The Screening of Commercial Wood by Chemicals

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Commercial wood in the Jharkhand State of India is destroyed by various fungi e.g. *Fomes caryophylli, Trametes lactinea, Polyporus ostreiformis* and *Cubamyces cubensis* etc. which are controlled via chemical preservatives, viz., Creosote, Arsenic Copper Compound (ASCU-PS$_2$), Zinc chloride and borax, of which creosote and borax proved most effective.

**Keywords:** preservation, wood, chemical

Wood is destroyed in different ways by various types of micro-organisms. One of the most important methods is by fungi in which it infects wood and causes death and finally decay of wood tissues. Wood decaying fungi poses a great problem by causing very serious damage.

Many chemicals have been in use as wood preservatives. These preservatives are in fact metabolic poisons which may be either pure chemical compounds or a mixture of compounds. Wood preservatives have been developed to prevent or retard wood from destruction by micro-organisms, making it resistant. Toxicity is the tool of measuring effectiveness of a preservative. This can be measured in the laboratory by raising micro-organisms in culture media containing different concentrations of preservatives. According to Hunt and Garratt (1953) toxicity is measured in terms of "inhibition point" and "killing point". The killing point represents the minimum concentration of the preservative required to kill a fungus whereas inhibition point stops the growth without causing the death of wood. Broad spectrum chemical preservatives of wood rotting fungi are used to protect wood from death and decay when properly applied.

Some of the most important chemicals are creosote, pentachlorophenol, arsenicals (CCA, CCB, ASCU-PS$_2$), zinc chloride, borax etc. According to Highley (1987) identification of the biochemical agents in decaying fungi which are responsible for the degradation of wood within the cell matrix can lead to new, sharply targeted, ecofriendly and effective methods of wood preservation for controlling decay. There are several toxicity tests but none is accepted as a universal standard method. There are three common toxicity tests viz., (1) "Malt-agar-culture test" suggested by Bateman (1933), Schmitz (1930), (2) "Soil block-test" advised by Duncan (1953), Duncan and Richards (1950), and (3) "Agar-block-test" devised by Cartwright and Findley (1946). However, Malt-agar-culture test is comparatively simple and rapid. Hunt and Garratt (1953) are of the opinion that malt-agar-culture method has the advantage of simplicity and usefulness but resistance can be obtained from the Soil-block-test or Agar-block-test. They emphasised that these tests have indicative and useful information on the relative effectiveness of different preservatives on commercial timbers.

The present investigation on toxicity test of wood preservation was undertaken in light of the above observations. However, the present experiments were designed by modifying the Malt-agar-culture method for the study on the role of different toxic chemicals or the so called metabolic poisons or preservatives in controlling the wood decay, caused by various wood rotting fungi in the Chotanagpur forests of Jharkhand, India.

**Materials and Methods**

2% Malt-agar medium was prepared and sterilized, 3% aqueous solution of creosote, arsenic copper
compound (ASCU-PS₂), zinc chloride, and borax each were separately prepared and sterilized of which six different grades viz; 0.03%, 0.06%, 0.09%, 0.12%, 0.15% and 0.18% of creosote, zinc chloride and borax were prepared. These percentage of each chemical were mixed with malt-agar medium contained petri plates but for ASCU-PS₂ the concentrations of 0.01%, 0.02%, 0.03%, 0.04%, 0.05% and 0.06% were selected. The media with each chemicals were inoculated at the centre separately with uniform discs of 5mm diameter of mycelia punched out from young cultures of *Fomes caryophylli*, *Trametes lactinea*, *Polyporus ostreiformis* and *Cubamyces cubensis*. These were then incubated for 14 days at 30±1° C in darkness. Four replicates were maintained for each test fungi along with control. Colony growth was measured in terms of linear dimensions and mycelial dry weights.

**Results and Discussion**

The results has been presented in Figures 1 to 8. The results clearly reveals that the toxic points of the four test fungi fell within the range of concentrations of chemicals selected. The results further show that the growth of all the four test fungi decreased in the presence of the testing preservative chemicals than the control. All four test fungi showed decrease of linear growth as well as mycelial dry weight with the addition of different chemicals in the culture media than the control. It is also evident that the growth of the fungus gradually decreases with increase in the concentrations of the chemicals.

