Engineered yeast speeds ethanol production

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Scientists from Whitehead Institute and MIT have engineered yeast that can improve the speed and efficiency of ethanol production, a key component to making biofuels a significant part of the U.S. energy supply.

Currently used as a fuel additive to improve gasoline combustibility, ethanol is often touted as a potential solution to the growing oil-driven energy crisis. But there are significant obstacles to producing ethanol. One is that high ethanol levels are toxic to the yeast that ferments corn and other plant material into ethanol.

By manipulating the yeast genome, the researchers have engineered a new strain of yeast that can tolerate elevated levels of both ethanol and glucose, while producing ethanol faster than un-engineered yeast.

The work will be reported in the Dec. 8 issue of *Science*.

Fuels such as E85, which is 85 percent ethanol, are becoming common in states where corn is plentiful; however, their use is mainly confined to the Midwest because corn supplies are limited and ethanol production technology is not yet efficient enough.

Boosting efficiency has been an elusive goal, but the researchers, led by Hal Alper, a postdoctoral associate in the laboratories of MIT chemical engineering professor Gregory Stephanopoulos and Whitehead Member Gerald Fink, took a new approach.

The team targeted two proteins that belong to a class of proteins called transcription factors. These proteins typically control large groups of genes, regulating when these genes are turned on or shut off.

When the researchers altered a transcription factor called the TATA-binding protein, it caused the over-expression of at least a dozen genes, all of which were found to be necessary to elicit an improved ethanol tolerance. As a result, that strain of yeast was able to survive high ethanol concentrations.

In addition, this altered strain produced 50 percent more ethanol during a 21-hour period than normal yeast.

The prospect of using this approach to engineer similar tolerance traits in industrial yeast could dramatically impact industrial ethanol production, a multi-step process in which yeast plays a crucial role. First, cornstarch or another polymer of glucose is broken down into single sugar (glucose) molecules by enzymes, then yeast ferments the glucose into ethanol and carbon dioxide.

Last year, four billion gallons of ethanol were produced from 1.43 billion bushels of corn grain (including kernels, stalks, leaves, cobs, husks) in the United States, according to the Department of Energy. In comparison, the United States consumed about 140 billion gallons of gasoline.

Source: Whitehead Institute for Biomedical Research