Evidence for room temperature delignification of wood using hydrogen peroxide and manganese acetate as a catalyst

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HIGHLIGHTS

- Mn(OAc)₃ catalyzes wood delignification with hydrogen peroxide at room temperature.
- Poplar sections turned into a fine powder within 4 days and without agitation.
- Raman microscopy showed the preferential oxidation of lignin-rich middle lamellae.
- Pretreatment for 2, 4, 7 days at room temperature led to improved glucose yields.
- This method could be a mild, inexpensive pretreatment of lignocellulosic biomass.

GRAPHICAL ABSTRACT

ABSTRACT

Manganese acetate was found to catalyze the oxidative delignification of wood with hydrogen peroxide at room temperature. The delignification reaction was monitored by optical and Raman microscopy, and liquid chromatography/mass spectrometry. When exposed to H₂O₂ and Mn(OAc)₃ in aqueous solution, poplar wood sections were converted into a fine powder-like material which consisted of individual wood cells within 4 days at room temperature and without agitation. Optical and Raman microscopy provided the spatial distribution of cellulose and lignin in the wood structure, and showed the preferential oxidation of lignin-rich middle lamellae. Raman spectra from the solid residue revealed a delignified and cellulose-rich material. Glucose yields following enzymatic hydrolysis were 20–40% higher in poplar sawdust pretreated with Mn(OAc)₃ for 2, 4, and 7 days at room temperature than those in sawdust exposed to water only for identical durations, suggesting the viability of this mild, inexpensive method for pretreatment of lignocellulosic biomass.

1. Introduction

Lignocellulosic biomass, including agricultural and forest wastes, is a potentially abundant and environmentally-friendly source of liquid transportation fuels and commodity chemicals (Sims et al., 2010). However, efforts to use lignocellulose for chem-