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Microbial Degradation of Lignin for Production of Valuable Chemicals

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Abstract : Lignin, a heterogeneous three-dimensional biopolymer, is one of the building blocks of lignocellulosic biomass. Due to its limited chemical reactivity, lignin is currently processed as a low-value by-product in pulp and paper mills. Among various industrial lignins, Kraft lignin represents a major source of by-products generated during the widely employed pulping process across the pulp and paper industry. Therefore, valorization of Kraft lignin holds great potential as this would provide a readily available source of aromatic compounds for various industrial applications. Microbial degradation is well known for using both highly specific ligninolytic enzymes secreted by microorganisms and mild operating conditions compared with conventional chemical approaches. In this study, the degradation of Indulin AT lignin was assessed by comparing the effects of Basidiomycetous fungi (Coriolus versicolour and Trametes gallica) and Actinobacteria (Mycobacterium sp. and Streptomyces sp.) to two commercial laccases, T. versicolour (≥ 10 U/mg) and C. versicolour (≥ 0.3 U/mg). After 54 days of cultivation, the extent of microbial degradation was significantly higher than that of commercial laccases, reaching a maximum of 38 wt% degradation for C. versicolour treated samples. Lignin degradation was further confirmed by thermal carbon analysis with a five-step temperature protocol. Compared with commercial laccases, a significant decrease in char formation at 850ºC was observed among all microbial-degraded lignins with a corresponding carbon percentage increase from 200ºC to 500ºC. To complement the carbon analysis result, chemical characterization of the degraded products at different stages of the delignification by microorganisms and commercial laccases was performed by Pyrolysis-GC-MS.

Keywords : lignin, microbial degradation, pyrolysis-GC-MS, thermal carbon analysis
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