Novel Feedstocks for Cost Effective Biofuels Production

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Abstract:

Dedicated energy crops and agricultural waste are the preferred long-term solutions for renewable, cheap, and globally available biofuels as they avoid some of the market pressures and secondary greenhouse gas emission challenges currently facing corn ethanol. Typically lignocellulosic biomass are converted to fermentable sugars using a variety of chemical and thermochemical pretreatments, which disrupt cellulose and lignin cross-links, allowing exogenously added recombinant microbial enzymes to more efficiently hydrolyze cellulose for deconstruction into glucose. This process is plagued with inefficiencies, primarily due to the recalcitrance of cellulosic biomass, mass transfer issues during deconstruction, and low activity of recombinant deconstruction enzymes.

One potential solution to these problems is found in synthetic biology. We have engineered plants that self-produce a suite of cellulase enzymes targeted to the apoplast for cleaving the linkages between lignin and cellulosic fibers; the genes encoding the degradation enzymes, also known as cellulases, are obtained from extremophilic organisms. These enzymes will remain inactive during the life cycle of the plant but become active during hydrothermal pretreatment. Deconstruction can be integrated into a one-step process, thereby increasing efficiency and reducing costs.

The unique aspects of this technology are the rationally engineered, highly productive enzymes, targeted to specific cellular locations and their dormancy during normal plant proliferation, which become Trojan horses during pretreatment conditions. We discuss our initial results and possible implications of this work on developing dedicated energy crops and their advantage in consolidated bioprocessing.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.