Understanding the role of pentose sugars on *C. thermocellum* metabolism

U.S. DEPARTMENT OF ENERGY | Office of Science

Background

- *Clostridium thermocellum* efficiently ferments the cellulose component of lignocellulosic biomass but is unable to utilize pentose sugars solubilized from xylan.
- The question remains as to whether these sugars, if allowed to accumulate during the conversion of minimally pretreated biomass at high-solid loadings, will affect the growth and metabolism of the microbe.

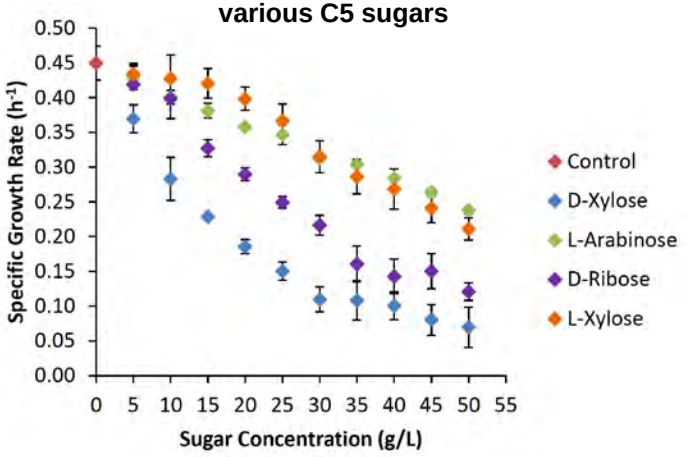
Approach

- Applied a multi-omics approach to determine changes in metabolites, gene expression, and secreted peptides during growth in the presence of 15 g/L D-xylose;
- Identified possible mechanisms of inhibition; and
- Tested hypotheses regarding inhibition through characterizing several targeted gene deletion strains.

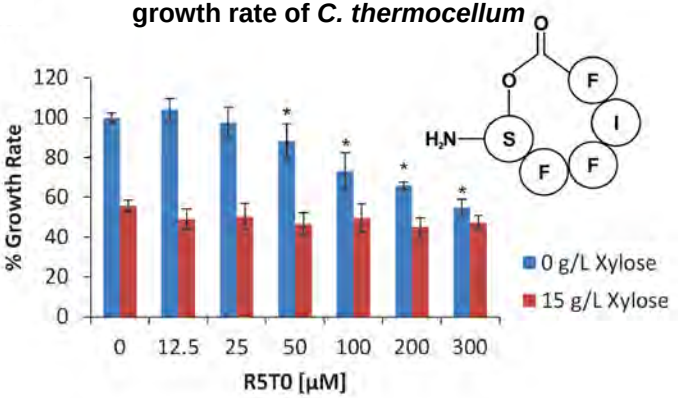
Outcome

- Increasing concentrations of pentoses, especially D-xylose, negatively affected growth and end-product titers.
- A xylitol dehydrogenase was identified that reduces xylose to xylitol resulting in loss of reducing equivalents.
- A cell signaling system was activated in the presence of xylose and synthetic cyclic peptides were shown to inhibit growth.

Growth rate of *C. thermocellum* in response to various C5 sugars



Effect of the ArgD cyclic pentapeptide on the growth rate of *C. thermocellum*



Significance

- This work highlights the importance of removing pentose sugars during bioconversion to biofuels which could be achieved with C5 utilizing co-cultures or engineered strains of *C. thermocellum,* and is the first report of a functional ArgD-type cell signaling system in a thermophilic Firmicute and further work is warranted to understand the role of cell-to-cell signaling in achieving robust fermentations of lignocellulosic biomass.

BESC BioEnergy Science Center

Verbeke TJ, Giannone RJ, Klingeman DM, Engle NL, Rydzak T, Guss AM, Tschaplinski TJ, Brown SD, Hettich RL, Elkins JG. 2017. Pentose sugars inhibit metabolism and increase expression of an AgrD-type cyclic pentapeptide in *Clostridium thermocellum*. *Scientific Reports*. (Accepted).