Results in Brief

Cyanobacteria for hydrogen production

A pioneering European consortium has launched a research project into blue-green algae, also known as cyanobacteria, which are adapted by synthetic biology approaches to produce hydrogen as an alternative biofuel.

The aim of the EU-funded CYANOFACTORY (Design, construction and demonstration of solar biofuel production using novel (photo)synthetic cell factories) project was to introduce new genetic circuits into cyanobacteria.

These aquatic microorganisms can generate hydrogen as a side product of photosynthesis. However, the hydrogen produced quickly degrades before it is released from the cells. In order to produce larger quantities at faster rates, cyanobacteria were engineered to prevent the chemical conversion of the produced biohydrogen.

Synthetic biology approaches, therefore, played a central role in the CYANOFACTORY project. By exploiting the knowledge of well-established biochemical processes and gene functions, highly specific genetic modifications were introduced to the photosynthetic organisms to produce biohydrogen.
cyanobacteria carry foreign genes, particular attention was paid to safety.

CYANOFACTORY partners inserted genes encoding more efficient enzymes and down regulated genes for the unnecessary chemical conversion of the produced hydrogen. Strains were acclimatised to increase their tolerance to the chemicals they produce and the fluctuating growth conditions to which they are exposed in outdoor photobioreactors.

A suicide mechanism was introduced in case of accidental leakage of cyanobacteria from photobioreactors into the environment. This programmed cell death was based on pairs of toxins and antitoxins existing in the cells of these aquatic microorganisms and is harmless to humans.

The final step of the CYANOFACTORY project was the construction of a network of interconnected 100-litre photobioreactors, which were flat enough to allow the microorganisms to get enough light. This system enabled project partners to validate hydrogen production parameters determined in the small-scale laboratory experiments and to identify potential manufacturing bottlenecks.

Project partners trained many students and young scientists at the outset of their careers in this important field of microbial solar fuel production. There was a clear focus on innovative synthetic biology and advanced photobioreactors as well as how to handle, store and analyse larger data sets.

CYANOFACTORY biohydrogen synthesis does not compete with the production of food nor have an adverse impact on the environment, as it requires little more than microbial cells, sunlight and a biohydrogen-capturing system. This new technology will have a beneficial impact on Europe’s emerging bioeconomy by growing engineered organisms efficiently and economically on a large scale.

**Keywords**

Cyanobacteria, biofuel, CYANOFACTORY, biohydrogen, photobioreactor, bioeconomy

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**Project Information**

**CYANOFACTORY**

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EU contribution

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