Syngas fermentation - Growing bacteria on CO2

K. B. Falkenberg

DTU Biosustain, Technical University of Denmark

ABSTRACT

Currently an increasing number of initiatives are being implemented to decrease the levels of greenhouse gases in the atmosphere, carbon dioxide (CO2) in particular. Common for most green technologies, is the focus on decreasing the emissions of CO2, created in industrial processes. This often means changing to less efficient and more expensive alternatives of production.

Now the tendency is changing from viewing the greenhouse gases as a pollutant, to instead utilizing them as a resource. This principle is conceptualized in the process called “syngas fermentation”.

Syngas fermentation utilizes a group of bacteria’s natural property to metabolize a gas mixture called syngas, consisting of CO2 and hydrogen (H2). Syngas can either be mixed by gas from different sources or synthesized by gasification of coal, biomass or organic waste, which makes it a cheap and sustainable resource.

The bacteria utilized in syngas fermentation are called acetogens, which, when grown in a liquid environment, can fixate dissolved syngas and use it as substrate to create useful biochemicals. The most promising type of acetogens is called Moorella, and when grown on syngas as substrate, the un-engineered bacteria found in nature produce acetate, which can be converted to petrochemicals by chemical polymerization. Another possibility is using the acetate as building block for further metabolic conversion by engineering the Moorella bacteria or feeding the acetate to other bacteria, which in both instances could convert it to other biochemicals such as pharmaceuticals, food additives or biofuels.

Very little is known about these bacteria, and their sensitivity to oxygen and thermophilic nature creates an inherent challenge in studying and working with them in the laboratory. Thus a lot of effort is put into researching and genetically enhancing these bacteria.

In my research with the Moorella bacteria, I study well-known biotechnological methods used in other organisms, in order to find potential analogs compatible with the Moorella bacteria. One of these methods is the β-galactosidase assay, which incorporates a gene in the bacteria, turning the bacteria blue when grown on plates containing a lactose-analog called X-gal. This can be used in molecular cloning, as a visual indication of whether or not DNA has successfully been incorporated into the cells, and thus a very convenient way of distinguishing a successful cloning product from other unsuccessful ones. The challenge being that the method has to be compatible with the oxygen-free environment, the organism and its optimal growth conditions at high temperatures. This and other advances in the field will hopefully lead to us being able to commercialize the bacteria as a green biocatalyst, turning otherwise harmful CO2 into useful fuels or pharmaceuticals.