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NREL Explains the Higher Cellulolytic Activity of a Vital Microorganism

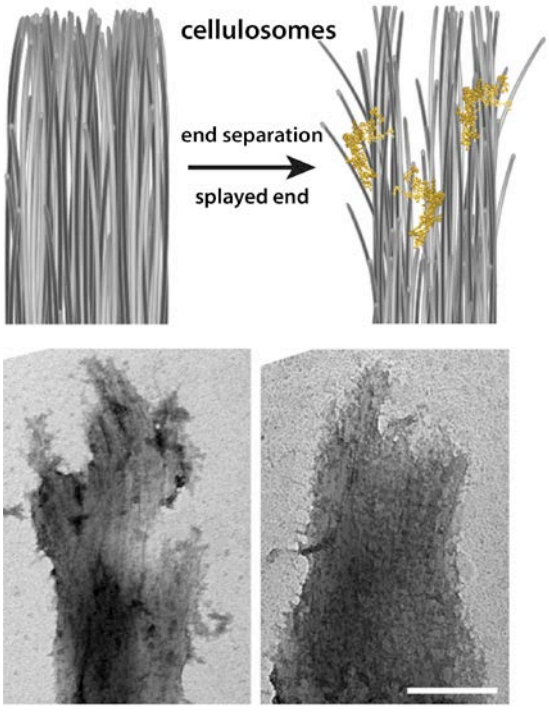
Highlights in Research & Development

A newly discovered category of scaffolded enzymes in *C. thermocellum* has the potential for superior conversion of biomass into biofuel.

During a recent investigation, NREL researchers uncovered a surprising property of the microorganism *C. thermocellum*. Using newly published cloning strategies to probe the importance of the primary and secondary scaffoldins of *C. thermocellum* by using scaffoldin deletion strains, the scientists found that the microorganism not only utilizes the common cellulase degradation mechanisms known today (free enzymes and scaffolded enzymes attached to the cell), but also uses a new category of cell-free scaffolded enzymes.

This anaerobic bacterium is a major candidate for the production of biofuels from biomass feedstocks because it already possesses both an external cellulase system and the internal metabolic pathways to convert biomass to ethanol. Additionally, *C. thermocellum* is the best cellulolytic anaerobe ever tested to date on unpreatreated biomass. This microorganism is also ubiquitous and has been isolated from soil, compost, herbivores, and hot springs.

The findings have important implications for industry, because this discovery is expected to influence the strategies used to improve the cellulolytic activity of biomass-degrading microbes going forward. However, more research is needed to bring *C. thermocellum* to its full potential, improving its activity on biomass and increasing yields of biofuels. Biomass conversion affects not only biofuels production but also other areas such as herbivore health and hot spring ecosystems.



A graphic illustration (top) and transmission electron microscopy (TEM) micrographs (bottom) of Avicel particles digested by Clostridium thermocellum strains (scale bar = 500 nm). Illustration by Bryon Donohoe, NREL

Key Research Results

Achievement

The discovery of a new mode of action by *C. thermocellum* to convert biomass to biofuels is significant because the bacterium is already recognized as one of the most effective in the biosphere.

Key Result

Researchers found that, in addition to using common cellulase degradation mechanisms attached to cells, *C. thermocellum* also uses a new category of cell-free scaffolded enzymes.

Potential Impact

The new discovery will influence the strategies used to improve the cellulolytic activity of biomass degrading microbes going forward. Better understanding of this bacterium could lead to cheaper production of ethanol and drop-in fuels. Also, this discovery demonstrates that nature's biomass conversion behaviors are not fully understood and remain as opportunities for future microbial/enzyme engineering efforts.

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References: Q. Xu, M. G. Resch, K. Podkaminer, S. Yang, J. O. Baker, B. S. Donohoe, C. Wilson, D. M. Klingeman, D. G. Olson, S. R. Decker, R. J. Giannone, R. L. Hettich, S. D. Brown, L. R. Lynd, E. A. Bayer, M. E. Himmel, and Y. J. Bomble (2016). "Dramatic performance of *Clostridium thermocellum* explained by its wide range of cellulase modalities." *Science Advances*, Vol. 2, no. 2, e1501254.

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