Digesting the termite digestome -- a way to make biofuels?

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If the biofuel known as bioethanol is to make a major contribution to our fuel supplies, then we may well require the assistance of some tiny insect helpers, says Michael Scharf, an assistant professor of entomology at the University of Florida, Gainesville.

In a review to be published in *Biofuels, Bioproducts & Biorefining*, Scharf and his colleague Aurélien Tartar describe how the enzymes produced by both termites and the micro-organisms that inhabit their gut – known as symbionts – could help to produce ethanol from non-edible plant material such as straw and wood.

"Through millions and millions of years of evolution, termites and their symbionts have acquired highly specialised enzymes that work together to efficiently convert wood and other plant materials into simple sugars," says Scharf. "These enzymes are of the most value to bioethanol production."

Current bioethanol production processes tend to use edible plant materials, such as starch from corn (maize) and sugar from sugar cane, which contain easily accessible sugar molecules that can be fermented to produce ethanol. However, using food crops to produce ethanol has proved highly controversial, with bioethanol being blamed for much of the recent rises in food prices.

The non-edible parts of many plants also contain a large number of sugar molecules, which could potentially be used to produce ethanol. But the problem is that these sugar molecules are far less accessible. This is because they're locked up within a substance known as lignocellulose, which provides structural support for plant cell walls.

Breaking this substance up into its component sugar molecules is far from easy. One approach involves pretreating the lignocellulose by heating it in combination with acids or bases and then exposing the pretreated material to various enzymes. Another approach is very fine grinding followed by enzymatic treatment.

Termites, on the other hand, don't seem to have too much trouble digesting wood and other lignocellulosic materials into their component sugars, as many homeowners can attest. The termite appears to favour the fine grinding approach in combination with its own unique set of enzymes. These enzymes are secreted by both termites and the symbionts that colonise their gut, and act on the lignocellulose that has been chewed to very small particle sizes by the termite.

Despite the small size of the termite gut and the difficulty in analysing its contents, a few research groups have attempted to study what Scharf and Tartar call the termite digestome. This is the pool of genes, both termite and symbiont, that code for the enzymes that break down and digest lignocellulosic material.

Using a variety of genomic and proteomic techniques, these groups have managed to identify a number of the main enzymes, many of which could prove useful for producing ethanol. This work has already provided strong preliminary evidence that the enzymes produced by the termites and their symbionts tend to work collaboratively, with the lignocellulosic material having to be partially digested by termite enzymes before it can be further digested by symbiont enzymes.

But the study of the termite digestome has really only just begun. "There are many directions that the science can now head," says Scharf. "First, we now have the ability to produce and test individual enzymes for their competency and roles in lignocellulose degradation. Once we identify major players (from termites and symbionts), we can test combinations that may have applications in making bioethanol production more feasible from existing feedstocks, and maybe even other feedstocks that aren't on our radar screens yet."

This kind of digestome analysis could also be applied to other insects that feed on woody material, such as wood-boring beetles, and certain wasps and flies, Scharf adds.

Source: Wiley

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