Mixed Lignocellulosic Biomass Degradation and Utilization for Bacterial Cellulase Production

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Abstract Feedstock supply challenges provide impetus into the exploration of lignocellulosic mixtures in bioprocessing. Such mixtures have not been fully explored for bacterial cellulase production. Four bacterial species were evaluated for ability to utilize a mixture of oil palm and rice residues (MS) for cellulase production. Bacillus aerius, Bacillus anthracis, Cellvibrio japonicus and Klebsiella pneumoniae with ability to utilize MS for growth were investigated. A two-step sequential strategy was employed in selecting the candidate for cellulase production and degradation of MS. B. aerius displayed better cellulolytic activity than the others during plate screening on carboxymethyl cellulose-enriched medium. However, C. japonicus produced the highest activities of endoglucanase and total cellulase during targeted screening on MS. Analyses revealed that sequential pretreatment with NaOH and moist heat increased the accessibility and disrupted the surface morphology of MS for subsequent bacterial utilisation. C. japonicus achieved significant degradation of MS with 52.33 % substrate dry weight loss after 7 days as compared to B. aerius which degraded 21.33 % of MS in the same period. Substrate was hydrolyzed via the amorphous region. The low residual concentration of reducing sugars in the medium suggested that C. japonicus could be used in the production of biocatalysts for the biofuel industry.

Keywords Bacillus aerius · Bacterial cellulase · Bioconversion · Bioprocessing · Endoglucanase · Mixed lignocellulosic biomass

Introduction

Lignocellulosic biomass, comprised of agricultural and forest residues, industrial and municipal wastes, and dedicated energy crops, is the most abundant alternative to fossil resources for the production of fuels and platform chemicals [1]. Lignocellulose is predominantly made up of cellulose and hemicellulose backbone, which is bound by lignin. These carbohydrate polymers can be hydrolysed by cellulase and hemicellulase enzymes to obtain useful precursors, which can be converted (via thermochemical or biochemical/fermentation routes) to an array of products such as biofuels and biochemicals. Cellulases are of great importance because of the recalcitrant nature of cellulose, which, unlike hemicellulose, does not easily yield to pretreatments to which lignocellulosic materials are normally subjected [2]. Cellulase is a suite of β-1,4-glycosidic bond hydrolysing enzymes (endoglucanase, exoglucanase, and β-glucosidase), which work in synergy to break down...