Soybeans a source of valuable chemical: Scientists turn low-value soy mash into high-value succinic acid

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Indigestible byproducts of soybeans can be turned into valuable succinic acid through a process developed at Rice University. Credit: Photos.com

(Phys.org)—The humble soybean could become an inexpensive new source of a widely used chemical for plastics, textiles, drugs, solvents and as a food additive.

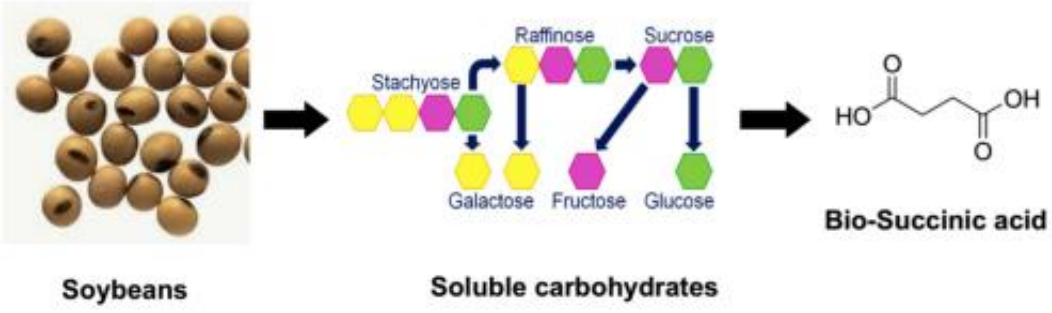
Succinic acid, traditionally drawn from petroleum, is one focus of research by Rice chemists George Bennett and Ka-Yiu San. In 2004, the Department of Energy named succinic acid one of 12 "platform"

chemicals that could be produced from sugars by biological means and turned into high-value materials.

Several years ago, Rice patented a process by Bennett and San for the bio-based production of succinic acid that employed genetically modified *E. coli* bacteria to convert glucose into succinic acid in a way that would be competitive with petroleum-based production.

The new succinate process developed by Bennett, San and Chandresh Thakker and reported recently in *Bioresource Technology* promises to make even better use of a cheap and plentiful feedstock, primarily the indigestible parts of the soybean.

"We are trying to find a cheaper, renewable raw material to start with so the end product will be more profitable," said Thakker, a research scientist in the Bennett lab at Rice's BioScience Research Collaborative and lead author of the study. "The challenge has been to make this biomass process cost-competitive with the petrochemical methods people have been using for many years."



Byproducts of soybeans include soluble carbohydrates that can be turned to succinic acid when metabolized by E. coli bacteria engineered at Rice University. Succinic acid is used in a variety of products, including plastics, textiles, drugs, solvents and food. Credit: Bennett Lab/Rice University

Bennett feels they have done that with soybean-derived feedstock as an inexpensive source of the carbon that microorganisms digest to produce the desired chemical via fermentation. "A lot of people use plant oils for cooking – corn or soybean or canola—instead of lard, as they did in the old days," he said. "The oils are among the main products of these seeds. Another product is protein, which is used as a high-quality food.

"What's left over is indigestible fiber and small carbohydrates," said Bennett, Rice's E. Dell Butcher Professor of Biochemistry and Cell Biology. "It's used in small amounts in certain animal feeds, but overall it's a very low-value material."

The Rice researchers are changing that with the help of *E. coli* bacteria engineered to process soy meal that generally gets discarded. Certain microbes naturally produce succinic acid from such feedstock, but manipulating *E. coli*'s metabolic pathways (by eliminating pathways that produce other chemicals like ethanol, for instance) can make it far more efficient.

Expanding on their success in producing succinic acid from glucose, the new microbes are engineered to metabolize a variety of sugars found in soybean meal. The theoretical ideal is a 1:1 ratio of feedstock (the extracted sugars) to product, which they feel is achievable by industry. In the lab, under less controlled conditions, they still found the process highly efficient. "We're demonstrating a very high yield," Thakker said. "We're achieving in a flask a non-optimized formation of succinate that is close to the theoretical goal."

Bennett said his lab has been looking at soybeans for nearly three years. "We're always interested in low-cost feedstock," he said. "We were able to get a connection with a soybean group that is very interested in technologies to make better and more profitable use of their crop.

"There's a fair amount of oilseed residuals available including cottonseed carbohydrates, that's not used for any high-value product, and we're in the space of microbial engineering to enable these sorts of materials to be used in a good way," he said.

More information: www.sciencedirect.com/science/ … ii/S096085241201663X

Provided by Rice University