Enhanced Lignin Biodegradation by Consortium of White rot Fungi: Microbial Synergistic Effects and Product Mapping

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Research

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Abstract

Background : As one of the major components in lignocellulosic biomass, lignin has been considered as the most abundant renewable aromatic feedstock in the world. Featuring with mild conditions and diversity, biological degradation of lignin is a promising approach comparing with thermal or catalytic ones.

Results : In this study, a consortium of white rot fungi composed of Lenzites betulina and Trametes versicolor was employed in order to enhance the ligninolytic enzyme activity of laccase (Lac) and manganese peroxidase (MnP) under microbial synergism. The maximum enzymatic activity of Lac and MnP was individually 18.06 U·mL-1 and 13.58 U·mL-1 along with a lignin degradation rate of 50%, which were achieved from batch cultivation of the consortium. The activity of Lac and MnP obtained from the consortium was all improved more than 40%, compared with monocultures of L. betulina or T. versicolor under the same culture condition. Our findings of enhanced biodegradation were in accordance with the results observed from scanning electron microscope (SEM) and secondary-ion mass spectrometry (SIMS). Finally, the analysis of heteronuclear single quantum coherence (HSQC) NMR and gas chromatography-mass spectrometry (GC-MS) provided a comprehensive product mapping of the lignin biodegradation, suggesting that the lignin has undergone depolymerization of the macromolecules, side-chain cleavage, and aromatic ring-opening reactions.

Conclusions : Our results revealed a considerable escalation on the enzymatic activities obtained in a short period from the cultivation of the L. betulina or T. versicolor due to the enhanced microbial synergistic effects, providing a potential bioconversion route for the applications of lignin utilization.

Full Text

This preprint is available for download as a PDF.

