Switchgrass Deconstruction Mechanisms on Biomass Solubilization Elucidated through Characterization of Consolidated Bioprocessing Residues.

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Abstract

The most significant obstacle to commercially viable biofuels and bioproducts remains the cost-effective breakdown of cellulosic biomass. Consolidated bioprocessing (CBP) has been acknowledged for its ability to decrease the number of process steps and eliminate the costs associated with additional saccharolytic enzymes. Current developments in the use of cellulolytic anaerobes like *Clostridium thermocellum* for deconstruction, which are highly successful at solubilizing recalcitrant biomass than industry-standard fungal cellulase, provide proof-of-concept for CBP. The solubilization of both herbaceous and woody non-pretreated biomass is significantly increased by the novel and promising CBP/CT using thermophilic anaerobes combined with cotreatment (i.e., milling during fermentation). In this study ball milling and disc milling operations were used along with anaerobic fermentation as part of the CBP/CT process. The residues from the milling followed by fermentation steps were analyzed using a variety of characterization techniques such as scanning electron microscopy (SEM), Heteronuclear single quantum

coherence (HSQC) – Nuclear magnetic resonance (NMR), Gel permeation chromatography (GPC). Considerable differences in the microfibril structure were observed among the ball-milled and disc-milled switchgrass CBP/CT residues. The lignin, cellulose molecular weights, monolignol composition, and interunit linkages resulting from different milling conditions were investigated to understand the deconstruction mechanisms of CBP/CT. Moreover, the total lignin and sugar contents of the CBP/CT residuals provide an estimation of the process efficiency in depolymerizing the lignocellulosic matrix and fermentation of cellulosic and hemi-cellulosic sugars. Quantifying the effects of CBP/CT (mechanical disruption) on biomass will identify its current limitations and can help in developing potential improvement strategies along with the application of CBP/CT solid residuals for value-added products.