major objections to the use of wood for many purposes is of course the question of its long term resistance to the natural process of degradation (Richardson, 1978 and Yalinkilic, 2000).

The treatment of wood will prevent damage by those deteriorating agents,
protect and extend the life of wood in service far beyond that of the natural durability of the wood (Allan, 2000 and Craig et al; 2001). The use of chemical preservatives have for long been a common practice among Builders and Architects. This led to the flooding of market with different types of chemical preservatives under various trade names; However many of them have not gained acceptance either because of toxic side effects, low efficacy, high cost or corrosiveness (Murphy, 1990 and Owoyemi, 2008).

Chromated Copper Arsenate (CCA) is a water-borne preservative that is highly effective and chemically fixed in wood by the formation of insoluble material that cannot be leached out by water. Chromium provides for fixation while copper is added to act against soft rot fungi (Zabel and Fengel, 1990). It preserves the wood from decay fungi, wood attacking insects, including termites, and marine borers. It also improves the weather-resistance of treated timber and may assist paint adherence in the long term. CCA is generally accepted as a very effective preservative treatment with certain wood species. Kenneth (1998), reported that CCA treatment provide very good protection against termites at retention as low as 1.6kg/m³. CCA is generally accepted as a very effective preservative treatment with certain wood species. Best protection has been achieved with carefully balanced mixtures of copper and chromium salts, sometimes with addition of arsenic, the latter enhancing the toxicity against insects. CCA-treated wood is used primarily for construction lumber and timbers, utility and construction poles, marine timbers and pilings, fence posts and wood foundation lumber (Cooper 1991). However, with the inclusion of some contaminants in wood preservatives such as CCA and Creosote oil containing heavy metals and organochlorine insecticides such as drin and chlordane compounds with its attendant widespread existence of chemicals in the food chain, attempts are being made to evaluate the performance of environmentally friendly treatments from plant extracts (Asari et. al 2004).

Cashew Nut Shell Extract (CNSE) is extracted from the nut shell of cashew (Anarcardium occidentale) fruits using any of the following methods; thermal, steaming or solvent (Adetogun, 1998). The shell oil is 18-28% of the total raw nut weight. CNSE is oily, viscous and dissolved in organic solvents enhancing penetrability. The composition of CNSE was found to be 73.3% anarcardic acid; ardol 19.1% methyl l cardol 2.8% and anacardol 4.8% (Tyman1979). Among these components, anarcardic acid has been found to contain antimicrobial ingredients (Himejima and Kubo, 1991). The numerous uses of CNSE are based on the fact that it lends itself to polymerization by either physical or chemical means or combinations of both. CNSE is widely used in formulation of etergents, anti-oxidants, synthetic dyes fungicides and disinfectants (John-
Fagboyegun 1998). Ability of natural plant extractives to protect wood against wood degrading fungi has been one possible approach for trying new wood preservatives (Kartal et. al 2004).

Current research effort has been to find a way of making non – durable wood species like *Ceiba pentandra* resistant to fungal infestation when used in an environment where the wood is vulnerable to damage by these aggressive bio-deteriorating agents. This paper therefore examined the efficacy of CCA and CNSE in inhibiting fungal activities on *Ceiba pentandra* wood.

**Sample collection and preparation.**
The materials for the project work were samples of *Ceiba pentandra* wood, Chromated Copper Arsenate and Cashew Nut Shell Extract preservatives. *C. pentandra* wood was sawn into 20mm x 20mm x 60mm block with the circular sawing machine. The wooden blocks were marked with water-proof ink and weighed before impregnation. The preparation and impregnation of sample blocks were carried out according to Indian Standard (2006), using alternative Agar – block (Kolle-flash). The blocks were oven dried at 100°C – 105°C to a constant weight (T₁), which was referred to as the initial weight or untreated weight of wood samples.