Figures

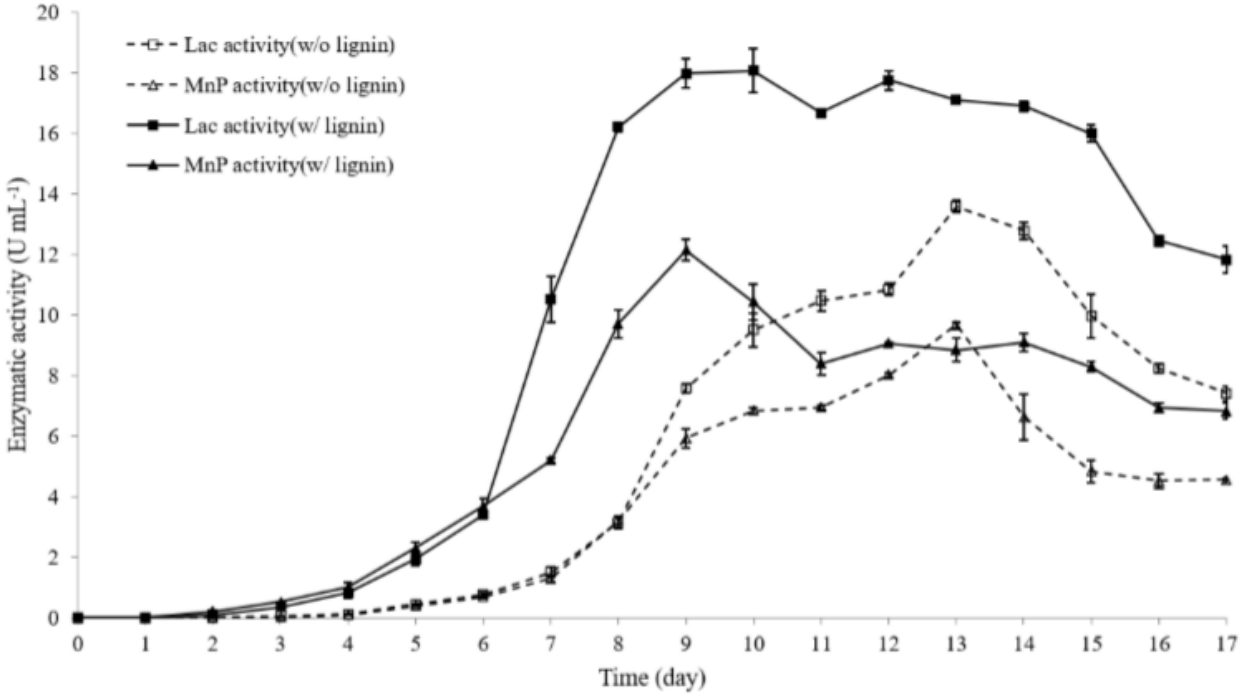

Figure 1

Time courses of Lac and MnP enzymatic activities in the culture of consortium. Dot lines present the cultures without adding lignin; solid lines present the cultures with adding lignin.

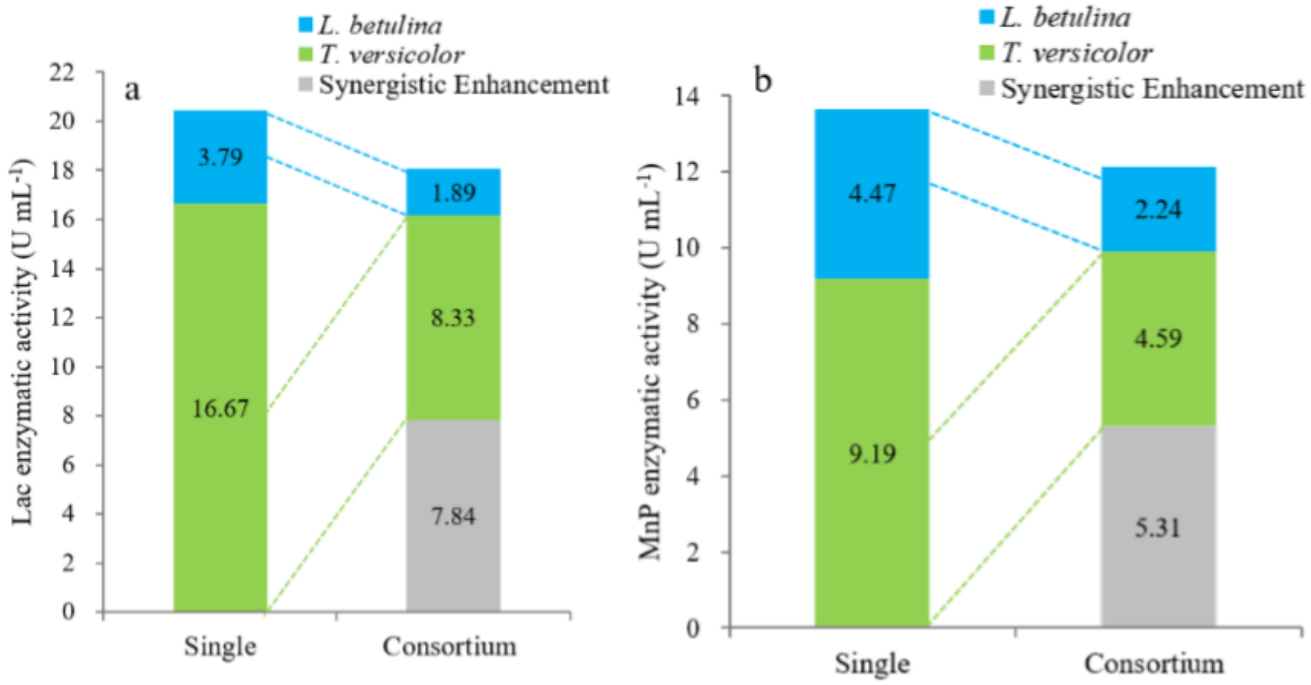

Figure 2

Enhanced synergistic effects on enzymatic activities of Lac (a) and MnP (b)

