State of Play in Ethanol Production using Consolidated Bioprocessing with *C. thermocellum* and *T. saccharolyticum*

U.S. DEPARTMENT OF ENERGY | Office of Science

Background

A comprehensive book chapter addresses:

- Consolidated Bioprocessing (CBP) organism development strategies
- Plant cell wall solubilization by *C. thermocellum*
- Bioenergetics of *C. thermocellum* cellulose fermentation
- Metabolic engineering and the current state of strain development (see table at right)

Key Outcome

In a comprehensive comparison to industry-standard fungal cellulase, *C. thermocellum* was found to be much more effective, e.g., 3-fold, at cellulosic biomass deconstruction under a broad range of conditions including:

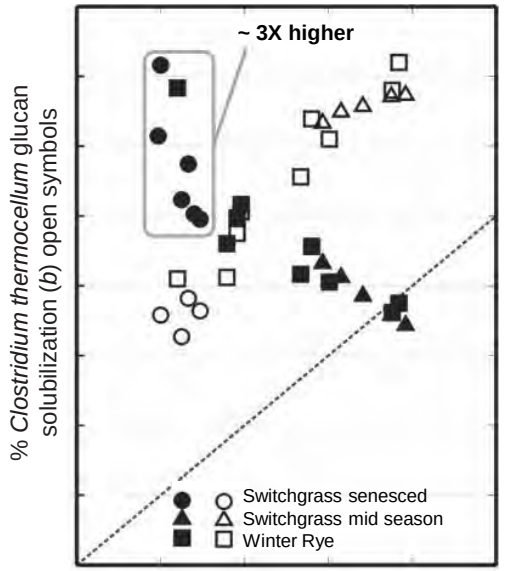
- Five biofeedstocks
- > 10-fold range of catalyst loadings
- > 10-fold range of particle size
- 0-fold range of substrate loadings
- The presence or absence of fermenting microbes
- Incubation temperature (for fungal cellulase)

Significance

This summary is the most definitive indication yet that nature offers biocatalysts that are substantially more effective at biomass solubilization and deconstruction than those used in the industry today. Further improvements in yield and titer to desired products for strategic deployment of CBP are ongoing.

Current state of strain development of *C. thermocellum* and *T. saccharolyticum*

Metric, strain	Values	Conditions
Ethanol yields (engineered strains), % theoretical		
T. saccharolyticum M1442	90	Several feedstocks, ethanol titers ≥50 g l^{-1}, inhibitors present
C. thermocellum LL1210	75	Titer 25 g l^{-1}, no inhibitors
Ethanol titer (selected strains) (g l^{-1})		
T. saccharolyticum M1442	70	Produced from maltodextrins and cellobiose in 90 h
C. thermocellum LL1210	25	Produced from Avicel in 122 h
C. thermocellum E50C and E50A	50	Added, tolerated for growth on Avicel



Comparison of biomass solubilization by *C. thermocellum* relative to fungal cellulases. The dashed line represents values where solubilization would be equal between *C. thermocellum* and fungal cellulases. Closed symbols, the same data plotted as the ratio between *C. thermocellum* and fungal enzyme solubilization (right axis).

Lynd, L.R., Guss, A.M., Himmel, M.E., Beri, D., Herring, C., Holwerda, E.K., Murphy, S.J., Olson, D.G., Paye, J., Rydzak, T., Shao, X., Tian, L., and Worthen, R. (2017). "Advances in consolidated bioprocessing using *Clostridium thermocellum* and *Thermoanaerobacterium saccharolyticum.*" in C. Wittmann and J. C. Liao (Eds.), *Industrial Biotechnology: Microorganisms* (1st ed., pp. 365-394). Wiley-VCH Verlag GmbH & Co. KGaA, doi:10.1002/9783527807796.ch10

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