Modified *E. coli* Bacteria Produces Butyric Acid in Greater Concentrations

This genetically modified bacterial biocatalyst produces butyric acid at higher concentrations than previously possible in mineral salts medium without complex nutrients. Butyric acid and its derivatives are used in the food, perfume, chemical, and pharmaceutical industries. For example, it’s used in the preparation of various butyrate esters used as food and perfume additives. Butyric acid is also converted to butanol, which depending on the source of carbon is a renewable biofuel. Other applications of butyric acid include plastics production, octane enhancement, and it’s also implicated in improving intestinal health and having anti-inflammatory effects. Currently, industrial scale butyric acid is produced by oxidation of butyraldehyde derived from propylene obtained during refining of petroleum. Although this is an inexpensive pathway for production as long as oil prices remain low, there remains a need to develop cost-competitive production from renewable sources. Butyric acid production by fermentation mostly utilizes anaerobic bacteria and is a sustainable way of producing this chemical but generating much higher yields depends on improvement of butyrate-producing microbial biocatalysts. Feed additives also contain butyrate due to its suggested medial properties, but bio-based butyric acid is more preferable than petroleum-based butyrate in this application.

Researchers at the University of Florida have developed a genetically modified strain of *E. coli* that efficiently converts simple sugars to butyric acid in a medium with only mineral salts and sugar without generating byproducts that reduce yield and complicate downstream processing.

Application

Genetically modified bacteria that improve the production of butyric acid for use in the manufacture of renewable fuel, medications, and ester-based commodities

Advantages

- Uses genes from anaerobic microorganisms to establish a butyrate metabolic pathway in *E. coli*, generating higher yields of butyric acid
- Produces butyric acid with low levels of contamination by other metabolic byproducts or medium components, reducing cost of manufacture

Technology

*E. coli* does not naturally produce butyric acid; to overcome this limitation, genes from microorganisms that produce butyric acid have been added to the *E. coli* genome. Typically, the process of converting
simple sugars to butyric acid also produces other organic acid byproducts. However, this newly engineered microbial biocatalyst produces butyric acid as the primary product, maximizing the yield of butyric acid and minimizing the need to remove byproduct contaminants. Additionally, fermentations further improve the economics of the process when conducted in a mineral salts medium.

Inventors

Keelnatham Shanmugam, Ph.D., is a professor in the Microbiology and Cell Science Department in the College of Agricultural and Life Sciences at the University of Florida, where he researches bacterial anaerobic metabolism, dinitrogen fixation and dihydrogen production by fermentative bacteria, and cyanobacteria molybdate transport and regulation.

Lonnie Ingram, Ph.D., was a distinguished professor in the Department of Microbiology and Cell Science at the University of Florida and Director of the Florida Center for Renewable Chemicals and Fuels. He earned his Ph.D. in Botany from the University of Texas at Austin in 1971. The U.S. Department of Agriculture (USDA) awarded him with a Distinguished Service Award for his research achievements, and in 2001 he was inducted into the US National Academy of Science. His research interests included global redirection of central metabolism by genetic engineering, industrial fermentation processes, carbohydrate metabolism, expression and secretion of glycohydrolases that degrade plant polymers, and alcohol tolerance.

Contact:  
John Byatt • 352-392-8929 • jbyatt@ufl.edu  
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