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Optimisation of synergistic biomass-degrading enzyme systems for efficient rice straw hydrolysis using an experimental mixture design

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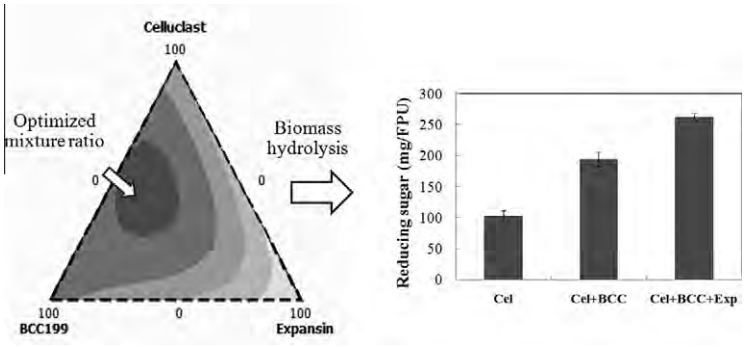
HIGHLIGHTS

- Mixture design was used for optimisation of ternary enzyme complex.
- Ternary enzyme system contained Celluclast™, *A. aculeatus* enzyme, and expansin.
- Synergy of expansin at practical cellulase dosage for biomass hydrolysis was shown.
- Proteomic profiles of crude enzymes from *T. reesei* and *A. aculeatus* were explored.
- This work demonstrated development of enzyme formulation for biorefinery industry.

GRAPHICAL ABSTRACT



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ABSTRACT

Synergistic enzyme system for the hydrolysis of alkali-pretreated rice straw was optimised based on the synergy of crude fungal enzyme extracts with a commercial cellulase (Celluclast™). Among 13 enzyme extracts, the enzyme preparation from *Aspergillus aculeatus* BCC 199 exhibited the highest level of synergy with Celluclast™. This synergy was based on the complementary cellulolytic and hemicellulolytic activities of the BCC 199 enzyme extract. A mixture design was used to optimise the ternary enzyme complex based on the synergistic enzyme mixture with *Bacillus subtilis* expansin. Using the full cubic model, the optimal formulation of the enzyme mixture was predicted to the percentage of Celluclast™: BCC 199: expansin = 41.4:37.0:21.6, which produced 769 mg reducing sugar/g biomass using 2.82 FPU/g enzymes. This work demonstrated the use of a systematic approach for the design and optimisation of a synergistic enzyme mixture of fungal enzymes and expansin for lignocellulosic degradation.

1. Introduction

Lignocellulosic plant biomass represents the most abundant renewable carbon source and provides the basis for the sustainable biorefinery industry. Enzymatic saccharification of agricultural residues has long been envisioned as a promising approach for

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