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Laccase mediator systems trigger oligomerization of phenolic extractives for improved mechanical properties of fiberboards

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PURPOSE OF THE ABSTRACT

Laccases (benzenediol?oxygen oxidoreductase, EC 1.10.3.2) belong to a broad group of enzymes called polyphenol oxidases. In nature, laccases are found in plants, fungi, bacteria and insect. Higher fungi are the main source of today's commercial laccases, and the vast majority of these fungi secrete them into the extracellular environment, where they grow onto lignocellulosic substrate. Laccases have been used as biological tools for lignocellulosic biomass delignification and for broader applications, especially the modification/functionalization of lignocellulosic-derived materials.

Wet-process hardboards are currently one of the main types of fibreboards commonly used in furniture. They are made from the composite produced by hot-pressing wood-fiber webs. The modification of lignocellulosic material with fungal laccases pre-treatment prior to hot-pressing is one of the potential alternatives how to improve the hardboard performance and propose more energy-friendly technological process on-site to existing ones.

In this work, the laccase pretreatment of wood fibers was tested for small-scale wet-process production of hardboards. Fibers from Norway spruce (Picea abies) were produced by thermomechanical pulping. The thermomechanical pulp was further treated by two laccases differing in redox potential from Pycnoporus cinnabarinus and Myceliophthora thermophile either in the presence or in the absence of the synthetic mediator 1-hydroxybenzotriazole (HBT). High-performance size-exclusion chromatography indicated that wood phenolic extractives underwent oligomerization upon enzymatic treatment to the extent depending on the enzyme source

and concentration, and the presence or the absence of HBT. The internal bonding within the fibers increased up to 2-fold with lower polymerization levels, whereas hydrophobization was favored by higher ones. X-ray photoelectron spectroscopy and scanning electron microscopy revealed the alteration of the surface lignin content and morphology. These results demonstrated that pre-treatment of spruce fibers with laccase-mediator systems prior to the hot processing improves the physico-mechanical properties of hardboards most likely due to the modification lignin surface by laccase-mediator activated soluble phenolics.
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FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
laccases | hardboards | lignin | HBT

BIBLIOGRAPHY