Energy conversion of wood biomass using ligninolytic activities of basidiomycetes

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To prevent serious global warming by emission of carbon dioxide from fossil fuels, it is an urgent task to produce energy and chemicals from carbon-neutral renewable resources. The development of conversion systems from lignocelluloses into biofuels and chemicals has received much attention due to immense potentials for the utilization of renewable resources. Since lignin makes the access of cellulolytic enzymes to cellulose difficult, it is necessary to decompose the network of lignin prior to the enzymatic hydrolysis. Thus, effective pretreatments are needed for enzymatic saccharification and ethanol production from wood. To this end, biological pretreatments with lignin-degrading fungi possess a great potential if the fungal treatment could decompose the network of lignin with minimum loss of polysaccharides. There have been many proposals for thermal pretreatments of wood. These include steam explosion, microwave irradiation and ethanolysis. However, extent of enzymatic saccharification of softwood after these pretreatments was much lower than that of hardwood and non-wood lignocellulosics. Therefore, combination with catalysts like sulfuric acid and SO_2 has been examined to apply the thermal pretreatments to softwood. However, use of toxic chemicals like sulfuric acid decrease the advantage of environmentally-friendly process, enzymatic saccharification. In this context, development of pretreatments without the use of toxic chemicals with low energy input has been required for producing ethanol and methane by enzymatic saccharification and fermentation.

In the present study, we propose a new pretreatment process using selective white rot fungi and microwave solvolysis. We screened white rot fungi capable of degrading lignin in Japanese cedar wood because the softwood species shares over 60% of forest plantation in Japan. We isolated a new strain (*Phellinus* sp. SKM2102) which exhibited high pretreatment effects comparable to those of the best biopulping fungus, *Ceriporiopsis subvermispora*. In cultures of *Phellinus* sp. SKM2102, positive reaction was found in Bavendamn test with guaiacol and gallic acid. This fungus secreted manganese peroxidase and manganese-independent peroxidase as a major ligninolytic enzyme. Although the pretreatment effects of *Phellinus* sp. SKM2102 was higher than that of *C. subvermispora*, decrease in total weight and hollocellulose content in the Japanese cedar wood chips was lower than that of *C. subvermispora*. *Phellinus* sp. SKM2102 consumed fatty acids (C16~C18) in Japanese cedar wood at an incipient stage of decay within 20 days, and produced long-chain fatty acids (C20 over) after 20 days. Methane fermentation was accelerated by fungal treatment with *Phellinus* sp. SKM2102. The strain exhibited accelerating effects on enzymatic saccharification of Japanese cedar wood in combination with microwave solvolysis. Ethanol was produced from the enzymatic digests of the pulp fraction by *Saccharomyces cerevisiae* without intensive fermentation inhibitation. Thus the new strain was effective for the pretreatments of Japanese cedar wood.