The effect of different concentrations of ASCU-PS₂ on the mycelial growth of all the four test fungi on Malt-agar has been illustrated in Figure 1 and 2, Figure 1 clearly shows that mycelial growth was inhibited after the addition of ASCU-PS₂. It also indicates the inhibition point in the case of *P. ostreiformis*, *C. cubensis* while it was noticed as 0.05% ASCU-PS₂ in case of *T. lactinea*. So far the dry weight of the fungal mycelium is concerned the result in Figure 2 clearly shows that there was gradual decrease in the dry weight of the fungal mycelium with increase in the concentration of ASCU-PS₂ was added in the culture media and this decrease in dry weight was calculated to 83.3% when 0.04% ASCU-PS₂ was added in culture media. Similarly decrease in dry weight by 39.6% was observed when 0.01% ASCU-PS₂ was added in case of *C. cubensis* and this decrease in dry weight reached to 29.07% at 0.04% ASCU-PS₂ concentration and it was inhibition point. However, the decrease was noticed as 16.6% and 93.5% at 0.01% and 0.05% concentration of ASCU-PS₂ in case of white rotter *T.*

![Figure 1](image-url)  
*Figure 1.* Effect of different concentrations of ASCU-PS₂ on mycelial growth of four test wood rotting fungi.
lactinea. In this case the inhibition point was observed as 0.05% ASCU-PS₂. Among all the four test fungi, the white-rotter F. caryophylli was most affected by the addition of ASCU-PS₂. In this case decrease in dry weight by 37.4% was observed when 0.01% ASCU-PS₂ was added in the culture media but the growth of the fungus was completely stopped when 0.04% ASCU-PS₂ was added in the culture media. The decrease in dry weight by 82.1% was noticed at 0.03% ASCU-PS₂ concentration. Here the inhibition point was at 0.03%. This result indicates that the chemical ASCU-PS₂ is no doubt a good inhibitor which inhibits the growth of all the four test fungi considerably, among all the four test fungi. F. caryophylli is most severely affected by ASCU-PS₂. Statistical analysis shows that Trametes lactinea performed best growth at 58.58 among all the four species, which was found to be at par with Polyporus ostreiformis at 51.30 and Fomes caryophylli at 26.81 was found to be least. (Table-1). It can be concluded with ASCU-PS₂ inhibits the growth and development of the different tested fungi but the degree of inhibition varies and it depends upon the nature of the wood rotting fungi.

The results illustrated in Figure 3 and 4 presents the effect of different concentrations of creosote on mycelial growth of the four test fungi. It is evident that creosote affects the growth of the test fungi significantly and the growth is checked considerably when only 0.03% creosote is added in the culture media. Decrease in dry weight by 42.1% and 83% was noticed when 0.03% and 0.16% creosote respectively was added in the culture media. Likewise decrease in dry weight increased from 40.9% to 83.1% when the concentration of creosote in the culture media increased from 0.03% to 0.12%. In case of T. lactinea the inhibition point was observed at 0.12% of creosote. There was decrease in dry weight by 69.5% in comparison to control, when 0.12% creosote was added in the culture media. Further, it was also observed that there was no growth, i.e., complete inhibition of the mycelial growth of the fungus. F. caryophylli and noticed when 0.09% creosote was added in the culture media (Figure 4).

When the activity of creosote is compared with that of ASCU-PS₂ it is clear that creosote is more active in inhibiting the fungal growth.

Zinc chloride was added in 0.03%, 0.06%, 0.09%, 0.12%, 0.15%, 0.18% and 0.21% concentrations in the culture media and its affect on the mycelial growth of all the four test wood rotting fungi was observed. These observations have been presented in Figure 5 and 6. It is evident from these figures that zinc-chloride inhibits the growth of all the four test fungi and the percent
Table 1. Effect of different concentration of ASCU-PS$_2$ on mycelial growth of all four test fungi on malt agar after 14 days.

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Polyporus ostreiformis</th>
<th>Cubarea cubensis</th>
<th>Trametes lactinea</th>
<th>Poria caryophylli</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01%</td>
<td>8.285</td>
<td>15.41</td>
<td>93.31</td>
<td>60.25</td>
<td>311.82</td>
</tr>
<tr>
<td>0.02%</td>
<td>7.206</td>
<td>64.75</td>
<td>80.88</td>
<td>42.03</td>
<td>302.35</td>
</tr>
<tr>
<td>0.03%</td>
<td>55.03</td>
<td>41.03</td>
<td>61.70</td>
<td>22.50</td>
<td>180.26</td>
</tr>
<tr>
<td>0.04%</td>
<td>34.31</td>
<td>12.85</td>
<td>36.30</td>
<td>9.00</td>
<td>91.16</td>
</tr>
<tr>
<td>0.05%</td>
<td>12.25</td>
<td>6.50</td>
<td>21.75</td>
<td>0.00</td>
<td>40.50</td>
</tr>
<tr>
<td>Mean</td>
<td>51.30</td>
<td>40.04</td>
<td>58.88</td>
<td>26.81</td>
<td>186.21</td>
</tr>
</tbody>
</table>

