

Harnessing Plant-based Platform for Low-cost Cellulosic Sugar Recovery from Bioenergy Crops

Background/Objective

The price of pure cellulase enzyme for the recovery of fermentable cellulosic sugars is one of the major challenges that limit the commercialization of second-generation biofuels and bio-based products. This study presents a potential development and application of an integrated synthetic biology and bioprocessing strategy to reduce the cost of cellulase in biorefineries.

Approach

Transgenic tobacco leaves overexpressing heterologous cellulases were processed to extract active enzymes. The crude leaf extracts containing the cellulases were analyzed for their ability to recover cellulosic glucose from energycane bagasse. A basic economic analysis was performed based on literature and experimental data obtained in the study.

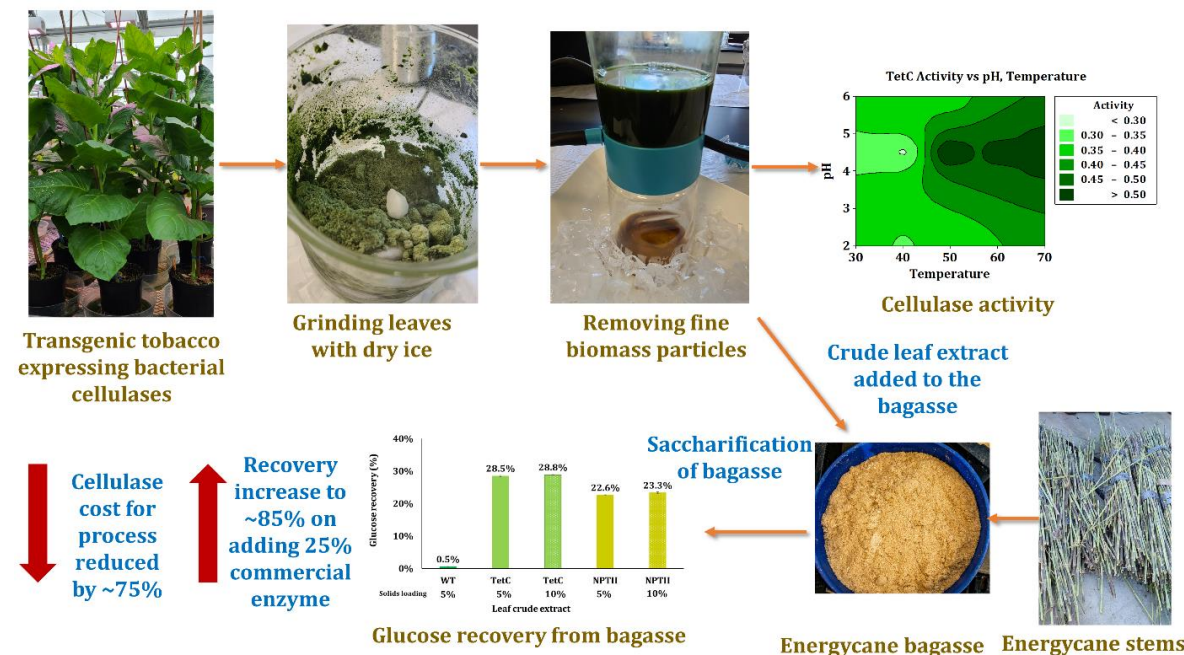
Results

Unpurified crude extracts of *NPTII* and *TetC* transgenic tobacco leaves recovered ~23% and ~29% w/w cellulosic sugars from energycane bagasse, respectively. A supplementation of as low as 25% of purified commercial cellulase improved the glucose recovery by 2.9 times (~85% w/w). Assuming 40% cellulase yield in total soluble protein and 1-3 harvests a year, the study estimates the potential cost for saccharification of 1 t of lignocellulosic biomass can be reduced to 67–200 USD.

Significance/Impacts

The study provides a proof-of-concept for recovering active cellulases from plant sources, followed by their application in cellulosic sugar recovery from bioenergy crops at the bench scale. The experimental results suggest a reduced requirement of commercial cellulases, which can potentially reduce the enzyme cost by 75% for biorefineries.

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Cellulosic sugar recovery from energycane bagasse using crude leaf extract of transgenic tobacco overexpressing cellulases