



NYUGAT-MAGYARORSZÁGI EGYETEM
SIMONYI KÁROLY MŰSZAKI, FAANYAGTUDOMÁNYI ÉS MŰVÉSZETI KAR

**MODIFICATION METHODS OF HORNBEAM (*CARPINUS BETULUS* L.)
WOOD IN ORDER TO ACHIEVE HIGH-QUALITY PRODUCTS**



MODIFICATION METHODS OF HORNBEAM (CARPINUS BETULUS L.) WOOD IN ORDER TO ACHIEVE HIGH-QUALITY PRODUCTS

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ACCSYS
TECHNOLOGIES

accoya 



OVERVIEW

1. About
hornbeam

2. Possibilities
and our
results

3. Ideas and
further
research



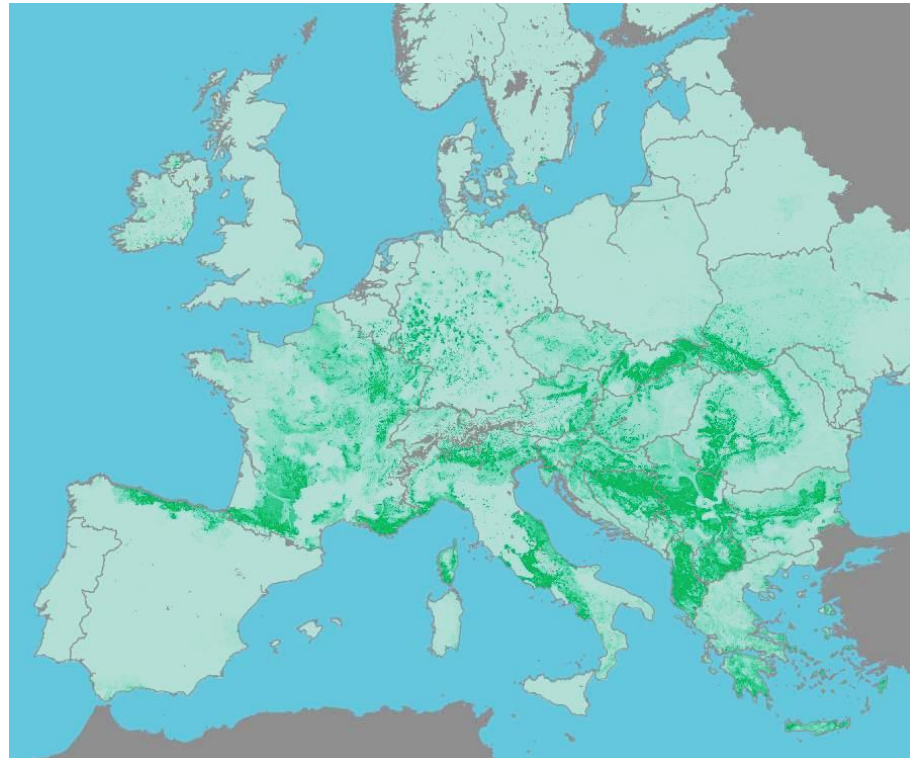
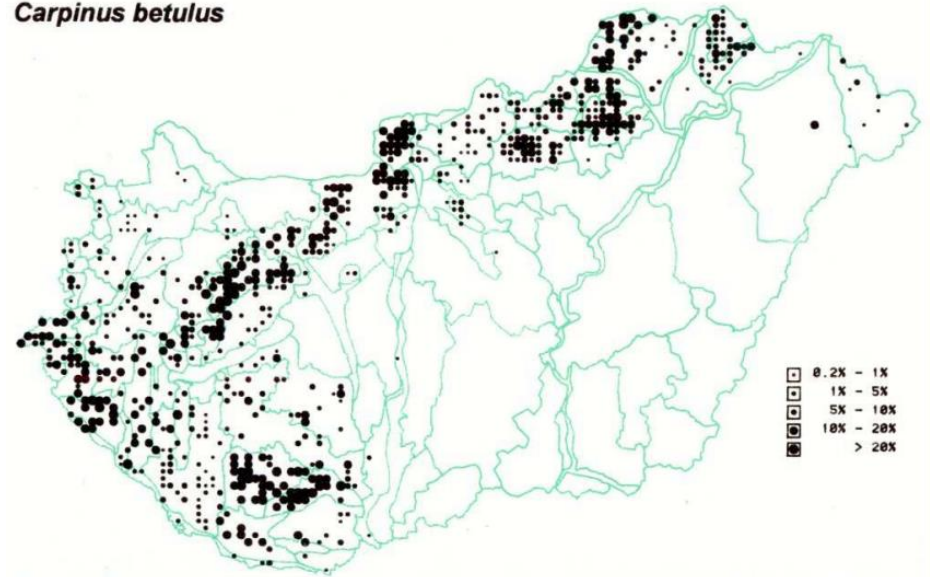
1. ABOUT HORNBEAM

5.22% of the forested area in Hungary
(about 111,806 ha)

