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Cooperative State Research, Education, and Extension Service

National Research Initiative (NRI)

Adding Value to Biofuel Waste

by Stacy Kish, CSREES

What do you get when you cross *E. coli* with biofuel waste products? A new process that may revolutionize the economic development of the growing biofuel industry. >>

Biofuels represent the best sustainable, secure, and renewable alternative to fossil fuels. Unfortunately, biofuel production is beset by the same problem as traditional petroleum refining – excess waste. In traditional refining, only about 60 percent of the crude oil becomes gasoline, the rest is used to make other products. Similarly, as biofuel production increases, the market is being flooded with its waste byproducts, specifically glycerin, also known as glycerol.

Glycerin is cheap and abundant in the current marketplace. Although there are many potential uses for the substance, it is difficult to break it down into products with greater economic value.

With funding from USDA's Cooperative State Research, Education, and Extension Service (CSREES), Ramon Gonzalez at Rice University developed a new fermentation process that uses *E. coli* to convert glycerin into high-value chemicals, like succinate.

Succinate and its derivatives have an annual domestic market of more than $1.3 billion.

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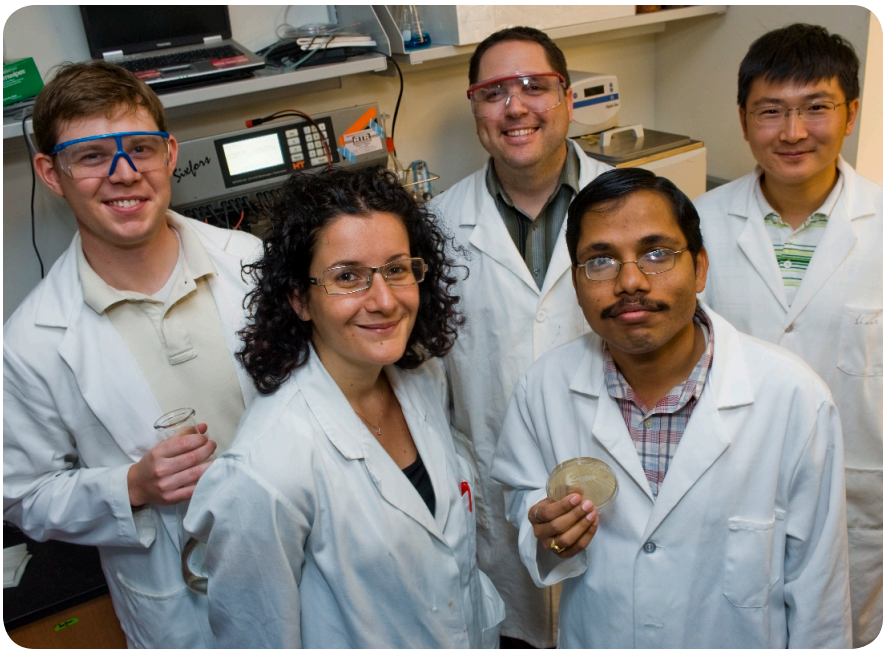

Right: Ramon Gonzalez (center), the William W. Akers Assistant Professor in Chemical and Biomolecular Engineering, joins graduate students (from left) James Clomburg, Clementina Dellomonaco, Ashutosh Gupta and Ruiqiang Sun in the lab.

***Credit:** Jeff Fitlow, Rice University*

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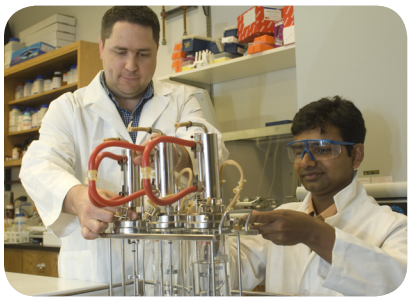

Above: Ramon Gonzalez, the William W. Akers Assistant Professor in Chemical and Biomolecular Engineering, and Syed Shams Yazdani, postdoctoral research associate, have identified the metabolic processes and conditions that allow a known strain of *E. coli* to convert glycerin into ethanol.

Credit: Jeff Fitlow, Rice University

Succinate is used in a variety of products including flavoring agent in food and beverages, an intermediate compound for dyes and perfumes, and medical applications. Another product, formate, is principally used as a preservative and antibacterial agent in livestock feed.

Most of the waste glycerin comes from the production of biodiesel, one of the two types of biofuels (the other being ethanol). Biodiesel is converted from a variety of oils, including rapeseed and soybean oils, mustard, flax, sunflower, and palm oil, waste vegetable oil, animal fat oil, and algae.

About one pound of glycerin is produced for every 10 pounds of biodiesel. According to the National Biodiesel Board, U.S. companies produced about 450 million gallons of biodiesel in 2007. With 60 new plants capable of producing 1.2 billion gallons of biofuel slated for operation by 2010, an answer to the glycerin question cannot come soon enough.

"Biodiesel producers used to sell their leftover glycerin, but the rapid increase in biodiesel production has left them paying to get rid of it," Gonzalez said. "The new metabolic pathways we have uncovered pave the way for the development of new technologies to convert this waste product into high-value chemicals."

Technologies based on Gonzalez's work have been licensed to Glycos Biotechnologies Inc., a Houston-based startup company that plans to open its first demonstration facility within the next 12 months.

NRI awards grants for research, education, and extension activities that address key problems of national and regional importance in biological, environmental, physical, and social sciences relevant to agriculture, food, the environment, and communities on a peer-reviewed, competitive basis. For more information, visit:

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The research team is now working to further understand the biochemical pathways used by the organism to break down the glycerol so new organisms can be engineered for the production of fuels and other chemicals from glycerol.

"Our goal goes beyond using this discovery for a single process," Gonzalez said. "We want to use the technology as a platform for the 'green' production of a whole range of high-value products."

CSREES funded this research project through the National Research Initiative Biobased Products and Bioenergy Production Research program. Through federal funding and leadership for research, education and extension programs, CSREES focuses on investing in science and solving critical issues that affect people's daily lives and the nation's future. For more information, visit www.csrees.usda.gov. ■

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