Industrial Crops and Products

The effects of chemical and structural factors on the enzymatic saccharification of Eucalyptus sp. samples pre-treated by various technologies

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Abstract
Lignocellulosic biomass is an important renewable resource to produce biofuels, due to its abundance and high polysaccharide content. Bioconversion is generally achieved in two stages: (i) pre-treatment, to reduce biomass recalcitrance, and (ii) enzymatic cellulose hydrolysis into fermentable sugars. However, the key structural and chemical features of biomass which hinder enzymatic hydrolysis remains challenging to evaluate. In this study, we explored the effect of eight different pre-treatments on the enzymatic hydrolysis of a Eucalyptus sp. – a potential feedstock for biofuel production. The analytical data collected covered the mass fractions of cellulose, hemicellulose and lignin, the syringyl: guaiacyl (S/G) ratio of lignin, functional group determination, crystallinity index (CrI) and accessibility of cellulose. Enzymatic hydrolysis was then performed using an in-house optimised cellulolytic enzyme cocktail (either alone or supplemented with xylanase or laccase) to elucidate the key factors of biomass recalcitrance which influence its enzymatic hydrolysis. Enzymatic saccharification was improved by changes in Eucalyptus induced by steam explosion pre-treatment, such as substantial removal of hemicelluloses, increased cellulose accessibility, and disruption of cell wall architecture and exposure of fibres. Partial removal of lignin, increased S/G lignin subunit ratio and lowered cellulose crystallinity exhibited no significant positive effects on biomass enzymatic hydrolyzability. Thus, this study provides insight into important chemical and structural features related to biomass recalcitrance arising from various pre-treatment methods, which can ultimately be used as a platform for the development of more efficient conversion technologies for novel and competitive bio-refineries.