Subsidiary next to beech and sessile oak

Harvested after 60 to 80 years

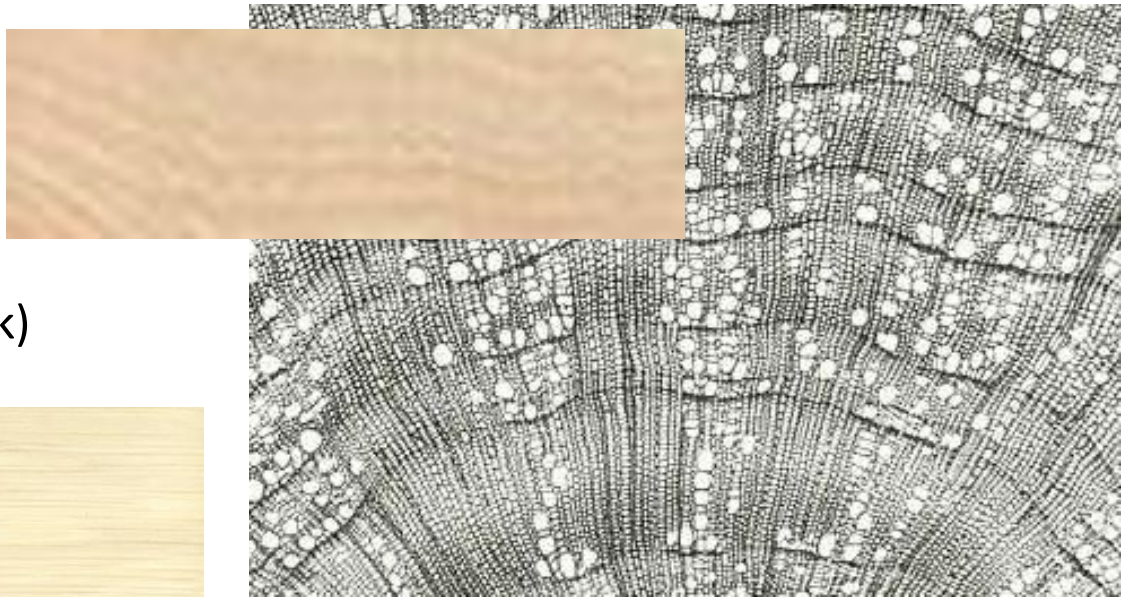
Carpinus betulus





1. ABOUT HORNBEAM

- No heartwood
- Greyish yellowish white color
- Plain structure
- Diffuse pores
- Wavy annual rings (ridged trunk)



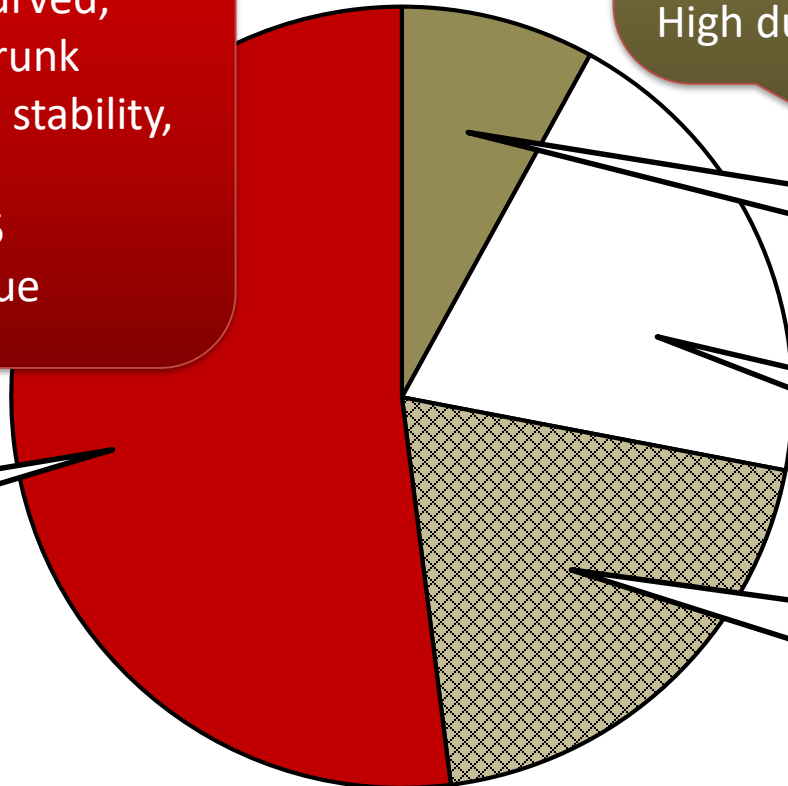


1. ABOUT HORNBEAM

Hornbeam assortments:

Wood defects: curved, twisted, ridged trunk
Low dimensional stability, high EMC
Durability Class 5
High calorific value

Firewood
52%



High-density and wear-resistance
Outstanding hardness and strength properties
High proportion (66%) of very long (2.3mm on average) and thick-walled fibers
High durability indoors

Logs, sawn wood
8%

Pulp and paper
20%

Fiber and particle raw material
20%



1. ABOUT HORNBEAM

Hornbeam products:



Tool handles



High-density and wear-resistance
Outstanding hardness and strength properties
High proportion (66%) of very long (2.3mm on average) and thick-walled fibers
High durability indoors



Parquet





1. ABOUT HORNBEAM

Hornbeam products:



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High durability indoors



Turned products

Carved products





1. ABOUT HORNBEAM

Hornbeam products:

