Decay resistance of Maple (*Acer insigne*) wood against white rot in natural state and treated.

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Abstract

In this study, the decay resistance of maple (*Acer insigne*) in natural state and treated with ACC (Acid copper chromate) was investigated against the white rot fungus (*Coriolus versicolor*). ACC is a kind of water borne preservatives that was used in this study for treating specimens under vacuum and pressure (Bethell procedure) with 3 percent concentration. In conducting mentioned evaluation, kolleschale’s method according to DIN 52176 and B.S. 838: 1961 were used in completely randomized block design. Specimens were contaminated with cultured fungus for fourteen weeks in condition (22, 75% relative humidity). After this period, weight reduction, compressive strength (parallel to grain) and hardness of specimens were tested. Under test conditions weight reduction of control sample were much higher than treated ones. Compressive strength (parallel to grain) and hardness of treated samples were higher than control ones.

**Keywords** Maple (*Acer insigne*), *Coriolus versicolor*, Natural Durability, Hardness, Bethell method, ACC salt
Introduction

Wood is subject to biodegradation by a variety of microorganisms, but the greatest damage is often caused by decay fungi, because they can rapidly cause structural failure. Many treatments are available to prevent or retard the destructive action of decay fungi. However, more than 5.2 billion in annual losses in the United States are estimated to result from fungal deterioration (Powell et al. 1992). Microbial attack of wood has traditionally been controlled through the use of wood preservatives. Effective broad-spectrum fungicides, such as creosote, pentachlophenol, and chromate copper arsenate, inhibit enzymes of many metabolic pathways, and are currently used to protect wood from decay. However, these toxic preservatives have been subjected to public criticism by their broad toxicity. The result has been an increased demand for the development of low toxicity alternatives or safe non-toxic treatments to prevent wood deterioration (Illman and Highley 1989). Previous studies have indicated that sapwood and heartwood of oak (Quercus castaneifolia) have middle durability against Coniofera cerebella fungi and high durability against versicolor fungi (Tabatabaei 1960). Sapwood of Oak, Walnut, Alder and Beech have non durable than their heartwood [6].

The aim of this research was to investigate the decay resistance of Maple (Acer insigne), in two forms of natural (without using preservative materials) and treated with Acid-Cupper-Chromic (ACC) against white rot (Coriolus versicolor) destructive fungus.

Materials and methods

Three maple trees were randomly selected from Chaloos forest (Shahchesme region) and cut down. Age ranged from 20 to 25 years old and mean diameter at breast height (DBH) was 15.3cm when all trees were considered. Wood samples were cut from slices of heartwood removed at a height of 1.3 m in the tree stem. The exact location of each wood sample, according to its position in the stem, was recorded by measuring its cambial age and the distance from the pith. A total of 240 wood samples were used to evaluate natural durability, hardness and compressive strength parallel to grain of wood (according to DIN 52176 and B.S. 838: 1961 standard). Measurement of resistance to pathogen attack Natural durability tests were carried out using the European standard NF-EN 350-1 guidelines (AFNOR 1994).

Coriolus versicolor, a white rot were used to test natural durability. Fungi were inoculated in malt agar medium in sterilized glass jars, until the fungal mycelia had completely covered the surface of the medium, a procedure which took approximately 15 days. 120 samples were impregnated with 3% concentration Acid –crome- crommat (ACC), using Bethell method.

Decay resistance measurements

Two blocks of wood, which had been removed side by side from the stem, were dried to 12% moisture content and weighed (Mi) before placing them in the jars (kolle). Samples were left in a growth chamber for 14 weeks, at a temperature
Of 22°C and 75% humidity. After 14 weeks, treated and untreated samples were removed from the glass jars and the mycelia present on the samples scraped off the wood surface. The treated and untreated samples were then dried at 103°C for 48 h and weighed (mass $M_f$). The difference in mass, $M_m$, between $M_i$ and $M_f$ was then calculated using

$$MM = \frac{MS - M_f}{MS}$$

Where $MS$ is the supposed dry mass of the sample before fungal attack, and is calculated using $MS = K \times M_i$, $K$ is a coefficient allowing the estimation of theoretical dry mass of samples before fungal attack. $K$ was calculated for the series of control wood samples identical to those used for testing, but which were not subjected to fungal attack.

$$K = \frac{Ma}{M12}$$

Where $Ma$, dry mass (g) of the control samples; $M12$, mass (g) of control samples dried to 12% moisture content.