CD/SP = 12.993  CD  = Critical difference
CD/C = 15.003  SP  = Species
CD/SP x C = 25.986  C  = Concentration

Figure 3. Effect of different concentrations of creosote on mycelial growth of four test wood rotting fungi.

of inhibition in growth increased with increase in the concentration of zinc-chloride from 0.03% onwards. The inhibition point was noticed at 0.09% F. caryophylli and T. lactinea whereas it was at 0.12% in case of C. cubensis and at 0.15% in case of P. ostreiformis (Figure 6). Thus, it is obvious that the inhibition point differs in white rotters and brown rotters. The white rotters are more severely affected by zinc-chloride in comparison to the brown rotters. The loss in dry weight was observed by 1.8%, 24.2%, 33.2% and 27.9% in the mycelial growth of P. ostreiformis, C. cubensis, T. lactinea and F. caryophylli respectively on addition of 0.03% zinc-chloride in the culture media. This decrease in dry weight increased to 82.06% on additions of 0.15% zinc-chloride in case of P. ostreiformis whereas in case of C. cubensis the loss increased to 79.79% at 0.12% of zinc-chloride in the culture media. Similarly the loss in dry weight increased tremendously and was observed to be at 81.5% and 79.8% by the white rotters. T. lactinea and F. caryophylli respectively in addition of 0.09% zinc-chloride in the culture media. It is clear from these results that zinc-chloride exhibits much more inhibition in the growth of mycelium of white rotters i.e., T. lactinea and F. caryophylli than that of brown rotters.
Figure 4. Effect of different concentrations of creosote on mycelial growth (dry weight) of four test wood rotting fungi.

Figure 5. Effect of different concentrations of zinc chloride on mycelial growth (diameter) of four test wood rotting fungi.
Lastly the effect of different concentrations of borax (0.03%, 0.06%, 0.09%, 0.12%, 0.15% and 0.18%) on the mycelial growth of all the four test fungi was studied and the observations have been illustrated in Figure 7 and 8. The results show very clearly that mycelial growth decreased with increase in the concentrations of borax. The inhibition point also varied in different wood rotters. The inhibition point was observed as 0.15% in case of *P. ostreiformis* whereas it was 0.09% in case of *C. cubensis*, 0.12% in case of *T. lactinea* and *F. caryophylli*. The results further makes it also clear that the mycelial growth was completely checked after 0.15% of borax in case of *P. ostreiformis* after 0.09% in case of *C. cubensis*, after 0.12% in case of *T. lactinea* and *F. caryophylli*.

Similarly the diameter of the mycelial mat also decreased with the addition of borax in the culture media and this diameter of mycelial growth increased with increase in borax concentration.

These results further exhibits that ASCU-PS proved to be most effective against all the wood rotting fungi. However, Mendels and Reese (1963) reported inhibition of microbial enzymes usually by metals like copper, chromium, mercury, lead etc. According to Costa (1967) growth of fungi are very resistance to copper. According to Collett (1987) chromium was the most effective inhibitor and metals like copper, chromium and arsenic form complexes which might interact with the organisms and their cellulose in different ways. These findings also exhibit that creosote and borax are quite effective and their inhibiting concentration against the tested fungi are fairly low.

From the above observations which have been illustrated in Figures 1 to 8, it shows that all the preservatives are quite effective in “Malt-agar culture test” even at low concentrations.

The present experiment also shows that linear growth as well as dry weight of the mycelia decreases gradually with increase in the concentrations of the preservatives. It is also evident that dry weight of the mycelia decreases along with the decrease in linear growth of these fungi.

**Conclusions**

The following conclusions have been drawn from the present study.

1. Creosote and borax chemical preservatives are best to combat the wood rots by fungi like *Fomes caryophylli, polyporus ostreiformis and Cubamyces cubensis*.
2. Creosote and borax are recommended to
Figure 7. Effect of different concentrations of borax on mycelial growth (diameter) of four test wood rotting fungi.

Figure 8. Effect of different concentrations of borax on mycelial growth (dry weight) of four test wood rotting fungi.
control the growth of white rot and brown rot attacking commercial timber e.g. *Shorea robusta*, *Dalbergia sissoo*, *Mangifera indica* and *Ficus benghalensis* and possibility on other woods of economic use.

3. The ASCU-PS chemical was most effective against all the wood rotting fungi.

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**References**