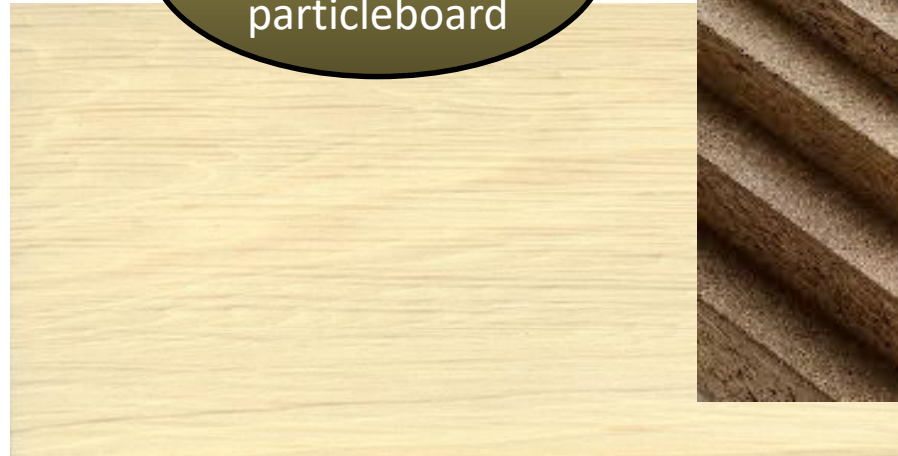


High-density and wear-resistance
Outstanding hardness and strength
properties

High proportion (66%) of very long
(2.3mm on average) and thick-walled
fibers

High durability indoors

Veneer,
fiberboard,
particleboard





1. ABOUT HORNBEAM

Hornbeam products:

High-density and wear-resistance
Outstanding hardness and strength properties
High proportion (66%) of very long (2.3mm on average) and thick-walled fibers
High durability indoors



Toys





1. ABOUT HORNBEAM

Hornbeam products:



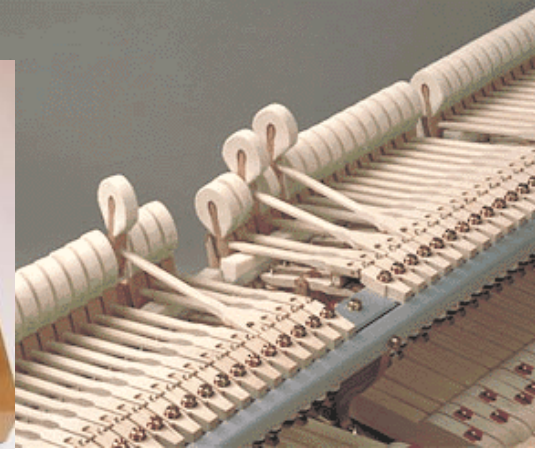
High-density and wear-resistance
Outstanding hardness and strength properties

High proportion (66%) of very long (2.3mm on average) and thick-walled fibers

High durability indoors



Other accessories





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Heat treatment: similar studies

Heat treatment of hornbeam at different temperatures (130 to 210 °C) and treatment times (3 to 12 hours).

- ✓ Decrease of radial and tangential shrinkage
- ✓ Greater dimensional stability
- ✓ Lower water absorption
- ✓ Darker color

- x Decrease in density
- x Appearance of visible and internal cracks
- x Decrease in mechanical properties: compression strength, Janka hardness, Brinell hardness, bending strength, modulus of elasticity, shear strength
- x Lower embedded force in case of dowel welding



