Unlikely element turns up in enzyme; commercial renewable fuels might ultimately result

August 14 2015

Tungsten is exceptionally rare in biological systems. Thus, it came as a huge surprise to Michael Adams, PhD., and his collaborators when they discovered it in what appeared to be a novel enzyme in the hot spring-inhabiting bacterium, *Caldicellulosiruptor bescii*. The researchers hypothesized that this new tungstoenzyme plays a key role in *C. bescii*'s primary metabolism, and its ability to convert plant biomass to simple fermentable sugars. This discovery could ultimately lead to commercially viable conversion of cellulosic (woody) biomass to fuels and chemical feedstocks, which could substantially reduce greenhouse emissions. The research is published 14 August in *Applied and Environmental Microbiology*, a journal of the American Society for Microbiology.

Cellulosic biomass' advantage as a feedstock for fuel and chemical production is that it need not compete with food production for land. Its big challenge is that cellulose is highly resistant to enzymatic degradation. To date, most efforts to convert it to useful chemicals have involved energetically expensive pretreatment.

Avoiding pretreatment would boost commercial viability. To this end, the investigators, members of the Department of Energy's BioEnergy Science Center, have been focusing on *Caldicellulosiruptor* species (the name of the genus means "hot cellulose-breakers,"), which inhabit volcanic hot springs around the world.

While the putative novel tungstoenzyme Adams et al. discovered looked fairly promising, Adams, who is Distinguished Research Professor of Biochemistry & Molecular Biology at the University of Georgia, Athens is quick to assert that a likely sequence does not constitute proof of function. In fact, "I would have predicted that the tungsten-processing system of *C. bescii* probably used molybdenum rather than tungsten," he said. (The two metals have similar properties, but molybdenum is frequently used by bacteria, most notably to break the bonds of atmospheric nitrogen, enabling biological nitrogen fixation.) So the investigators engineered *C. bescii* to produce a known tungstoenzyme from another organism. "That enzyme was active, proving that *C. bescii* is capable of synthesizing tungstoenzymes," said Adams.

The investigators then grew *C. bescii* under a variety of conditions, including directly on cellulose and plant biomass, and found that it always produced the enzyme, which the investigators dubbed XOR, at high cellular concentrations under all growth conditions. They also tried unsuccessfully to grow "knock-out" mutants lacking a functional XOR gene. That result suggested, but does not prove that the enzyme is necessary for growth, said Adams.

And so far, the enzyme's function has not been determined. "Elucidating that function will likely be essential if we are to fully understand the bacterium's ability to grow on unpretreated plant biomass," said Adams. That knowledge, he added, would make it possible to metabolically engineer *C. bescii* to produce fuels and other useful chemicals from such feedstocks.

Provided by American Society for Microbiology

enzyme-commercial-renewable-fuels.html