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The Effects of Sequential Hydrothermal-Mechanical Refining Pretreatment on Cellulose Structure Changes and Sugar Recoveries

Background/Objective

The recalcitrance of lignocellulosic biomass necessitates an efficient pretreatment protocol for operating a successful cellulosic biorefinery. Sequential hydrothermal-mechanical refining (HMR) pretreatment has been successfully applied to both Liberty switchgrass and oilcane, a transgenic sugarcane variety engineered to accumulate lipids in its vegetative tissues. This study sought to correlate cellulosic sugar yields with structural changes within the cell wall caused by HMR on two distinct bioenergy crops.

Approach

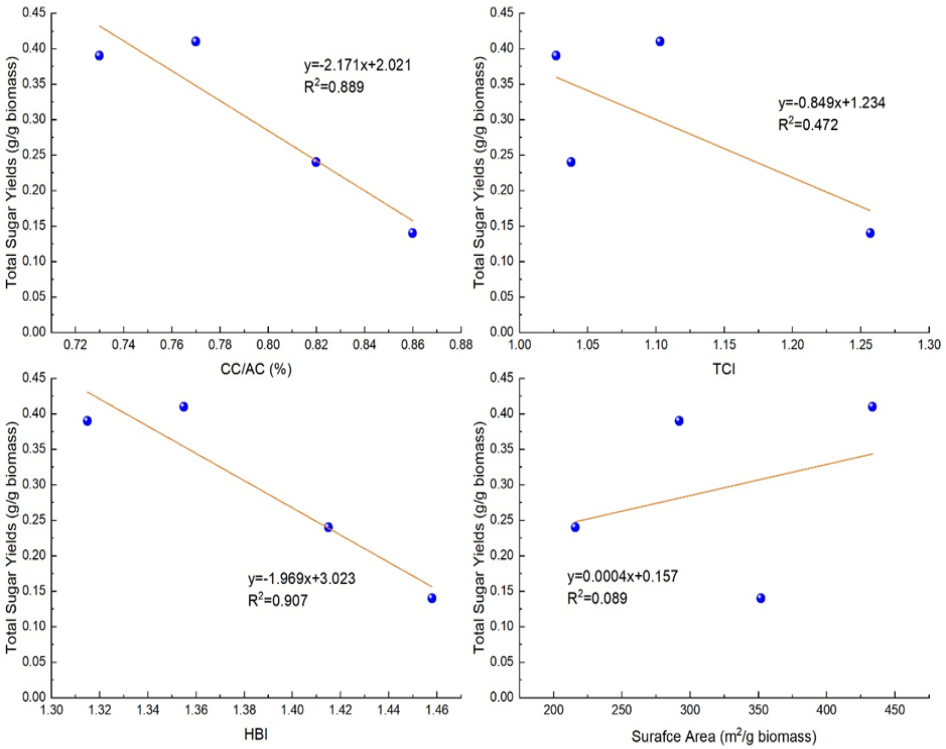
Investigated the consequences of biomass physical properties on the efficiency of cellulosic sugar recovery for a better understanding of the pretreatment process. The effects of HMR on the chemical and physical structure of cellulose and its corresponding sugar yields were analyzed by changes in specific surface area, total crystallinity index (TCI), hydrogen bonding intensity (HBI), and crystalline cellulose content.

Results

- HMR pretreatment at 190°C for 10 minutes increased the biomass specific surface area by 80-112%, decreased cellulose crystallinity by 3.5%, and reduced TCI and HBI by 7-13%.
- Sugar yields were negatively correlated to reducing values of HBI, crystalline cellulose content, and TCI.

Significance/Impacts

A detailed understanding of the structural alterations due to chemical-free pretreatment will help in designing the deconstruction processes for newly developed transgenic bioenergy crops that can prevent the degeneration of vegetative lipids and maximize their recovery along with the recovery of cellulosic sugars.



Correlations between sugar yields and biomass structure parameters.

Cheng, M.H., Maitra, S., Carr Clennon, A.N., Appell, M., Dien. B.S., Singh, V. Oct. 12, 2022. "The Effects of Sequential Hydrothermal-Mechanical Refining Pretreatment on Cellulose Structure Changes and Sugar Recoveries." *Biomass Conversion and Biorefinery*. DOI: 10.1007/s13399-022-03359-3.