2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Heat treatment: Uni Sopron

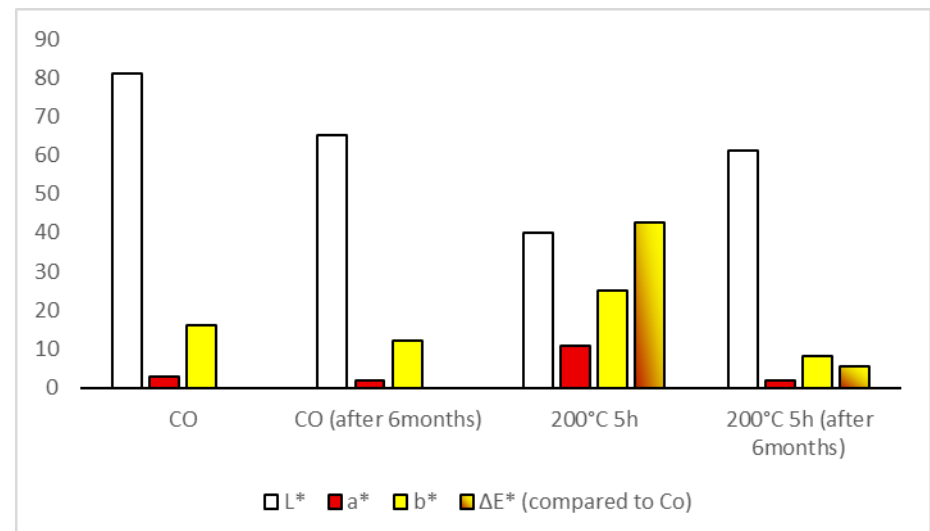
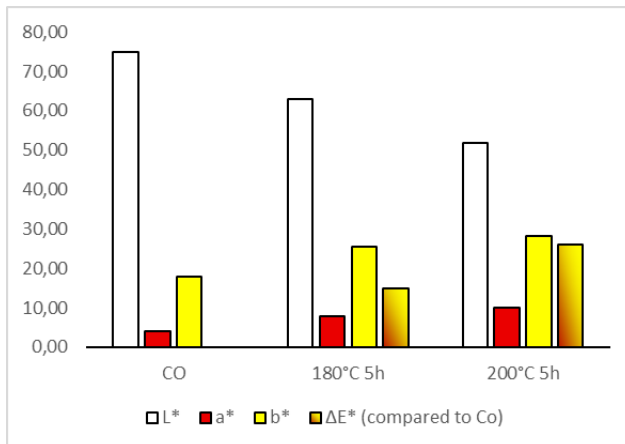
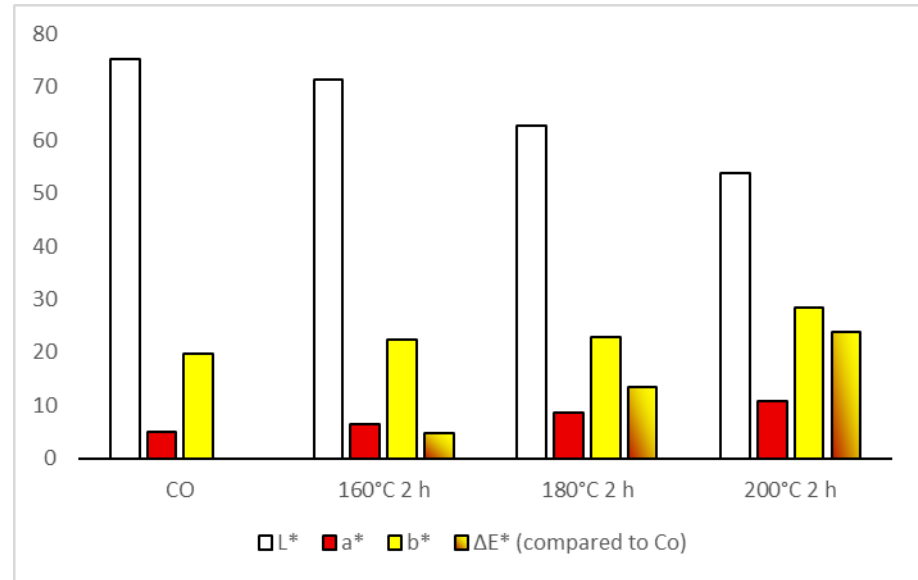
Scientific studies at the Institute of Wood Science (University of West Hungary in Sopron): Student Bachelor and Master Thesis, PhD thesis, and project reports as well.

Aranyosi (2014), Polyucsak (2014), Csizmadia (2015)

Decrease of L^* , increase of a^* , b^*

Increase of color difference

Not resistant to photodegradation





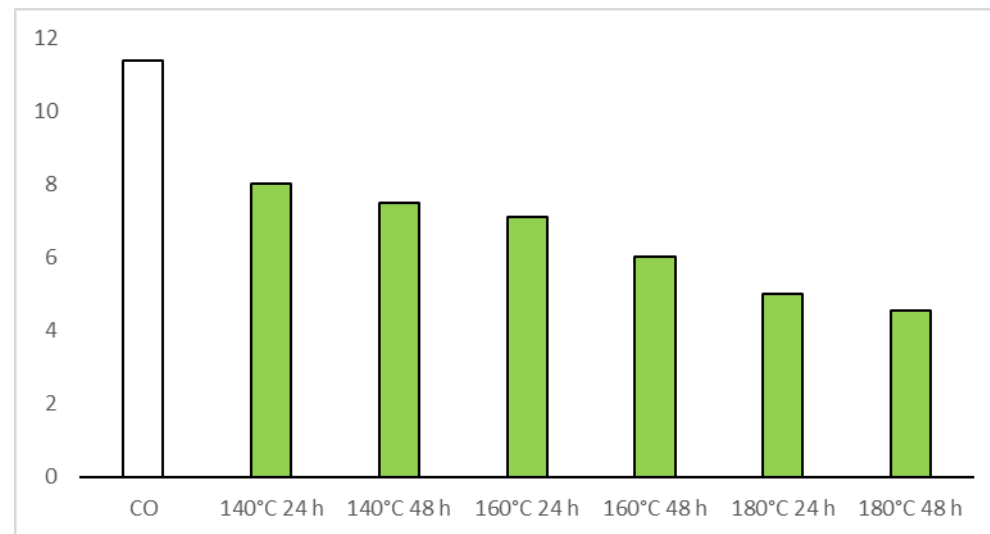
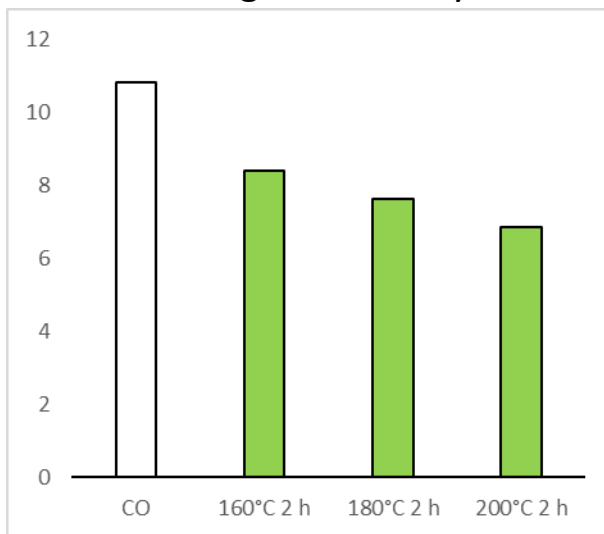
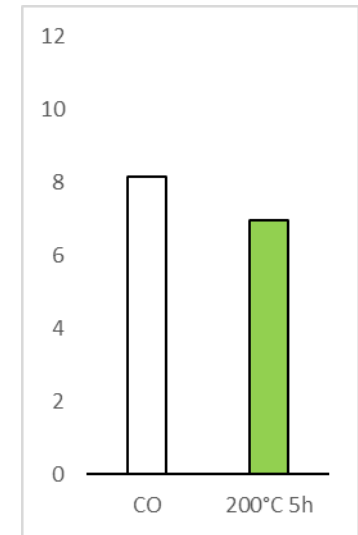
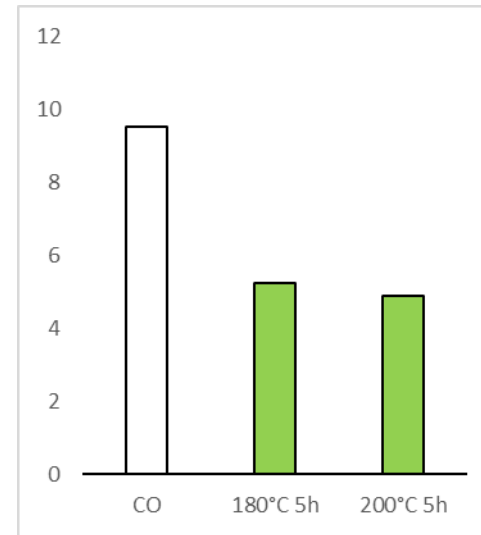
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Heat treatment: Uni Sopron

