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Bioengineers Develop Bacterial Strain to Increase Ethanol Biofuel Production

A team of bioengineers in the United States has modified a strain of bacteria to increase its ability to produce ethanol. The research, published in Biotechnology and Bioengineering, reveals how adaptation and metabolic engineering can be combined for strain improvement, a positive development for the biofuel industry?

The team focused their research on Zymomonas mobilis, a bacterium noted for its bio-ethanol producing potential. However, the team believed that ethanol production could be increased through improvement of xylose fermentation.

"Zymomonas mobilis is a superb ethanol producer with productivity exceeding yeast strains by several fold," said lead author Rachel Chen from the Georgia Institute of Technology. "In this study we sought to improve ethanol production by enhancing the ability of Z. mobilis to use and ferment xylose. Fermenting xylose at high concentration could in turn increase ethanol concentration, resulting in much improved productivity."

The team found that by metabolically altering the strain, sugar fermentation time was reduced from over 110 hours to about 35 hours. This improvement in fermentation allowed the strain to ferment higher concentrations of xylose.

"This demonstrated increase in fermentation and xylose utilization enabled us to produce ethanol to a concentration of 9% (w/v), the highest ever shown for this organism in mixed sugar fermentation," said Chen.

This research also investigated the underlying mechanism for the improvement. Interestingly, by adapting a strain in a high concentration of xylose, significant alterations of metabolism occurred.

One noticeable change was reduced levels of xylitol, a byproduct of xylose fermentation which can inhibit the strain's xylose metabolism. In addition, the first step of xylose metabolism, believed to be the rate-limiting step, was accelerated 4-8 times in the adapted strain, with the net effect of channeling xylose to ethanol instead of xylitol.

"This research illustrates the power of adaptation in strain improvement," concluded Chen. "This confirms that xylitol metabolism is the key to efficient use of xylose in this bacterium, which in turn can be vital for producing ethanol. This shows that adaptation is not only useful in improving strains, but is equally useful for pinpointing key bottlenecks in metabolically engineered strains."

Agrawal. M, Mao. Z, Chen. R. Adaptation yields a highly efficient xylose-fermenting Zymomonas mobilis strain. Biotechnology and Bioengineering, December 2010 DOI: 10.1002/bit.23021