Cow stomach holds key to turning corn into biofuel

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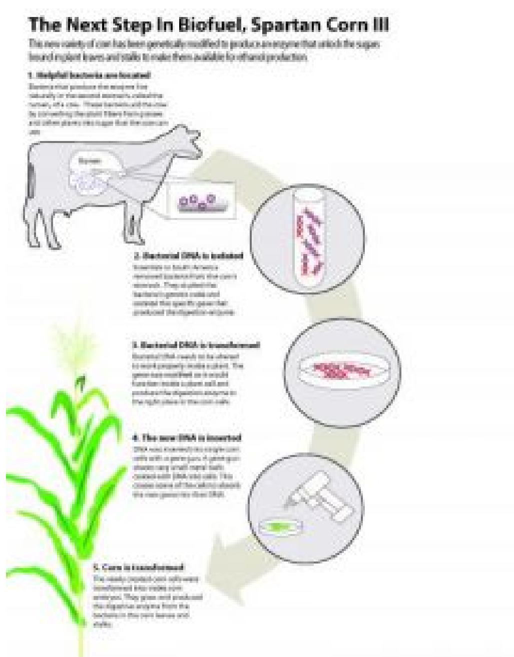

The graphic illustrates the process in which corn is genetically modified to produce an enzyme that unlocks the sugars bound in plant leaves and stalks to make them available for ethanol production. Credit: Gordon Shetler

An enzyme from a microbe that lives inside a cow's stomach is the key to turning corn plants into fuel, according to Michigan State University scientists.

The enzyme that allows a cow to digest grasses and other plant fibers can be used to turn other plant fibers into simple sugars. These simple sugars can be used to produce ethanol to power cars and trucks.

MSU scientists have discovered a way to grow corn plants that contain this enzyme. They have inserted a gene from a bacterium that lives in a cow's stomach into a corn plant. Now, the sugars locked up in the plant's leaves and stalk can be converted into usable sugar without expensive synthetic chemicals.

"The fact that we can take a gene that makes an enzyme in the stomach of a cow and put it into a plant cell means that we can convert what was junk before into biofuel," said Mariam Sticklen, MSU professor of crop and soil science. She is presenting at the 235th national American Chemical Society meeting in New Orleans today. The work also is presented in the "Plant Genetic Engineering for Biofuel Production: Towards Affordable Cellulosic Ethanol" in the June edition of Nature Review Genetics.

Cows, with help from bacteria, convert plant fibers, called cellulose, into energy, but this is a big step for biofuel production. Traditionally in the commercial biofuel industry, only the kernels of corn plants could be used to make ethanol, but this new discovery will allow the entire corn plant to be used – so more fuel can be produced with less cost.

Turning plant fibers into sugar requires three enzymes. The new variety of corn created for biofuel production, called Spartan Corn III, builds on Sticklen's earlier corn versions by containing all three necessary enzymes.

The first version, released in 2007, cuts the cellulose into large pieces with an enzyme that came from a microbe that lives in hot spring water.

Spartan Corn II, with a gene from a naturally occurring fungus, takes the large cellulose pieces created by the first enzyme and breaks them into sugar pairs.

Spartan Corn III, with the gene from a microbe in a cow, produces an enzyme that separates pairs of sugar molecules into simple sugars. These single sugars are readily fermentable into ethanol, meaning that when the cellulose is in simple sugars, it can be fermented to make ethanol.

“It will save money in ethanol production,” Sticklen said. “Without it they can’t convert the waste into ethanol without buying enzymes – which is expensive.”

The Spartan Corn line was created by inserting an animal stomach microbe gene into a plant cell. The DNA assembly of the animal stomach microbe required heavy modification in the lab to make it work well in the corn cells. Sticklen compared the process to adding a single Christmas tree light to a tree covered in lights.

“You have a lot of wiring, switches and even zoning,” Sticklen said. “There are a lot of changes. We have to increase production levels and even put it in the right place in the cell.”

If the cell produced the enzyme in the wrong place, then the plant cell would not be able to function, and, instead, it would digest itself. That is why Sticklen found a specific place to insert the enzyme.

One of the targets for the enzyme produced in Spartan Corn III is a special part of the plant cell, called the vacuole. The vacuole is a safe place to store the enzyme until the plant is harvested. The enzyme will collect in the vacuole with other cellular waste products

Because it is only in the vacuole of the green tissues of plant cells, the enzyme is only produced in the leaves and stalks of the plant, not in the seeds, roots or the pollen. It is only active when it is being used for biofuels because of being stored in the vacuole

“Spartan Corn III is one step ahead for science, technology, and it is even a step politically,” Sticklen said. “It is one step closer to producing fuel in our own country.”

Source: Michigan State University

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