**Treatment Procedure:**
The wooden blocks were treated with CCA at 4% concentration and CNSE in its undiluted state. The method of application was cold dipping by immersion. The wooden blocks were immersed in the preservatives (CCA and CNSE) for 24h in a tank. Thereafter, the treated samples were well drained to remove excess preservatives before they were weighed (T₂). Preservative absorption by the wood samples was determined using:

\[
\text{Absorption} \% = 100 \times \frac{T₂ - T₁}{T₁}
\]

Where:  
\(T₂ = \text{treated weight}\)  
\(T₁ = \text{dry weight}\).

**Calculation of Retention Value:**
The retention, which is the weight of active ingredients of preservatives left in the wood after treatment was also calculated using Indian Standard (2006):

\[
\text{Retention in Kg/m}^3 = 10 \times \frac{G \times C}{V}
\]

Where:  
\(G = (T₂ - T₁)\)  
\(C = \text{Weight of preservative in 100g of solution}\)  
\(V = \text{Volume of block cm}^3\)

**Isolation of fungi from the decayed wood sample and preparation of growing medium**
A decayed wood sample was crushed and serial dilution was made from it. Sterile potato dextrose agar (PDA) was aseptically
poured into Petri dishes and allowed to set. Poured plates were seeded with the decayed wood and then incubated at 25± 2°C for 3-5 days. Pure cultures of the fungal isolates were identified under the microscope as described by American Society for Testing Materials D 1413-76.

**Infection of wooden blocks.**
The blocks were exposed to fungal attack by placing them aseptically in the Petri dishes in which there are actively growing culture. The blocks were then placed in culture medium in a way that it came in contact with the aerial mycelium of the fungus and not the medium itself, with a feeder strip in between the preserved wood. The Petri dishes containing the test blocks were inside the inoculating chamber at 27 ± 10°C and 72± 4% relative humidity for a period of 12 weeks. At the end of the incubation period the blocks were removed from the Petri dishes, cleaned of the adhering mycelium. The blocks were dried at the room temperature and then conditioned (30°C and 70± 4 percent humidity) to a constant weight (T₄).

**Determination of weight loss:**
Percentage weight loss after twelve weeks of inoculation with fungal isolates was calculated from the conditioned mass of the blocks before and after fungal exposure.

\[
\text{Weight loss \%} = 100 \times \frac{T_3 - T_4}{T_3}
\]

Where: \(T_3\) = Weight of wood specimen plus preservative before exposure to test fungi(g), and \(T_4\) = weight of wood specimen after fungal exposure for 12 weeks.

**Statistical Analysis**
The numerical data obtained from the study were subjected to Analysis of Variance (ANOVA) using SPSS 17.0 software package. The treatment means were separated with Duncan’s Multiple Range test at 5% level of significance.

**RESULTS AND DISCUSSION**
The result of the identification of the colony of fungi placed in a clean glass slide and viewed under the microscope showed the following:

1. *Serpula lacrimans*: The sole causative agent of dry rot; moist conditions are required to initiate the growth. In badly ventilated areas of high humidity, the hyphae in the wood manifested themselves on the surface; giving rise to a white felt covering which later develops into flat rust coloured sporophore with a white margin wood damaged by this fungus often has a typical cubical cracking.

2. *Aspergillum wentii*: They are dark or smoky brown in colour, the growth was dense and a floccose mass of aerial
mycelium was formed. The species is described cosmopolitan, occurring in soil and on organic substrata such as moist grain.

**III. Penicillum brevicompactum:** The colony was restricted in growth. They were dull yellow or greenish brown in colour. Occasionally a secondary growth appears on top of an established culture, pale blue – green with long stiff stripes and enormous conidial heads. *Ceiba pentandra* wood samples treated will CCA recorded the higher absorption of 65.75% and mean retention of 10.23kg/m³ while CNSE recorded 31.44% absorption and 0.79k/m³ retention (Table 1). Absorptions are higher for water soluble preservatives like CCA because the hygroscopic nature of wood makes its micro fibrils easily wetted by water and increased preservative uptake (Richardson, 1978). The oily and highly viscous nature of CNSE was responsible for the low absorption. This phenomenon was also observed in the work done by Adetogun (1998).

