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Conversion of Carbon dioxide directly to a liquid fuel, Isobutyraldehyde

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Slowing down the effects of global warming, which refers to an increase in the average temperature of earth's atmosphere due to an increase in concentration of greenhouse gases, is an issue of universal concern. The global changes in climate have stimulated campaigns and drives to reduce CO_2 (a greenhouse gas) emissions due to burning fossil fuels. According to the US Energy Information Administration, world energy-related CO_2 emissions in 2006 were 29 billion metric tons with an increase of 35% from 1990. As a consequence of human activities, atmospheric levels of CO_2 have raised by ~25% over the past 150 years. Thus it has become increasingly crucial to develop new technologies to reduce CO_2 emissions.

In a novel approach, researchers from the UCLA Henry Samueli School of Engineering and Applied Science have genetically altered a cyanobacterium ***Synechococcus elongatus*** to consume carbon dioxide and produce isobutyraldehyde. The reaction is driven directly by energy from sunlight, through photosynthesis. Isobutyraldehyde is a precursor of various hydrocarbons such as isobutanol, isobutyric acid, acetal, oxime and imine but isobutanol can be used as a gasoline alternate particularly (**Figure 1**).

In this approach, employing the cyanobacterium Synechoccus elongatus the enzyme Rubisco (ribulose 1,5-bisphosphate carboxylase/oxygenase), which catalyzes the CO_2 fixation reaction in the Calvin-Benson-Bassham (CBB) cycle has been enhanced genetically because of its poor turnover number and the competition between O_2 and CO_2 at the active site. Then they spliced genes from other microorganisms to engineer a strain that intakes carbon dioxide and sunlight and generates isobutyraldehyde gas. Its low boiling point and high vapor pressure allows it to easily be stripped from the system and reduces product toxicity. The engineered strain stays active for 8 days and generates isobutyraldehyde at a higher rate than those accounted for ethanol, hydrogen, or lipid production by cyanobacteria or algae.

The need for biomass wipeout is obviated employing this new technology, either in the case of biomass obtained from cellulose or algae, which is a major economic barrier for biofuel production. Hence, this is potentially much more effective and less expensive than the current approach. The benefits of this method are that it recycles carbon dioxide, reducing greenhouse gas emissions resulting from the burning of fossil fuels and it consumes solar energy to convert the carbon dioxide into a liquid fuel that can be used in the existing energy infrastructure, including in most automobiles.

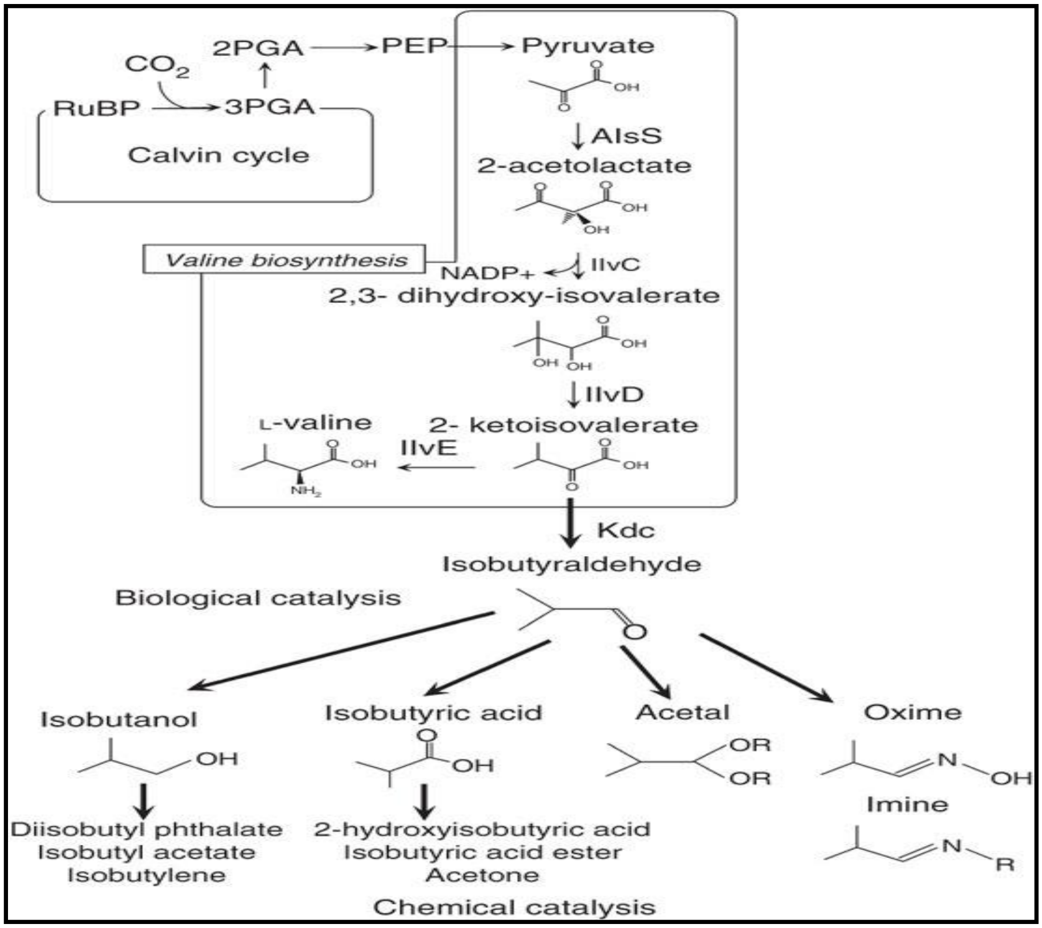

Figure 1. The pathway for isobutyraldehyde production

References:

1. S. Atsumi, W. Higashide, J. C. Liao, *Nature Biotechnol.* **2009**, *27*, 1177–1180.