In order to rate the natural durability and decay resistance of wood, the percentage reduction in mass of a sample must be calculated. Depending on this mass loss, a durability score (Table 1) is given to the wood using European standard NF-EN 350-1 guidelines (AFNOR 1994). Analysis of variance was used to determine if differences in fungal attack occurred between with regard to treated type (treated, untreated).

**Table 1** Natural durability of wood is rated from very to not durable, according to the percentage reduction in mass after fungal attack (European standard NF-EN 350-1 guidelines (ANFOR 1994))

<table>
<thead>
<tr>
<th>Durability rating</th>
<th>Description of durability</th>
<th>Reduction in mass $x$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very durable</td>
<td>$x \leq 5$</td>
</tr>
<tr>
<td>2</td>
<td>Durable</td>
<td>$5 &lt; x \leq 10$</td>
</tr>
<tr>
<td>3</td>
<td>Moderately durable</td>
<td>$10 &lt; x \leq 20$</td>
</tr>
<tr>
<td>4</td>
<td>Slightly durable</td>
<td>$20 &lt; x \leq 30$</td>
</tr>
<tr>
<td>5</td>
<td>Not durable</td>
<td>$x &gt; 30$</td>
</tr>
</tbody>
</table>

**Compressive strength (parallel to grain)**

Compressive strength (parallel to grain) of 60 samples (60*20*20mm) were measured with Instron machine. Maximum compressive stress (parallel to grain) of samples was computed with this equation:
\[ \sigma u = \frac{pu}{A} \]

Where:

- \( \sigma u \): Maximum compressive stress \( \text{\( N/m^2 \)} \)
- \( pu \): Maximum force at failure time (N)
- \( A \): samples surface area \( \text{\( m^2 \)} \)

**Hardness strength**

Hardness of 60 samples (15*20*50mm) were measured according to DIN 52176 standard with Instron machine.

**Result and discussions**

**Weight loss**

Significant differences were observed in Weight loss of treated and untreated samples so that treated maple wood samples subjected to the white rot were rated as durable, and untreated were not durable.

Table 2 shows the mycelium covered (%), weight loss and Wilitnner criterion. The mycelium percentage of fungus was low at treated samples.

**Table 2. Average of hyph cover percentage after 14 week decay**

<table>
<thead>
<tr>
<th>Standard deviation</th>
<th>WILLEITNER criterion</th>
<th>Weight loss (%)</th>
<th>cover of HYPH (%)</th>
<th>number of samples</th>
<th>state</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3</td>
<td>a</td>
<td>44.38</td>
<td>90</td>
<td>30</td>
<td>untreated</td>
</tr>
<tr>
<td>4.6</td>
<td>a</td>
<td>9.22</td>
<td>5</td>
<td>30</td>
<td>treated</td>
</tr>
</tbody>
</table>
Strength properties
There was significant difference in reduction of hardness & compressive strength between treated and untreated rotten samples at 5% level. The result show that these strengths were increase when samples treated with 3% concentration ACC as also shown by Parsapaguh(1999).

Fig 1 – hardness strength of samples at different state

Fig 2 – compressive strength (parallel to grain) of samples at different state
The strength of rotten treated samples related to the untreated without decay is similar so impregnation of maple wood (*acer insigne*) with this kind of waterborne preservative material (ACC) can increase decay resistance and natural durability and also conversion the undurable sample to durable.

*Acerc insigne* (non durable species) are recommended for furniture and other indoor structures and when it treated with ACC (durable species) can be used as alternatives to the durable primary wood species like Oak in building, permanent structures and in outdoor structures. It is very important for this timber species to be subjected to field trials to confirm these results.

**References**

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