BRC Science Highlight
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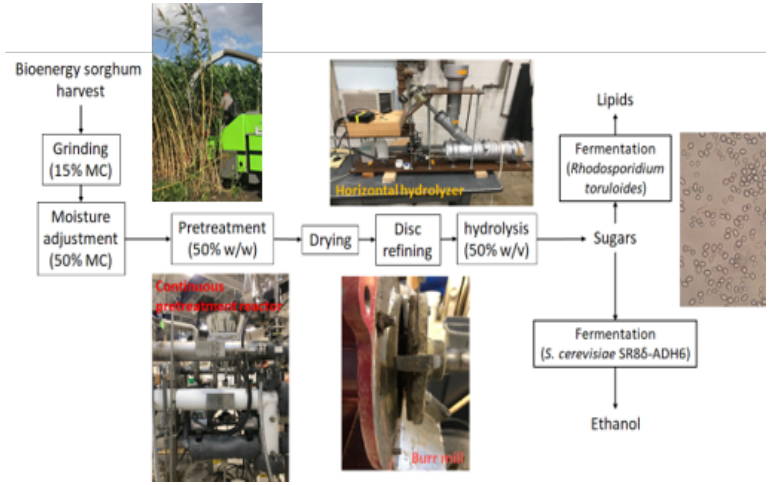
Conversion of High-Solids Hydrothermally Pretreated Bioenergy Sorghum to Lipids and Ethanol Using Yeast Cultures

Background/objective

Cellulose and hemicellulose are major carbohydrates present in plant biomass. After biomass deconstruction, the major sugars present in cellulosic hydrolysates (glucose and xylose) can be released by enzymatic hydrolysis. Microbial conversion of sugars to ethanol and lipids are the major routes for biofuel production. This study investigates the two leading microbial conversion routes to biofuels, which are directly compared using concentrated cellulosic sugar hydrolysates prepared from high-solids bioenergy sorghum processed at pilot-scale operations.

Approach

- Bioenergy sorghum was hydrothermally pretreated and sequentially mechanically refined to improve biomass accessibility for hydrolysis. Then, fed-batch enzymatic hydrolysis was conducted with 50% w/v solids loading and cellulase cocktail (50 FPU/g biomass) to achieve 230 g/L sugar concentration.
- Various strains of *Rhodosporidium toruloides* were evaluated for converting sugars for lipid production, and the best candidate was used for a two-stage culture scheme to enrich the yeast's lipid content.
- *Saccharomyces cerevisiae* SR8ΔADH6 was utilized to co-ferment glucose and xylose for ethanol production, which was then optimized for media nutrients, cellulosic sugar concentration, and sulfite conditioning.



The scheme of lipids and ethanol production from bioenergy sorghum using yeast cultures

Results

- The concentrated hydrolysates prepared from high solids processing had a high C/N ratio, which facilitates the lipid accumulation for oleaginous yeast.
- *R. toruloides* strain Y-6987 had the highest lipid titer (9.2 g/L), which was improved to 19.0 g/L (a yeast lipid content of 43%) by implementing a two-stage culture scheme.
- Optimal ethanol production conditions produced 50.1 g/L ethanol at 0.80 g/L/h, which meet the critical concentration (40 g/L) for industrial operations.
- The best ethanol yield was 73.3% of theoretical, which is the same or higher than using hydrolysates produced from lower solids loading processing.

Significance

Sugars produced at pilot scale from chemical-free, hydrothermally pretreated bioenergy sorghum were demonstrated to be a fermentable source for the production of single-cell oil using wild type *R. toruloides* or ethanol using *S. cerevisiae* SR8ΔADH6. These results demonstrate the potential of applying concentrated cellulosic hydrolysates from high solids processing in a biorefinery to increase the productivity of platform chemicals.

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