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CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

Sustainable Strategies to Achieve Industrial Ethanol Titers from Different Lignocellulosic Feedstocks: Scale-up Approach for Better Ethanol Yield

Background/Objective

Hydrothermal pretreatment is a promising approach to deconstructing lignocellulosic biomass for enzymatic hydrolysis and high-yield bioethanol fermentation, as it reduces downstream inhibitor content and the number of toxic byproducts generated. This study developed and tested a semi-integrated bioprocess that integrates enzymatic hydrolysis and bioethanol fermentation to determine its effectiveness in increasing ethanol yield on various feedstocks.

Approach

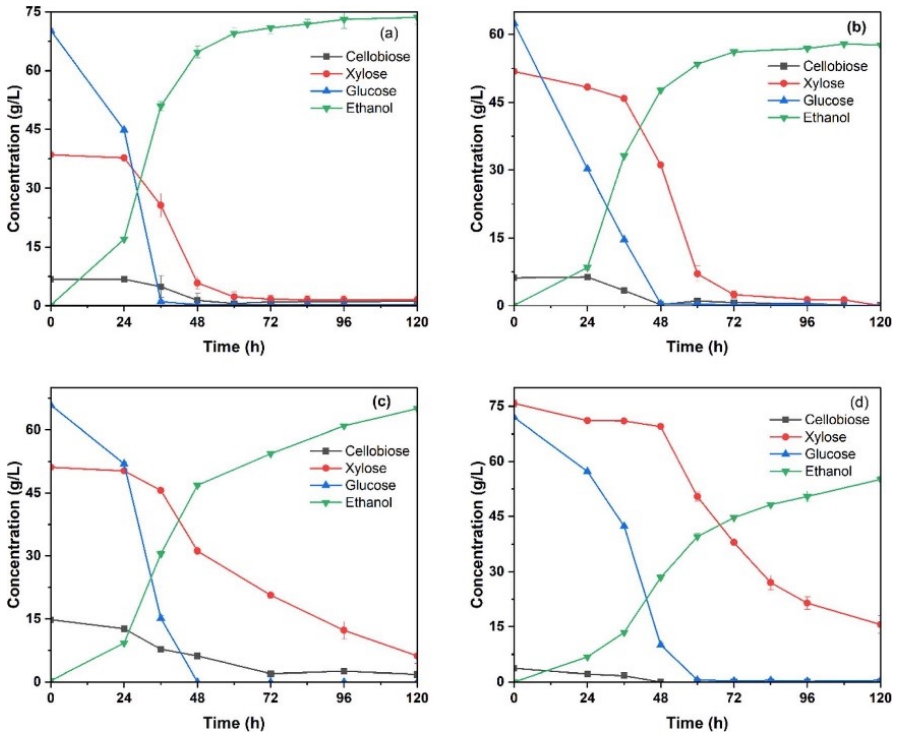
Bioenergy sorghum (BES), *Miscanthus* × *giganteus* (MG), energy cane (EC), and oilcane (OC) were pretreated in a continuous pilot scale hydrothermal reactor followed by disc milling. Enzymatic hydrolysis was performed without citrate buffer to produce monomeric sugars from cellulose and xylan. An engineered xylose-fermenting *Saccharomyces cerevisiae* was used for bioethanol production by supplementing the cheapest nitrogen source, urea. A semi-integrated bioprocess was developed to complete glucose and xylose consumption for industrial ethanol titer with better yield and productivity.

Results

Negligible concentrations of process-derived fermentative inhibitors, avoiding citrate buffer, and reducing the solid loading in the semi-integrated bioprocess enhanced the fermentability of hydrolysates. Industrial ethanol titers (g/L) of 73, 58, 65, and 55 were achieved from BES, MG, EC, and OC with the corresponding ethanol yields (gp/gs) of 0.49, 0.46, 0.42, and 0.41. BES is the best-performing feedstock regarding ethanol yield, titer, and productivity. Sugarcane-derived feedstocks presented challenges in incomplete sugar utilization, likely due to their inhibitor content.

Significance/Impacts

High ethanol yields can be obtained at larger scales, and multiple processes can be combined in a single bioreactor unit. These cost-saving measures can be incorporated into future bioprocesses.



Scale-up of semi-integrated bioprocess in a bioreactor (a) BES, (b) MG, (c) EC, and (d) OC.

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