Termite digestion findings could lead to new strategies for ethanol production

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As scientists search for alternatives to fossil fuel, producing chemical energy from wood fiber has become something of a Holy Grail — but termites have been working this alchemy for millions of years.

A University of Florida study published last month in the journal *Gene* sheds new light on the mysterious and complex process that enables the insects to eat cellulose, the main structural component of plant cells. For people and most animals, cellulose is indigestible, but termites break it down into glucose, a form of sugar most organisms need.

The study identifies four genes that produce enzymes responsible for taking cellulose molecules apart, insight that could lead to breakthroughs in energy production and pest control, said Michael Scharf, an assistant research scientist with UF's entomology department and a co-author of the paper.

"This is a significant step forward, especially because we looked at the dominant termite species in the U.S.," Scharf said. "But we're confident we haven't identified all the genes involved in producing these enzymes."

Only one of the genes actually belongs to the insect researchers studied, the eastern subterranean termite. The other three belong to microscopic organisms known as symbionts that live inside the termite's digestive system.
"The termites provide the symbionts with a home, and the symbionts pay the rent by producing enzymes," he said.

Altogether, there may be hundreds of cellulose-digesting enzymes produced by the termites and their tiny tenants, Scharf said.

One potential payoff from the research is that scientists may be able to transfer specific enzyme-producing genes into bacteria, then culture them to produce large quantities of enzymes to make ethanol from wood scraps and other fibrous materials, he said.

Known as cellulosic ethanol, this fuel has gained worldwide attention because it doesn't require edible material such as corn, used in conventional ethanol production.

The interaction of multiple genes makes cellulose digestion an efficient process in termites, but scientists want to pin down enzyme combinations that will digest cellulose affordably, Scharf said. Many genes remain undiscovered, and UF researchers have applied for funding to support a massive effort to identify all cellulose-digesting genes in the eastern subterranean termite and its common symbionts.

Greater genetic knowledge could also aid in termite control, an important issue in Florida, which accounts for about one-third of control efforts in the United States, said Phil Koehler, a UF entomology professor and co-author of the paper.

By identifying enzymes most crucial to termite digestion, scientists may be able to kill the insects by shutting down selected genes, he said.

Termite-control strategies, such as bait systems or treated lumber, would be environmentally friendly because they would have no effect on organisms that don't eat cellulose, he said.

"Anything we do with this kind of work will reduce the need for conventional pesticides," Koehler said.

Development of enzyme-blocking products could happen but will require attention to termite behavior, said Brian Forschler, an entomology professor at the University of Georgia in Athens.

Recent research shows that termites, which live in colonies that can number 1 million, often consume partially digested material excreted by their compatriots, he said. So it would be important that bait products not disrupt termites' feeding behavior. If it did, termites might avoid an enzyme-stopping bait and instead share more partially digested food.

"You just have to remember that you're dealing with an entire termite colony," Forschler said. "This research holds a great deal of promise."

Further termite genetics research could reveal effective methods of disrupting termite social behavior, perhaps in ways that cause the insects to die, said Faith Oi, an assistant extension scientist with UF's entomology and nematology department.

"The model for exploiting the termite's social behavior for control is not new," said Oi, another co-author of the paper. "In terms of pest control, we can look to this area of science enhancing existing methods."

Source: University of Florida