Bioremediation and Integrated Fungal Fermentation Process by White-rot Fungi

Ichiro Kamei (University of Miyazaki, Faculty of Agriculture)
kamei@cc.miyazaki-u.ac.jp

Basidiomycetes play an important role in the carbon cycle in forest ecosystems as decomposer. Lignin-degrading basidiomycetes, referred as white-rot fungi, are the microbes degrading all components of plant cell wall polymers including polysaccharides (cellulose and hemicellulose) and recalcitrant aromatic polymer lignin. Three major classes of extracellular enzymes, lignin peroxidases, manganese peroxidases and laccases are believed to be important in the fungal degradation on lignin. Therefore, many researchers reported that bioremediation of toxic compounds by white-rot fungi is possible and that biological delignification using white-rot fungi is useful for pretreatment of enzymatic saccharification of lignocellulosic biomass.

We indicated that white rot fungi can degrade a wide spectrum of organic pollutants, including persistent organic pollutants (POPs) such as polychlorinated dioxins (PCDDs), polychlorinated biphenyls (PCBs) and Dieldrin. Each compound was metabolized to several hydroxylated products by the white-rot fungi including *Phlebia brevispora*. We proved for the first time by characterization of intermediate that hydroxylation of substrate was a key step in the POPs degradation process by white-rot fungi [1]. Additionally, when the historically contaminated paddy soil was treated with *P. brevispora* under a slurry-state condition, 1,3,6,8-tetraCDD as the main contaminant was degraded significantly [2].

To establish the environmentally friendly and unique process for biorefinery of lignocellulose, the white-rot fungus *Phlebia* sp. strain MG-60 was proposed as a candidate for integrated fungal fermentation process (IFFP), which unifies aerobic delignification and semi-aerobic consolidated biological processing by a single microorganism based on its ability to efficiently degrade lignin and ferment the sugars from cellulose. Changing from aerobic conditions (biological delignification pretreatment) to semi-aerobic conditions (saccharification and fermentation) enabled the fermentation of wood by solely biological processes [3]. This is the first report of ethanol production from woody biomass using a single microorganism without addition of chemicals or enzymes. To improve IFFP, the development of a molecular breeding method for strain MG-60 was established. These results indicate the possibility of metabolic engineering of strain MG-60 for improving IFFP.

References

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