Enzymatic bioconversion and fermentation of corn stover at high-solids content for efficient ethanol production

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As a byproduct of corn production, corn stover is a low-cost agricultural residue that is available in large quantities representing a potential feedstock for second-generation biofuel production.Lignocellulosic ethanol production faces many obstacles due to the complexity and recalcitrance of lignocellulosic biomass and requires a two-step process in order to overcome these barriers (Saha et al. 2013).Pretreatment is the first step in the process of ethanol production from lignocellulose disrupting the structure of crystalline cellulose and providing accessibility to enzymes for the conversion of lignocellulosic biomass to soluble sugars and subsequently ethanol. Therefore, enzymatic hydrolysis is the second step aiming in producing fermentable sugars from carbohydrates present in the corn stover in the form of cellulose and hemicellulose.

Additionally, increased solid loadings are of great importance when trying to achieve ethanol concentrations above 4% (w/w), as higher sugar concentrations will be available for fermentation. However, high initial dry matter (DM), often above 15%, leads to a very viscous slurry with practically no free water resulting in many difficulties for the enzymatic bioconversion and subsequent fermentation.In order to surpass this obstacle, an extra liquefaction step is being employed while conventional stirring techniques have been replaced by gravimetric mixing systems converting the viscous slurry into an easier to handle liquid (Jørgensen et al. 2007).

In the current study, response surface methodology has been employed to identify the optimum hydrothermal pretreatment conditions in order to maximize the production of fermentable sugars from corn stover. Pretreated samples were evaluated through enzymatic hydrolysis using the benchmark commercial cellulase preparation Celluclast® 1.5L together with β-glucosidase Novozym® 188.The optimum pair of pretreatment temperature and duration for maximum glucose release was found to be: 231.19 °C and 15.82 min, with a maximum predicted glucose release of 7.71 g/L which is very close to the experimental value of 7.96 g/L. The potential of corn stover to be utilized as feedstock for ethanol production was also investigateddue to its considerable production in the Greek agroindustrial sector. Enzymatic liquefaction and saccharification of hydrothermally pretreated corn stover at high dry matter content using free fall mixing and commercial enzyme solution (Cellic® Ctec2) were followed by fermentation to ethanol by Ethanol Red®.

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