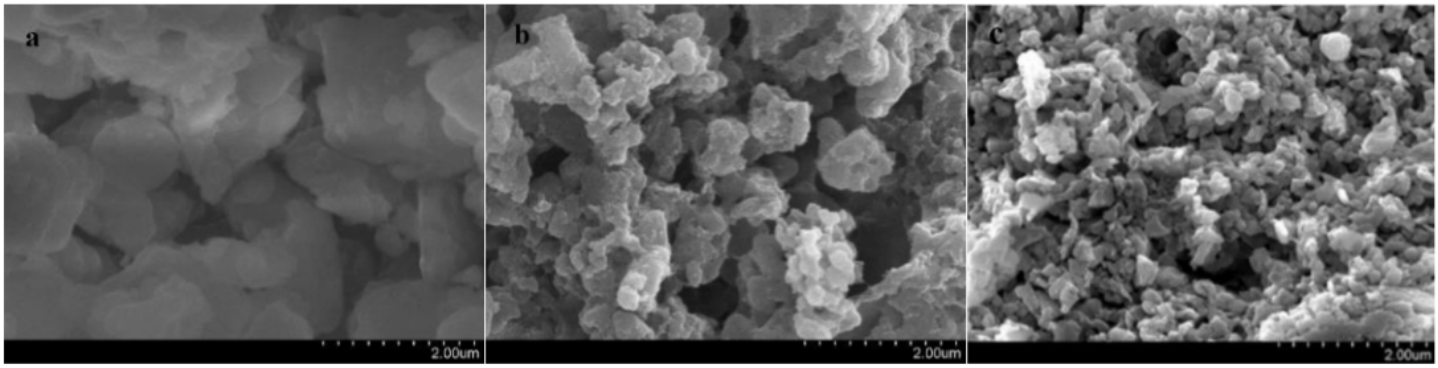

Figure 3

SEM images for comparisons of lignin samples before and after biodegradation. a control sample; b lignin sample (with no microorganisms); c lignin sample from the consortium.

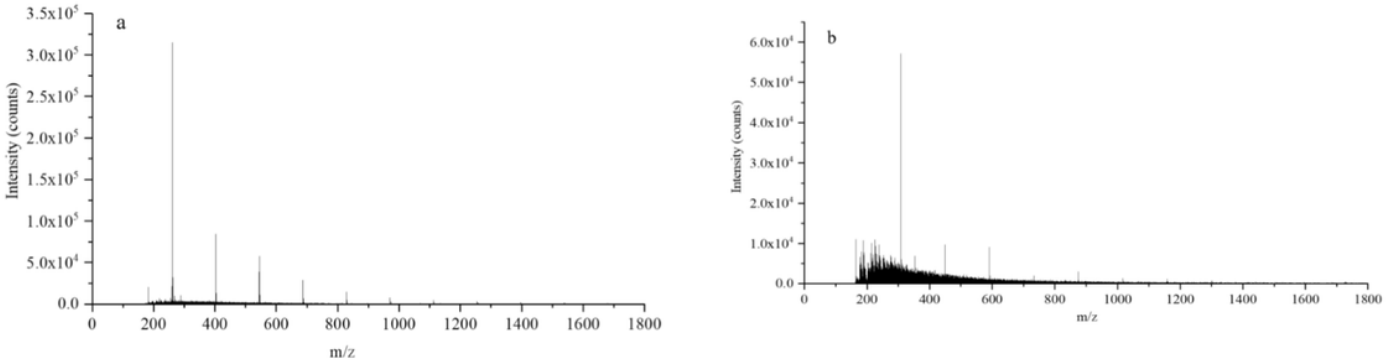

Figure 4

SIMS analysis of lignin for molecular weights comparisons. a control sample; b lignin sample from the consortium.