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Aranyosi (2014), Puskás (2006), Polyucsak (2014), Csizmadia (2015)

Decrease of EMC, swelling and density





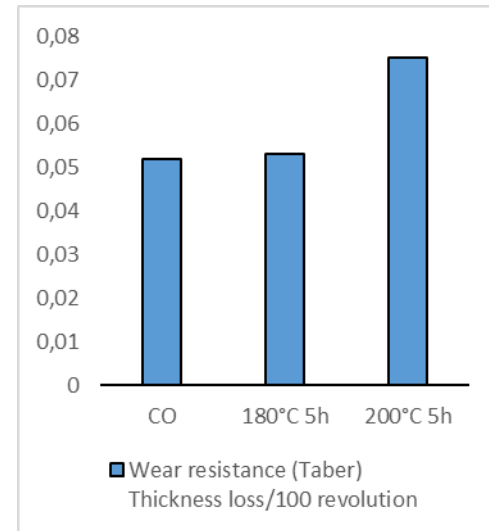
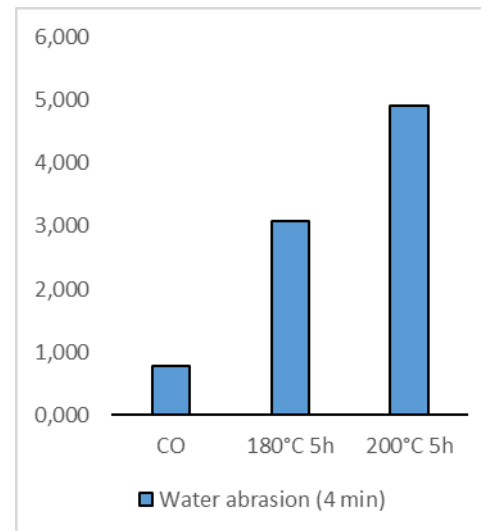
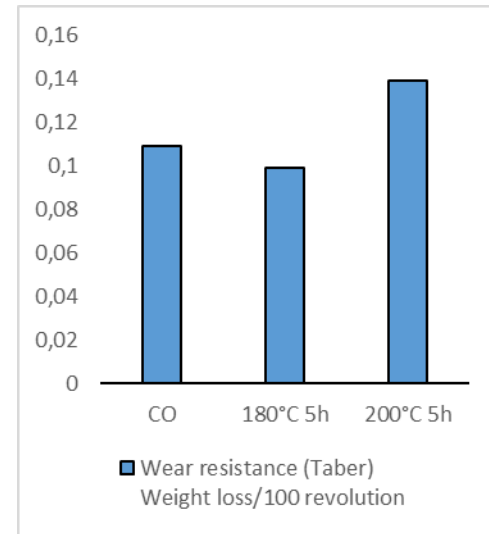
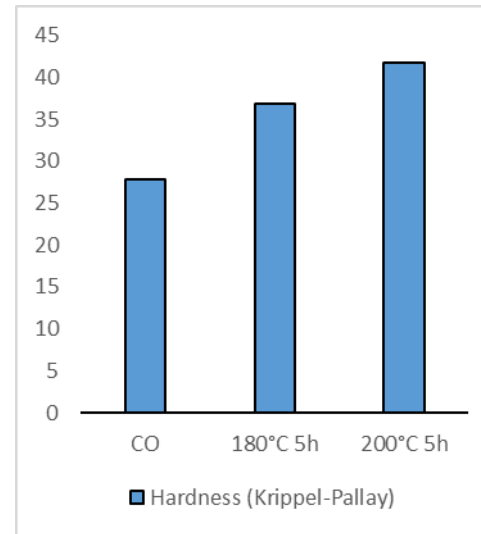
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Heat treatment: Uni Sopron

Scientific studies at the Institute of Wood Science (University of West Hungary in Sopron): Student Bachelor and Master Thesis, PhD thesis, and project reports as well.

