# Scientists work to plug microorganisms into the energy grid

May 18 2009

The answer to the looming fuel crisis in the 21st century may be found by thinking small, microscopic in fact. Microscopic organisms from bacteria and cyanobacteria, to fungi and microalgae, are biological factories that are proving to be efficient sources of inexpensive, environmentally friendly biofuels that can serve as alternatives to oil, according to research presented at the 109th General Meeting of the American Society for Microbiology.

"We have been charged to develop the next generation of cellulosic biofuels. When we successfully supply sources of energy to the grid from non-food, cellulosic, parts of plants we will mitigate the food versus fuel debate," says Tim Donohue of the University of Wisconsin, Madison, one of two directors of Department of Energy Bioenergy Research Centers who spoke today in a session at the meeting.

When it comes to alternative fuels, currently ethanol is king. Almost all ethanol produced in the United States is fermented from readily available sugars in corn starch or corn kernels. Producing ethanol from corn has also come under much criticism lately, accused of being responsible for rising food prices.

Researchers are looking at alternate biomasses as food for microorganisms to ferment into ethanol. The most attractive are known as lignocellulosic biomass and include wood residues (including sawmill and paper mill discards), municipal paper waste, agricultural residues (including sugarcane bagasse), dedicated energy crops (like switchgrass) or the non-edible parts of corn like cobs, stalks or stover. The problem is, unlike corn starch, the sugars necessary for fermentation are trapped inside the lignocellulose part of this plant biomass. The key to ending the food versus fuel debate is unlocking the sugars trapped in cellulosic biomass.

To do that, some scientists have taken a page out of the playbook of the pharmaceutical industry. Pharmaceutical companies routinely use a process known as high throughput screening to rapidly test thousands of compounds for potential new drugs. Martin Keller at Oak Ridge National Laboratory, the DOE bioenergy research center director, and his lab have adapted the method to rapidly test poplar tree samples for their ability to give up sugars.

"We for the first time ever have developed a super-screening pipeline to handle thousands of samples. We took samples from approximately 1,300 poplar trees in the northwestern United States and used the screening pipeline to see if there was a difference in sugar release," says Keller. "Trees can be very different. Some trees can be easier to digest, even within the same species."

Keller is not sure why some poplars are more likely to give up their sugars than others. It could be genetic or the result of some environmental factor or a bit of both. They are now conducting experiments, growing poplar saplings under controlled environments to better understand.

In addition to studying the biomass itself, Keller's lab is also looking for microbes or microbial products that can help break it down into simple sugars. They are currently studying a bacterium found in a hot spring in Yellowstone known as Anaerocellum. It grows at approximately 80 degrees Celsius and is what is known as a consolidate bioprocessing microbe: It can not only break down the cellulosic biomass to sugars but ferment it to acetate and ethanol, saving time and money.

"Right now it is expensive to break down cellulosic biomass. That is why we don't have a sustainable biofuels industry. This is what we as a center are working to overcome," says Keller.

Once they have overcome that problem, there are companies ready to move forward. Andreas Schirmer from the company LS9 in South San Francisco describes a unique strategy. LS9 has engineered a proprietary microbe to produce UltraClean™ diesel in a one-step process. They have discovered a way to exploit the pathway that microbes use to make energy-rich fatty acids for the synthesis of cell membranes and energy storage compounds, and divert them for their own purposes. Inside the fermentor, the microbes and feedstock sit in water, so the oil-like fuel compounds rise to the surface and can be easily collected, much more efficiently than the energy rich distillation process necessary to produce ethanol.

Schirmer says they are currently using sugar cane as a cost-effective option and estimates an 80 percent reduction in carbon footprint compared to petroleum-based fuels.

"It is a bridge feedstock. Once second generation feedstocks come online we will be able to convert production over to them quickly and achieve even greater reductions in greenhouse gas emissions," says Schirmer.

Beside ethanol and biodiesel, researchers are also looking at producing hydrogen from renewable resources. Donohue's lab is working with purple bacteria called Rhodobacter sphaeroides that use photosynthesis to produce hydrogen from a combination of cellulosic feedstocks and sunlight. The hydrogen can then converted to electricity using fuel cells that his lab is also developing. They have completed laboratory scale prototype "microbial batteries" using the bacteria and the fuel cells in a single enclosed system that, when exposed to sunlight, produces enough electrical current to power a laptop.

"This is just a look under the hood at the types of activities that are going on in the United States to take advantage of microbial activities and deploy them to create the next generation of fuels," says Donohue.

Source: American Society for Microbiology

Citation: Scientists work to plug microorganisms into the energy grid (2009, May 18) retrieved 23 April 2024 from https://phys.org/news/2009-05-scientists-microorganisms-energy-grid.html