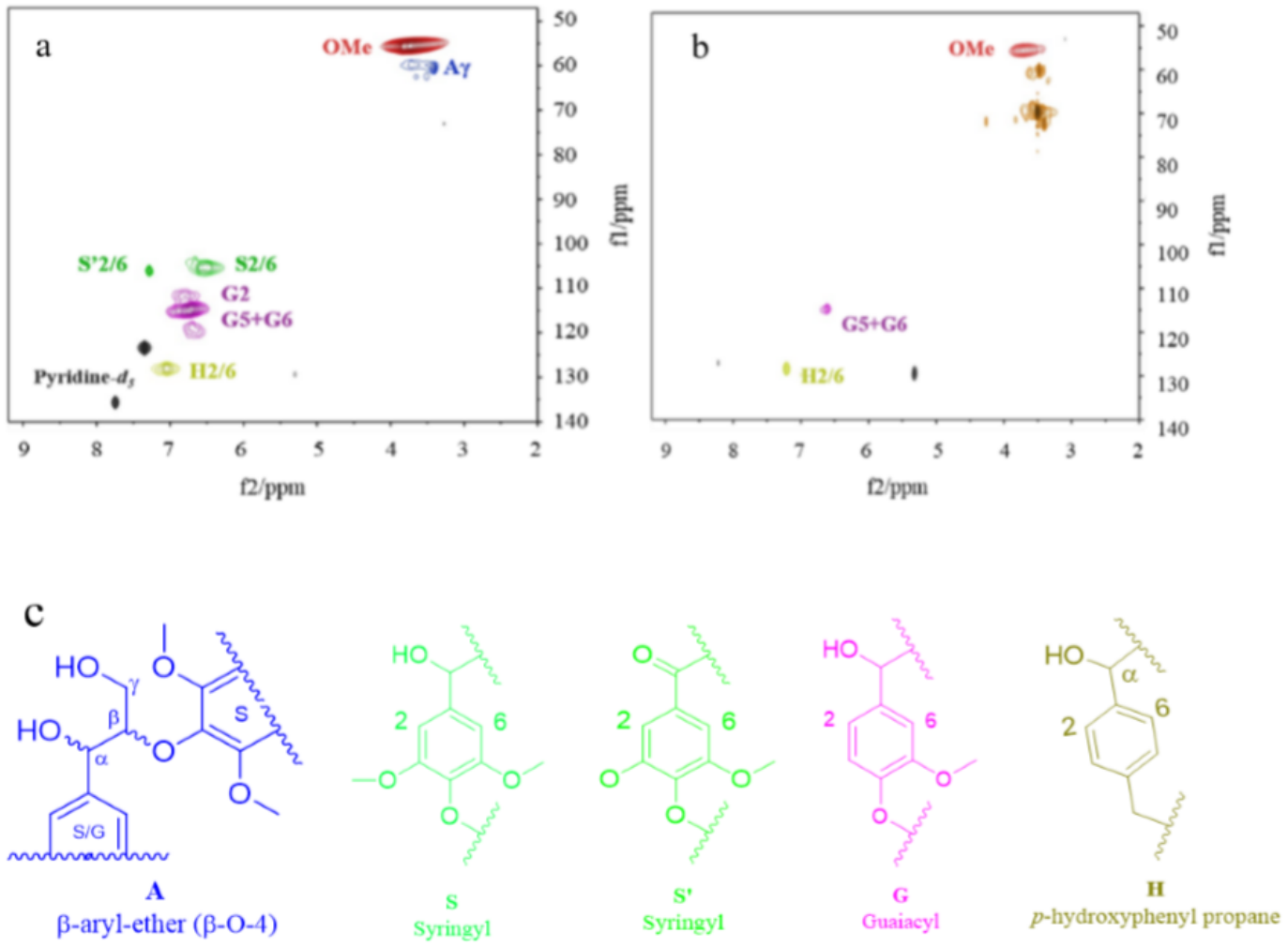

Figure 5

HSQC NMR spectra of lignin. a control sample; b lignin sample treated with the consortium; c corresponding lignin structures.