Aranyosi (2014)

Increased Krippel-Pallay hardness
Lower wear resistance and water abrasion resistance





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Heat treatment: Uni Sopron

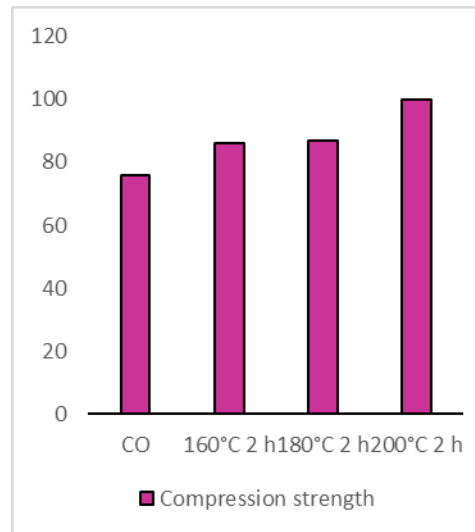
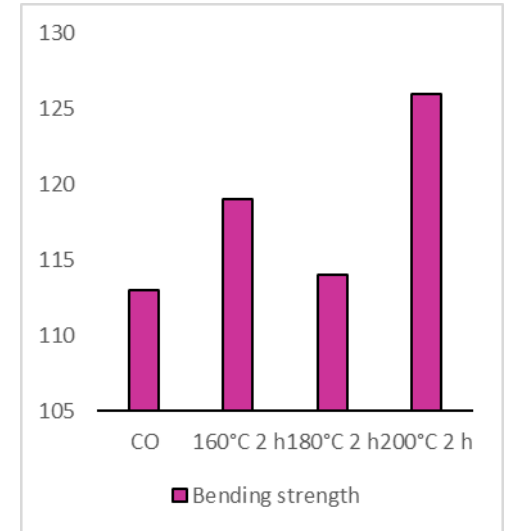
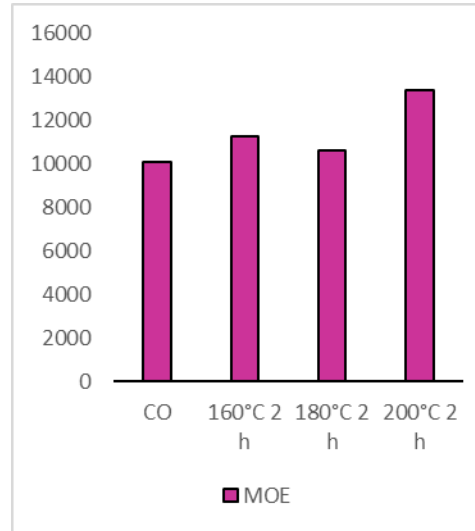
Scientific studies at the Institute of Wood Science (University of West Hungary in Sopron): Student Bachelor and Master Thesis, PhD thesis, and project reports as well.

Csizmadia (2015)

Increased durability on soil contact

Untreated: Class 2-4

Heat-treated (200°C 5h): Class 1-2



Polyucsak (2014)

Increased bending strength, MOE and compression strength



2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Heat treatment: Uni Sopron

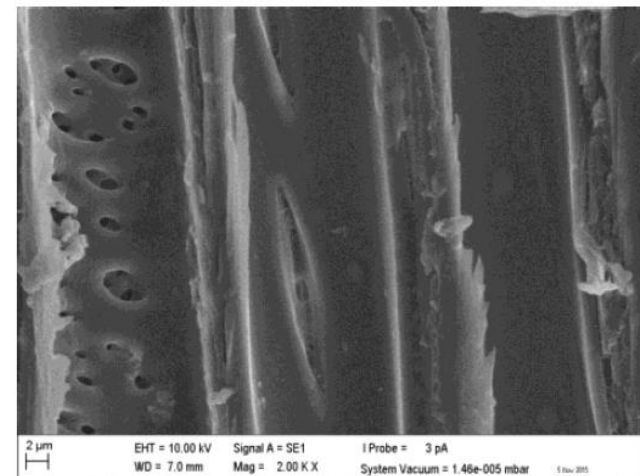
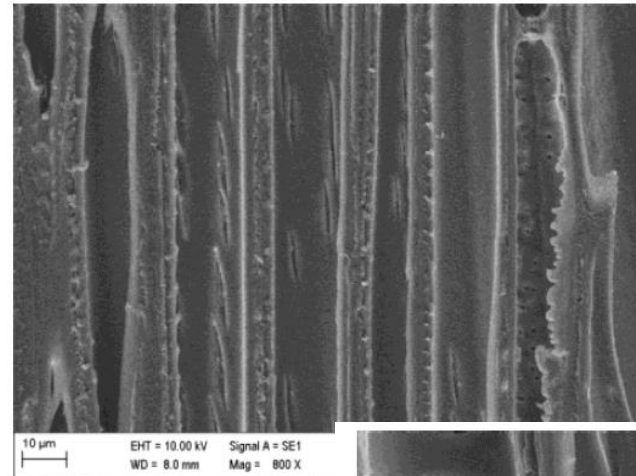
Scientific studies at the Institute of Wood Science (University of West Hungary in Sopron): Project report

