Comprehensive studies on optimization of ligno-hemicellulolytic enzymes by indigenous white rot hymenomycetes under solid-state cultivation using agro-industrial wastes

ABSTRACT

The disposal of oil palm biomass is a huge challenge in Malaysian oil palm plantations. The aim of this study was to develop efficient solid-state cultivated (SSC) ligno-hemicellulolytic bio-degrader formulations of indigenous white-rot hymenomycetes (Trametes lactinea FBW and Pycnoporus sanguineus FBR) utilizing oil palm empty fruit bunches (EFB), rubber wood sawdust (SD) and vermiculite (V) either alone or in combination as substrates. Based on significant laccase (849.40 U mg−1 protein), xylanase (42.26 U g−1 protein) and amylase (157.49 U g−1 protein) production, SD+V (T5) and V (T3) were the optimum substrates for SSC of T. lactinea FBW. Whereas, utilizing EFB (T1) substrate for SSC of P. sanguineus FBR enhanced the production of MnP (42.51 U mg−1 protein), LiP (103.20 U mg−1 protein) and CMCase (34.39 U g−1 protein), enzymes. Apparently, this is the first study reporting on the protein profiles by T. lactinea FBW, producing two isoforms of un-purified laccase (~55 and 70 kDa) and MnP (~40 and 60 kDa) and a CMCase band (~60 kDa) during SSC on SD+V (T5) substrate. Interestingly, this is also the first report to document a single isoform of un-purified laccase (~50 kDa), MnP (~45 kDa), CMCase (~60 kDa) and xylanase (~55 kDa) by P. sanguineus FBR during SSC on empty fruit bunches substrate. The computed Principal Component Analysis (PCA) Biplot analysis elucidated the relationship between the solid substrate compositions, the hymenomycete strain, ligno-hemicellulolytic enzyme profiles, and cultivation time. Therefore, it is suggested to use PCA as a tool for multivariate analysis method for comprehensive selection and optimization of ligno-hemicellulolytic enzyme cocktails by the indigenous white rot hymenomycetes. These non-toxic (acute oral toxicity) formulations are safe to be used in field applications to efficiently degrade oil palm trunks and root mass that had been felled, chipped or pulverized under zero burning waste management program. This study could also serve as an alternative method for efficient utilization of agro-industrial waste as substrates for the development of cost-effective bio-degraders formulations for agro-waste management.

Keyword: Waste management; Agro-industrial waste; Lignocellulosic biomass; Oxidative enzymes; Hydrolytic enzymes; PCA Biplot