Changes in the modulus of elasticity of beeswax impregnated wood during soil contact
The demand for timber is continually increasing, especially in slower growing hardwood and tropical species. Such species often offer a greater durability and higher aesthetic qualities than many of the faster growing softwood species.

http://www.golfrribute.com/shop/soft-touch-brass-flange/


http://sterrittlumber.com/product_category/poplar
It is well known that there are grave ecological and environmental concerns over current ‘virgin timber’ demands, and various attempts are underway to prevent the demise of many of the biologically diverse regions where these timbers originate.
A greater emphasis is now being placed in sustainable harvesting of timber species, though the slow growth of many species means a slow turnover in materials and profits. Thus it is necessary to encourage the use of faster growing timbers which may be readily gained from such sustainable plantations.

But the durability of these materials is usually very low.
• Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials.

• Apart from the risks involved in using such materials for treatments, there is increasing concern over the problems arising in the disposal of the timbers after the end of their commercial lifetime.

The advantage of beeswax is its biological origin and its nontoxic nature, but it is in general not biologically stable.

Beeswax is often used as conservation agent for wooden artifacts → under appropriate conditions beeswax is suitable for wood protection

Water repellent

Another advantage of wax impregnation is the improvement of mechanical properties (e.g. hardness)

Effectiveness of beeswax impregnation against the degradation of less durable wood materials?

http://webaruhaz.medinatural.hu/termek/tisztitott_mehviasz_lapok_125g.html
Materials and Methods

- Focus on hardwood species (resistance class 5, easy to impregnate)
- Plantation grown timber → poplar (*Populus × euramericana* cv. Pannonia)

http://www.woodanatomy.ch/

www.abh-system.hu
• Commonly used timber → beech (*Fagus sylvatica*)

http://www.woodanatomy.ch/

Materials and Methods

- Impregnation at 80°C (over melting point)
- Sample MC: 0%
- Samples separated to 3 groups according to the calculated degree of pore saturation (DPS)

<table>
<thead>
<tr>
<th>Group</th>
<th>Poplar1</th>
<th>Poplar2</th>
<th>Poplar3</th>
<th>Beech1</th>
<th>Beech2</th>
<th>Beech3</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPS (%)</td>
<td>20-40</td>
<td>40-55</td>
<td>55-70</td>
<td>60-75</td>
<td>75-90</td>
<td>90-100</td>
</tr>
</tbody>
</table>
Materials and Methods

Bending Test

• Standard 3-point bending method was used.
• Sample dimension was 20×20×300 mm.
• Modulus of elasticity (MOE) was determined before soil contact both on the unimpregnated and impregnated samples.
  • MOE was determined at a defined load. 400N for poplar and 600N for beech.
• After 1 month in soil MOE determination with the same loads
• After 18 months in soil MOE determination with 300N load for poplar and beech as well.
Materials and Methods

• Laboratory conditions (based on ENV 807/2001).
• Soil in plastic boxes → samples into soil to a depth of its 2/3 length.
• Boxes were seal up with plastic foil.
Results – visual inspection

Unimpregnated (left) and impregnated (right) poplar samples after 18 months

**Unimpregnated**
- completely decayed
- cross sections decreased markedly

**Impregnated**
- only surface decay could be observed
- cross sections remained almost unchanged
Results – MOE

MOE of poplar and beech samples in the investigation periods

- Initially, MOE increased markedly, depending on the impregnation efficiency (theoretical maximum of MOE)
- A strong decrease (30 to 60%) in the MOE after 1 month of soil contact
- Increase in the moisture content - MOE under utilization conditions
- No fungal decay visible
Results – MOE

MOE of poplar and beech samples in the investigation periods

- Untreated beech and poplar specimens lost their load-bearing capacity completely
- Some load-bearing capacity of the impregnated beech and poplar specimens remained
- Higher DPS for both beech and poplar specimens resulted in a higher MOE
MOE decrease of beech and poplar samples after 18 months

- Compared to the absolute dry state, after 18 months of soil contact exposure, the MOE of beech and poplar wood decreased from 65 to 80% and from 50 to 60%, respectively.
- But in opposition with the untreated wood, remarkable load bearing capacity remained.
Beeswax in the cell lumens of poplar wood

Results – SEM

Lumen filling

Only on the lumen surface
Hyphae in a beeswax free cell lumen of poplar wood

- The areas with proper impregnation of the lumens were untouched by decay
- If there was one or more empty vessel near the filled vessels, the hyphae could have spread through the cell walls in the direction of the impregnated cells and started the decomposition
Conclusions

• Beeswax impregnation increased MOE of beech and poplar wood
• Unimpregnated beech and poplar samples were decomposed completely during the 18 months soil contact.
• Damage of the impregnated samples was significantly lower.
• Remarkable remaining MOE of impregnated samples after exposure.
Conclusions

• Higher DPS resulted in lower decrease of the MOE during the investigated period.

• Beeswax fills the lumens and separates the most of the cell walls from the hyphae, which slows the spreading of the fungi in the wood.

• Beeswax impregnation could only slow the decay.

• Promising environment friendly preservation method for wood, but mainly for applications without soil contact.
Thank you for your attention!

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