Horváth et al. (2016)

Cooperation between Göttingen University

Analysis of structural and chemical changes of xylem in case of dry heat treatment at 200°C, and heat treatment in closed reactor system at 145-175°C and 90%RH

Almost no cracks or defects observed after treatment
Chemical analysis with FTIR





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Oil-heat treatment: Uni Sopron

Scientific study at the Institute of Wood Science (University of West Hungary in Sopron): Student research work

Bak et al. (2015)

Heat-treatment at 200°C for 6 hours
in linseed oil

Samples were of 3 different moisture state (0%, 12%, green)

Cracks only appeared in radial direction

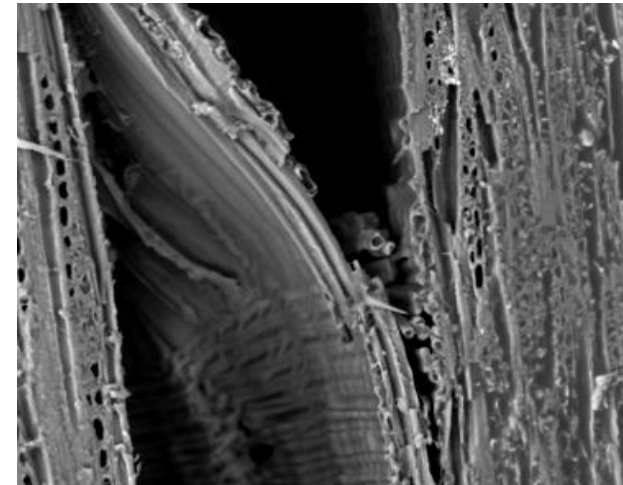
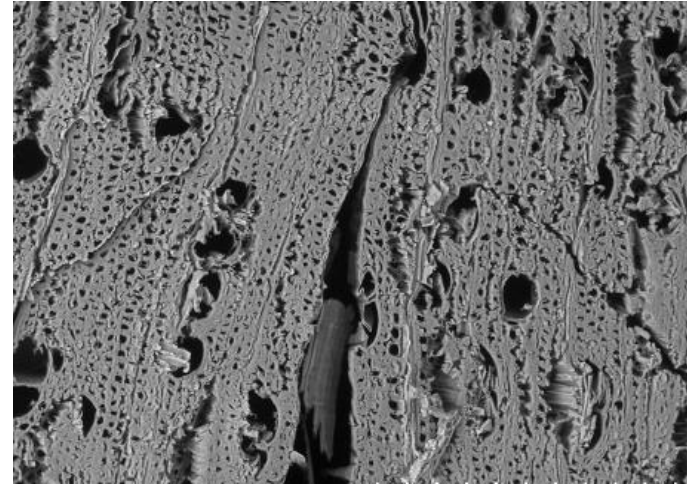
Some of them were visible to the naked eye

Mostly located in the cumulative rays between the single cells, along the middle lamella

No damage of vessels

The higher the initial moisture the bigger and more frequent appearance of cracks

The cross sections were rather curved





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

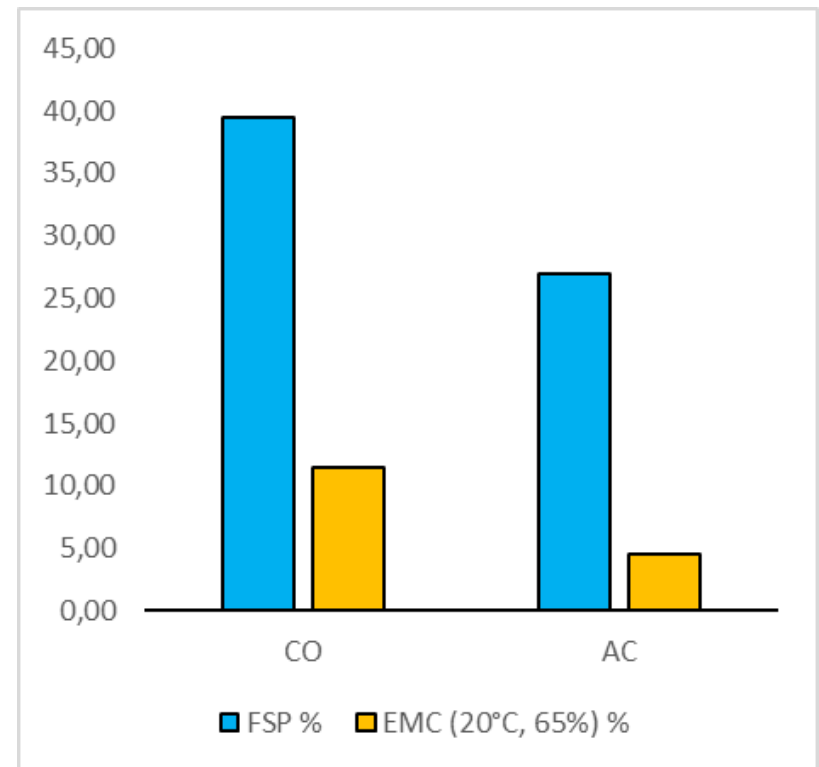
Acetylation: Uni Sopron

Scientific study at the Institute of Wood Science (University of West Hungary in Sopron): Student thesis

