Microbial breakthrough impacts health, agriculture, biofuels

September 7 2010

For the first time ever, University of Illinois researchers have discovered how microbes break down hemicellulose plant matter into simple sugars using a cow rumen bacterium as a model.

"This is ground-breaking research," said Isaac Cann, associate professor in the U of I Department of Animal Sciences and member of the Energy Biosciences Institute (EBI) in the Institute for Genomic Biology. "The implications are very broad, yet it all started with a simple rumen microbe. It's amazing how we can draw inferences to human health and nutrition, biofuel production and animal nutrition because of our new understanding of how a microbe works."

The cow rumen is an excellent model to study as it's one of the most efficient machines to deconstruct plant matter, Cann said. Microbes in the rumen break down plant matter into glucose and xylose to use as nutrients for fermentation and energy acquisition.

U of I researchers utilized DNA sequencing and transcriptomics (RNAseq approach) to determine all of the enzymes the organism, *Prevotella bryantii*, uses to deconstruct hemicellulose into simple sugars.

"If you don't completely understand what is happening, you can't improve it," Cann said. "The U of I's strong history in anaerobic microbiology and genomics, and the EBI's substantial funding enabled us to achieve this milestone. To my knowledge, this was the first time that anyone has systematically demonstrated the deconstruction of the plant

cell wall hemicellulose."

Breaking down hemicellulose is one of the biofuels industry's greatest bottlenecks. Currently, the industry has microbes that can ferment simple sugars into liquid fuels such as ethanol and butanol. But they have struggled to break down feedstocks such as corn stover, switchgrass and miscanthus.

"U of I's research has created an enzyme cocktail that can release simple sugars from hemicellulose and in turn, help the biofuels industry progress," Cann said.

Even though researchers used a bacterium from the cow stomach, their results apply to microbes in the human large intestine, too. Human health and nutrition researchers are interested in the similar strategies certain rumen bacteria and human intestinal bacteria use to capture energy from dietary fiber.

"By fermenting the fiber in our diets, the microbes in our large intestine help to provide about 10 percent of our daily energy requirement," he said. "The microbial fermentation products or short-chain fatty acids provide nutrition to the cells that line our intestines."

Cann added that a greater understanding of the large population of microbes in the large intestine can impact a person's health and nutritional status. For example, a simple change in the colon's microbial population can contribute to the development of inflammatory bowel diseases.

"Understanding how different microbes obtain energy may allow us to modify our diets to select for beneficial microbes to promote better health," he said.

The same principles hold true for livestock, he said.

"It's not possible to understand the nutrition of farm animals without understanding the lifestyle of the microbial populations in their gut," Cann said. "Cattle depend on microbes to obtain their energy from both grass and concentrate diets. A better understanding of how microbes capture nutrients from plant matter can help us to make animal agriculture more efficient."

U of I researchers are building on the knowledge gained from this study to understand how two other major rumen bacteria capture energy from cellulose and cellulose/hemicellulose.

More information: This study, "Transcriptomic analyses of xylan degradation by Prevotella bryantii and insights into energy acquisition by xylanolytic Bacteroidetes," was published in the *Journal of Biological Chemistry*.

Provided by University of Illinois at Urbana-Champaign