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Yeast fine-tuned for bio-fuel

Doctoring yeast and bacteria may be the answer to more gasoline-like bio-fuels, says S.Ananthanarayanan.

Alcohol, made from sugar and yeast, has been used as fuel for ages. More recently, since the entry of the internal combustion engine, alcohol has been mixed with petrol, both to depress the freezing point as well as a cheaper substitute. But alcohol has not been a viable replacement and we continue to depend on mineral oil resources. The breaking news is that bio-molecular scientists at Los Angeles, California, have engineered micro-organisms to produce more suitable forms of alcohol.

Good and bad

Fuels like petrol are superior to say wood or coal because they are portable and because they leave no residue when they burn. And their liquid form, of course, which makes them suitable for the automobile type engines. They also have greater energy content, for the same weight, than common combustibles.

In some of these terms, alcohol compares well, because alcohol is cheap, portable and suitable for the same kind of engine. It scores slightly higher on residue, because it produces no carbon monoxide when it burns but its great advantage is that it is a renewable energy source, readily generated from sugarcane cultivation. But the reason it has not replaced petrol is its negatives.

Brazil fuel outlets sell both petrol and alcohol

These are that it is volatile, it absorbs water vapour from the atmosphere, has less energy content for unit weight and causes corrosion of the engine where it is burnt. Nevertheless, it has become an important alternative and is widely used in Brazil and even in Russia.

Overcoming shortcomings

These disadvantages of alcohol get remedied if we go to the so called 'higher alcohols'. The common potable alcohol, or 'spirit' is the easiest, immediate product of fermentation of glucose, the simplest form of sugar, which is done with the help of yeast. Yeast, in a few steps, transforms glucose like this:

$$C_6H_{12}O_6 \text{ ---> } 2C_2H_5\text{--}OH + 2CO_2$$

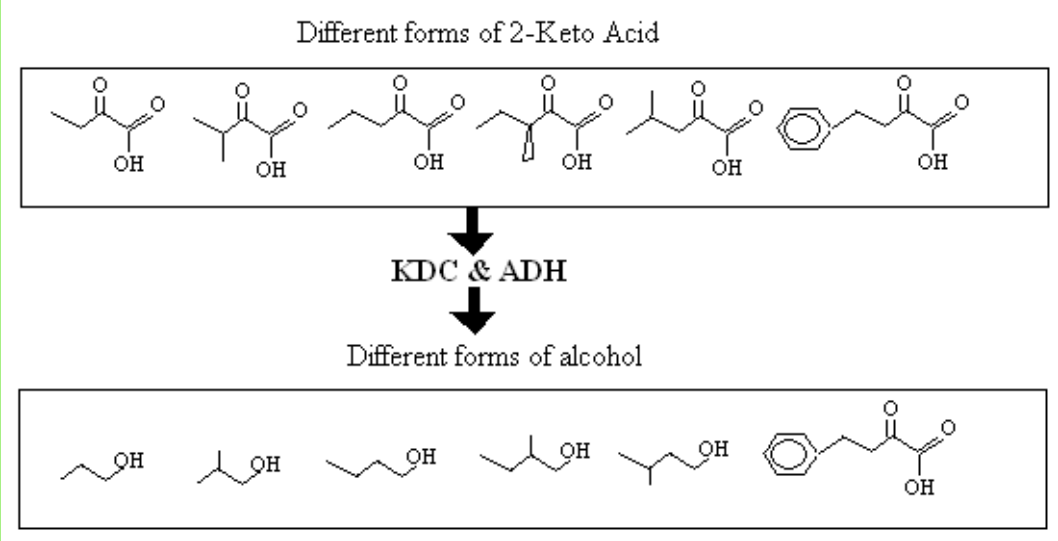
On the left of the equation is glucose, which consists of 6 parts of carbon, 12 of hydrogen and 6 of oxygen. Yeast breaks glucose up into ethyl alcohol, the first substance to the right of the arrow, and carbon dioxide. A bit of the energy of glucose gets used up but the process requires no oxygen and the best thing is that all we need is a colony of yeast and reasonably warm weather.

But this alcohol is the simple alcohol, with only two parts of carbon in the base, and this kind has the disadvantages of being volatile, etc. More complex alcohols, like propanol, butanol or phenylethanol, which contain more parts of carbon, are able to avoid these disadvantages – they are more stable and pack more energy. But the problem is that there has been no micro-organism, like yeast, which can generate these higher alcohols from sugars and they need to be produced by expensive procedures.

The Los Angeles brew

The UCLA scientists genetically modified the common bacterium, e-coli so that it could act on glucose to lead through the process to end as different higher alcohols. The method is to start with the natural property of e-coli to synthesise amino acids, the building blocks of proteins. E-coli does this magic in steps, with an intermediate step being to produce a substance called 2-Keto acid. This intermediate product can be readily converted into higher alcohols with the help of substances, called KDC and ADH, that are found in plants and other organisms.

Genetic engineering procedures then developed strains of e-coli that produced by themselves not just the just 2-Keto acids but also the KDC to lead to higher alcohols. The strains of e-coli could even be tweaked so that the right 2-Keto acids were produced and then different alcohols, as shown in the picture.



The procedure has been found to be quite general can be adapted for use with yeast or other micro-organisms that of industrial importance. The doors are being seen as opened to a vast prospect of bio-fuel production.