Fodor (2015)

Acetylation under industrial conditions
(Accoya method)

- ✓ Lower water uptake, EMC, FSP
- ✓ Lower shrinkage
- ✓ Increased density
- ✓ Increased durability against *Coniophora puteana*, *Poria placenta* and *Coriolus versicolor* (massloss under 1% after 16 weeks)





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

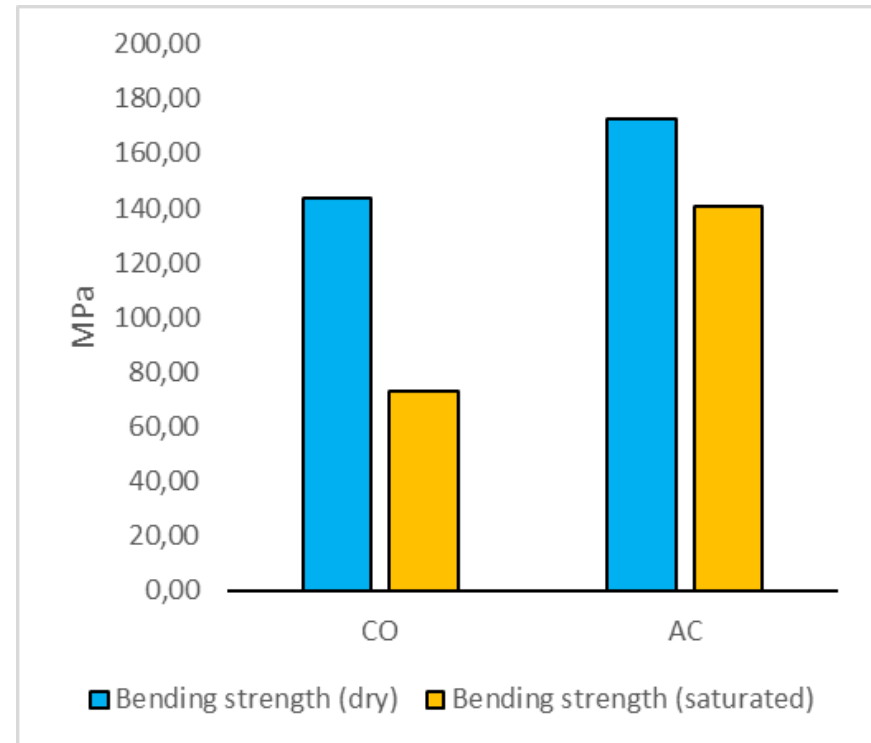
Acetylation: Uni Sopron

Scientific study at the Institute of Wood Science (University of West Hungary in Sopron): Student thesis

Fodor (2015)

Acetylation under industrial conditions
(Accoya method)

- ✓ Increased Janka and Brinell hardness in dry and also in saturated state
- ✓ Increased compression strength
- ✓ Increased bending strength and MOE in dry and also in saturated state
- ✓ Increased impact bending strength





2. POSSIBILITIES TO ACHIEVE BETTER PROPERTIES

Acetylation: Uni Sopron

Scientific study at the Institute of Wood Science (University of West Hungary in Sopron): Student thesis

Fodor (ongoing)

Acetylation under industrial conditions
(Accoya method)

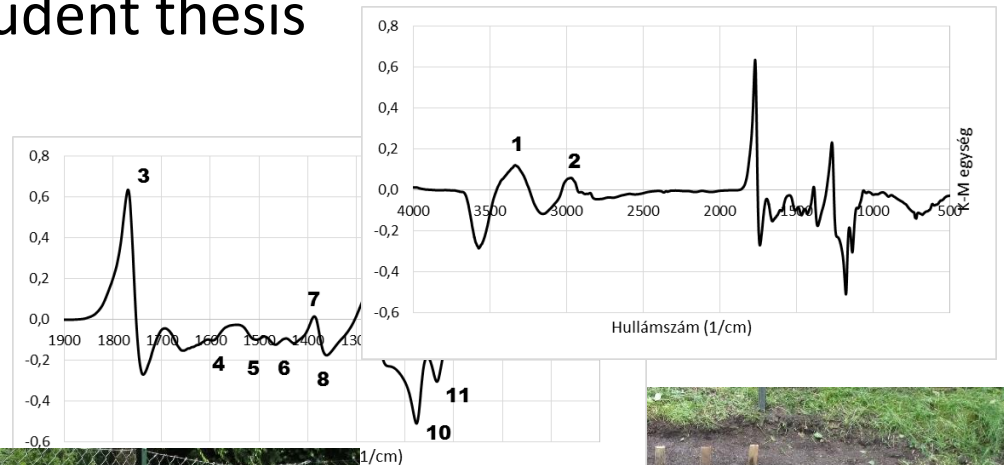
Determination of chemical components

Chemical analysis with FTIR

Durability on soil contact

Durability without soil contact

(photodegradation)





3. IDEAS AND FURTHER RESEARCH

To be continued...

- Find higher quality hornbeam material with less defects
- Try other modification methods
- Evaluate existing results and optimize treatment parameters
- Present results and possible product groups for the market and industry
- Establish student research topics (thesis): wood testing, wood design, wood market
- Make cooperations with manufacturers in order try these new materials
- Life Cycle Assessment
- ... other ideas?





Thank you for
your attention!