New method to isolate biofuel-producing bacteria

There has been much debate about converting foods like corn grain into fuel for our cars. Even if all the corn grain in the US were converted to ethanol, it still wouldn't make enough fuel to replace gasoline. Not even close. That's why some scientists have been working on using plant fiber, such as the corn stalk, to make ethanol or other fuels. But plant fiber contains the molecule cellulose, which is difficult to digest.

Currently, cellulosic ethanol is produced by using strong acids or bases and high temperatures to make plant fiber available to enzymes, and then subjecting the pre-treated fiber with enzymes to produce sugars. These sugars are then fermented to ethanol, and the ethanol is distilled. It is a difficult and expensive process.

What if you found a microorganism that could just digest the whole corn plant, and convert it into ethanol? Scientists from the University of Maryland, Richard Kohn and Seon-Woo Kim, reported in the October issue of the Journal of Theoretical Biology that they have discovered why plant fiber does not usually end up as ethanol or other biofuels, and using that knowledge, they isolated several different strains of bacteria that make high concentrations of ethanol or butanol from plant fiber.

It turns out, in our search for organisms that can be used to directly convert biomass to ethanol or other fuels, we looked in all the wrong places. Or more specifically, we looked in all the wrong ways. These organisms are actually abundant in nature. The reason they don't usually make ethanol is that it is more thermodynamically favorable to make other products. When they make ethanol in nature, it is converted to something else, like the acid in vinegar called acetic acid or methane gas. However, artificial conditions can be applied to make ethanol production thermodynamically favorable. And under these conditions, ethanol is made. Kohn and Kim reported that they isolated several different strains of bacteria that make ethanol from plant fiber by using these artificial conditions.

The authors used fluid from the first stomach chamber or rumen of a cow. Cows are known to harbor microorganisms in their rumen that digest plant fiber faster than any other ecosystem on earth, but ethanol does not usually accumulate in the cow's stomach. That's fortunate because that amount of alcohol would kill the cow from an alcohol overdose. However, organisms in the cow's stomach do make ethanol and others organisms take the ethanol up and convert it to acetic acid and other acids or methane. Once the ethanol-producers are isolated, they can be used to make ethanol accumulate in a fermentation bioreactor.

Kohn and Kim took the organisms out of the rumen through a hole placed directly to the rumen by a veterinarian. Then they changed the media and added a special ingredient, hydrogen gas, that made it thermodynamically more favorable to make ethanol than acids and methane. Under these conditions, organisms that make ethanol grew faster and could be enriched and isolated from the

rest.

Then Kohn and Kim went on to use the same method to make other alcohols and even the same hydrocarbons found in gasoline: hexane and octane. They also found they could make fuels directly from hydrogen and carbon dioxide.

Although the Department of Energy and many investors have invested millions of dollars trying to genetically engineer organisms like these, the article said that such organisms appear to be common in nature. You just have to look in the right places, and look in the right way.

Publication

Using the second law of thermodynamics for enrichment and isolation of microorganisms to produce fuel alcohols or hydrocarbons.
Kohn RA, Kim SW
J Theor Biol. 2015 Oct 7