<table>
<thead>
<tr>
<th>Preservative treatments</th>
<th>Absorption (%)</th>
<th>Retention (kg/m³)</th>
<th>Weight loss (%)</th>
<th>S. lacrymans</th>
<th>Aspergillus wentii</th>
<th>Penicillium brevicompactum</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCA</td>
<td>65.75</td>
<td>1.9</td>
<td>19.04</td>
<td>19.2</td>
<td>18.01</td>
<td></td>
</tr>
<tr>
<td>CNSE</td>
<td>31.44</td>
<td>0.79</td>
<td>35.7</td>
<td>37.4</td>
<td>35.9</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>40.42</td>
<td>42.7</td>
<td>41.41</td>
<td></td>
</tr>
</tbody>
</table>

*Means with same alphabet are not significantly different (P>0.05) Duncan’s Multiple Range Test.*

CCA = Chromated copper Arsenate; CNSE = Cashew Nut Shell Extract

The results of weight loss caused by the three decay inducing fungi are presented in Table 1. The weight loss of the untreated *Ceiba pentandra* wood was higher than the treated specimens after 12 weeks of incubation.

There was significant difference in the preservative treatments while there was no significant difference in the effect of fungi types used for the study (Table 2). However the result of the follow-up test in Table 2 showed that there was significant difference between CCA and CNSE, while there was no significance difference between CNSE and the control. In spite of legislation in some countries against CCA, it has proved an excellent protection for wood against termites and fungal infestation.
Table 2: Test for weight loss of wood samples exposed to fungi infection

<table>
<thead>
<tr>
<th>Fungi</th>
<th>S. lacrymans</th>
<th>Arspergillus wentii</th>
<th>Penicillum brevi – comapactum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>31.77&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preservatives</th>
<th>CCA</th>
<th>CNSE</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. 74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.29&lt;sup&gt;b&lt;/sup&gt;</td>
<td>41.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

*Means with same alphabet are not significantly different (P>0.05) Duncan’s Multiple Range Test

This is in consonance with report of Jeannette (2002) that CCA is highly toxic; formed complex chemical reactions which firmly bind the preservative to wood making it exceedingly resistant to leaching, and has a long history of excellent performance. CNSE did not protect the wood against the infestation of the three fungi; this could be as a result of the organic compound in the preservative which encouraged fungal growth as noticed in the study. However, the inclusion of sodium chloride with CNSE could improve the toxicity level and protection against fungal attack as carried out by Adetogun (2011). It was observed that while it took three weeks for the inoculums from serial dilution to grow on the medium (Agar produced from PDA), fungi growth was noticed on samples treated with CNSE after the first week, even while growth was yet to commence on the feeder strip. This phenomenon was also observed by Owoyemi (2008) on *Gmelina arborea* wooden stakes at the timber grave yard during termites’ exposure test.

The results showed high vulnerability of *Ceiba pentandra* to fungal infection and that the wood is not naturally durable, but requires preservative treatment to prolong its serviceable life. The wood resistance to fungal infestation can be enhanced through preservative treatment with Chomated Copper Arsenate because it provided excellent protection during the period of study. This study corroborated previous assertions by Jeanette (2002) that, CCA have been used in New Zealand for more than 50 years and that no other wood preservative has had such a long history of excellent performance or being cost effective. CNSE is not commonly processed as wood preservative but for other industrial uses. It did not provide the needed protection of the wood against the fungal infestation, addition of toxicants like Permetrin or Aldrex 40 may raise the toxicity level against fungal attack (Remadevi and Raja 2007).

Wood protection is an essential and indispensable aspect of wood processing,
but not given the seriousness it deserves during construction. This has lead to timber failure due to decay fungi attack. Wood users should be enlightened on the problem associated the use of untreated wood in construction and to adopt construction method that will reduce the contact of wood with water.

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REFERENCES:


