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11TH HARDWOOD CONFERENCE PROCEEDINGS

Róbert Németh, Christian Hansmann, Holger Militz, Miklós Bak, Mátyás Báder

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Editors: Róbert Németh, Christian Hansmann, Holger Militz, Miklós Bak, Mátyás Báder

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Formaldehyde emission from wood and wood-based products

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ABSTRACT

Actors of timber industry are in continuous search of solutions to satisfy the industry's demand for raw materials. In addition to cross breeding of cultivars, a possibility to solve this is the use of new wood species, a raw material base of which may be the use of invasive wood species. An indispensable prerequisite of their introduction to industrial use is the knowledge of the properties of their timbers, which must nowadays also include their formaldehyde content, due to the increasingly stringent health and safety requirements. Of the invasive wood species, the use of green ash, tree of heaven, box elder, Siberian elm, black cherry in timber industry sees no restrictions related to strength properties, but their formaldehyde release must also comply with the provisions of the corresponding regulations.

INTRODUCTION

Climate change puts our indigenous wood species in a constantly changing situation. Over the recent decades, professionals were faced with increasingly aggravated challenges of drought, and these meteorological parameters have also contributed to the spread of the invasive wood species already present in Hungary. These invasive species have a significant transforming influence on indigenous flora, in addition to other, mostly negative effects. The majority of the invasive species are among woody plants, and efforts are made worldwide to restrict their spread, although little (Figure 1) or no information is available on the suitability of their timbers for industrial processing (Varga and Komán 2019).

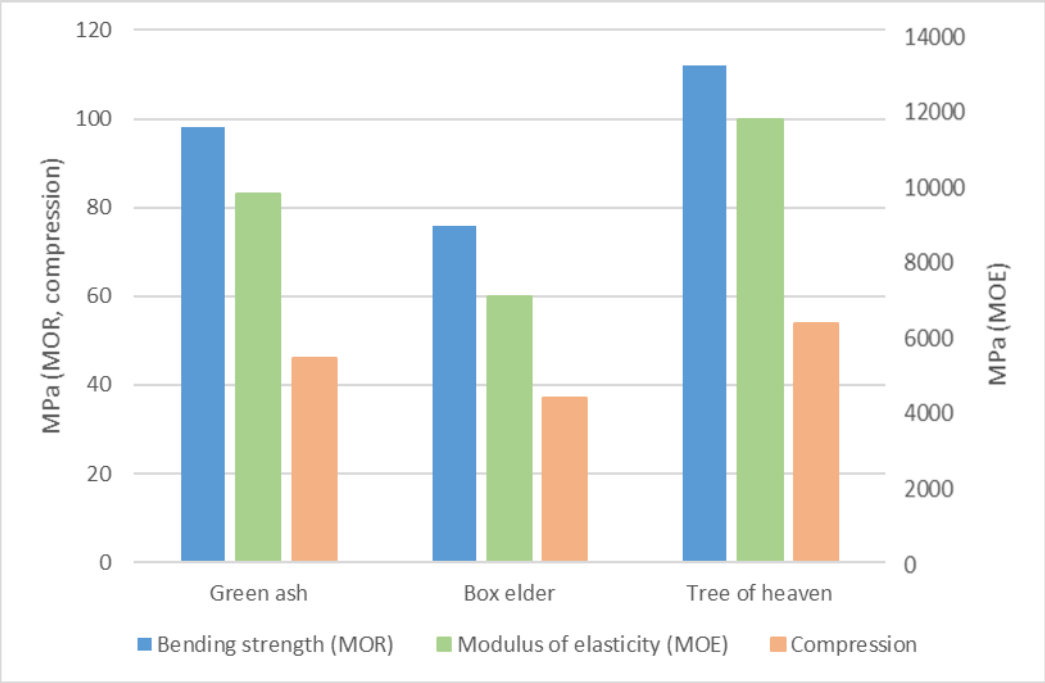

Figure 1: Strengths of the wood species (Varga and Komán 2019)

Their overwhelming propagation, outperforming that of the indigenous species in the recipient ecosystems is related among others to their growth rate, age of maturity, fertility and the spread of their speeds and pollens (Poré 2011). The most important parameter that decides the suitability of the timber of a wood species for industrial use is its density. "Denser species tend to have stronger wood than lighter ones. Knowing the value of the density is important, for example, for determining the wood chip's bulk density in cellulose or chipboard production." (Varga and Komán 2019)

In Hungary one of the most widespread (Figure 2.) invasive species is tree of heaven (*Ailanthus altissima*). Its genus has become established from Middle East to Australia, the species being originally native to central and eastern China and Korea. The tree is of medium size (-25 m), with diffuse foliage and a straight trunk, this latter covered by smooth, grey bark. As for its ecological characteristics, it tolerates warmth, has a particularly high light requirement, medium water requirement and prefers soils rich in lime, with low salt tolerance (Bartha 2012). It grows and spreads rapidly, and once it appears somewhere, it is particularly challenging to exterminate due to its aggressive suckering. The density of tree of heaven ranges between 537-617 kg/m^3, its modulus of elasticity is 10480 MPa, and has a bending strength of 81.36 MPa (Fehér and Komán 2014). International research has reported rather positively on its timber, and is considered a material of good quality based on its mechanical and physical properties (Panayotov et al. 2010). *„Test results unambiguously indicate that the technical parameters of tree of heaven wood is significantly influenced by its growth zone. Occasionally, it may yield lower grade timber in a growth zone of lower quality, where the wood's density would be around 600 kg/m^3. In contrast to this, wood from circumstances closer to optimal may exceed 700 kg/m^3."* (Fehér and Komán 2014) The durability of tree of heaven is particularly low, and is therefore not recommended for outdoor applications, but there are virtually no limits to its indoor use.

Figure 2: The presence of tree of heaven in Hungary (Fehér and Komán 2014)

In the Great Hungarian Plain, two intensive spreading invasive species are black cherry (*Padus serotina*) and Siberian elm (*Ulmus pumila*). Black cherry was primarily imported to Hungary to combat desertification in the Great Plain. It is native to the eastern part of North America and the mountainous regions of Mexico, all the way to Guatemala. As for its ecological characteristics, it requires moderate light- and heat, it is moderately drought resistant and is indifferent to the soil's acidity or basicity. It grows to medium height (-15 m) and has a good sprouting ability (Bartha 2012). Its habitat is originally a forest culture, occupying the subcanopy or shrub level in it. Its aggressive spread may cause it to compete with the wood species forming the population, endangering the renewal of indigenous wood species. Its morphological characteristics limit its industrial use to sawlogs (Nagy et al. 2016).
Siberian elm was brought to Hungary from Central and East Asia, primarily due to it immunity to Dutch elm disease (DED) caused by sac fungi. Unfortunately, it was subsequently proven that this immunity was far from being impenetrable. It prefers warmth and neutral soils, is moderately shade tolerant, and

drought and salt resistant. It grows to medium height (-15 m) and sprouts particularly well from stumps (Bartha 2012). As for its habitat, similarly to black cherry it also grows in forest cultures, and can also be found as an accompanying wood species or at the edges of populations. Resulting from the limited supply and morphology of its timber, its industrial use is marginal. When available in forestry product ranges, it may be used for sawlogs, custom sawing and strutting applications (Nagy et al. 2016).
Densities of black cherry and Siberian elm are 651 kg/m^3 and 633 kg/m^3 respectively. Modulus of elasticity of black cherry and Siberian elm are 9873 MPa and 8147 MPa. Both species are suitable for the production of interior design wood products, furniture and builders' joinery and carpentry (cabinets, seating furniture and internal doors), where aesthetic appearance is key. The two wood species are suitable for use in the timber industry (Figure 3.), but their morphological properties limit their respective yields (Nagy et al. 2016).

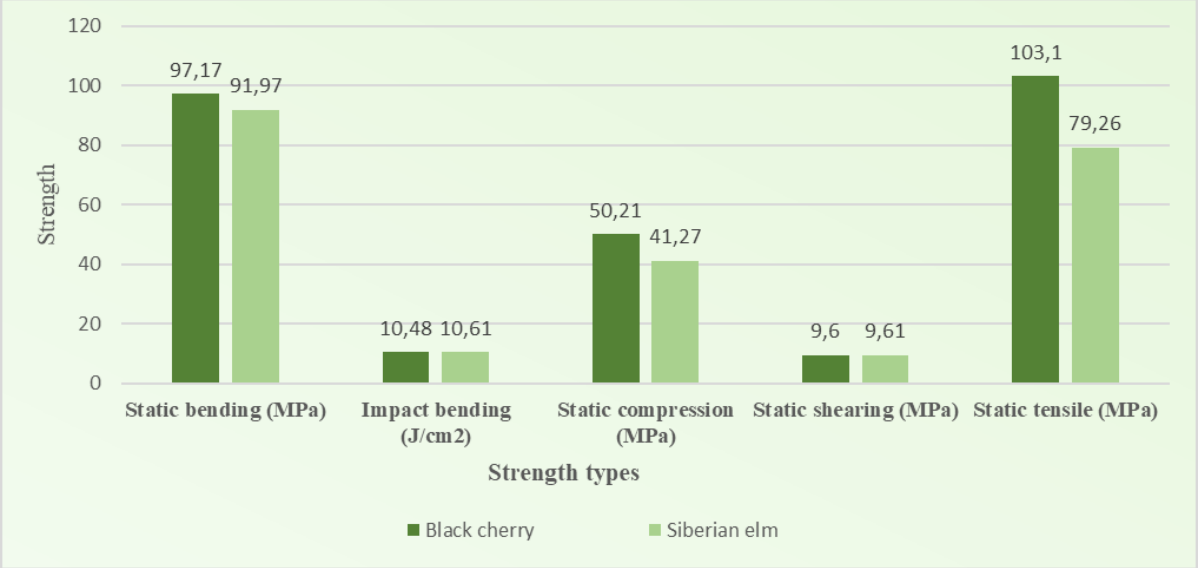

Figure 3: Strength properties of the wood species examined (Nagy et al. 2016)

Besides density, another important factor is the wood's formaldehyde content. Formaldehyde is an organic compound, in gaseous state at room temperature, it is colourless and has a pungent odour, and is quite abundant in nature. *„Formaldehyde is the most common harmful substance that evaporates from wood and wood-based construction raw materials."* (Patkó and Pásztory 2013)

Wood-based construction materials are used both indoors and outdoors, and is an adhesive (as artificial resin) for plywood, furniture and other wood-based products. To make furniture and interior design elements from wood, the material must meet several requirements, one of the most important being its formaldehyde content. At present, this may be examined in Hungary according to six standards, strictly under laboratory conditions, with predetermined apparatuses and materials. These standards are:

- MSZ EN 717-1:2005 Wood-based panels. Determination of formaldehyde release. Part 1: Formaldehyde emission by the chamber method
- MSZ EN ISO 12460-3:2021 Wood-based panels. Determination of formaldehyde release. Part 3: Gas analysis method (ISO 12460-3:2020)
- MSZ EN ISO 12460-5:2016 Wood-based panels. Determination of formaldehyde release. Part 5: Extraction method (called the perforator method) (ISO 12460-5:2015)
- MSZ EN ISO 12460-4:2016 Wood-based panels. Determination of formaldehyde release. Part 4: Desiccator method (ISO 12460-4:2016)
- ASTM D6007-14 Standard test methods for determining formaldehyde concentration in air from wood products using a small scale chamber

Commission Regulation (EU) 2023/1464 of 14 July 2023 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards formaldehyde and formaldehyde releasers. This regulation provides that no products may be released for commercial

circulation after 6 August 2026 whose formaldehyde concentration exceeds 0.062 mg/m^3 and 0.080 mg/m^3 in wood-based furniture and non-furniture products respectively (fatáj.hu 2024).

CONCLUSIONS

The invasive species of green ash, tree of heaven, box elder, Siberian elm and black cherry are worthy of industrial use based on their strength properties, but their aggressive spread endangers our currently dominant natural indigenous vegetation associations. When using their timber, the provisions of the EU regulations on the formaldehyde contents of the furniture and wood-based products made from them must be taken into consideration. The various timber modification procedures may change the formaldehyde content of timber, which may make it easier or harder for the end product in question to comply with the applicable limit.

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