M.Sc. Project

Title:

Reverting the carbon cycle: from CO_2 to biodiesel

Supervisors: Dr. Luís G. Gonçalves/ Prof. Helena Santos

Host Laboratory: Cell Physiology & NMR, ITQB-UNL, Oeiras

Duration: 1 year

Introduction

The modern society dependency on oil and other fossil resources is not sustainable at mid or long term. The exhaustion of fossil fuel reserves and the environmental problems caused by their combustion, with the release into the atmosphere of carbon dioxide and other pollutants leads to the urgent need to develop new processes for fuel production.

The transition from an oil based society to another based solely on renewable energy is difficult, expensive, and not feasible in the immediate future. Therefore, there is an urgent need to develop new short-term strategies to lessen the environmental impacts derived from the utilization of fossil fuels.

One of the most interesting and promising technologies relies on the use of carboxydotrophic microorganisms. These organisms have the ability to anaerobically convert CO/CO_2 and H_2 to multicarbon compounds, in most cases by the Wood-Ljungdahl pathway. Taken together, these three gases are referred to as syngas. Currently, carboxydotrophic organisms are commercially used for the production of ethanol through syngas fermentation. However, these microorganisms are not yet used for the production of more energetic fuels similar to diesel, such as alkanes, with increased commercial value. This is the major aim of the current proposal: to develop carboxydotrophic strains directed for the synthesis of alkanes from $CO/CO_2/H_2$ mixtures. Two strategies will be used to achieve this goal:

1) Screening diverse carboxydotrophic organisms for the ability of produce alkanes and characterization of their CO and CO_2 utilizing pathways;

2) Engineering *Clostridium ljungdahlii* for alkane production.

In the first strategy, we will investigate the carbon flow of CO_2 and CO in diverse organisms to understand their metabolism, resorting to ^{13}C-NMR. We will also look for natural alkane producers among the carboxydotrophic organisms. Special emphasis will be given to carboxydotrophic (hyper)thermophilic organisms.

In the second strategy, *C. ljungdahlii*, an already industrial producer, will be engineered with the recently discovered cyanobacterial genes involved in alkane synthesis. Those organisms produce alkanes from the reduction and decarbonylation of fatty acyl-ACP. The genes encoding those activities are absent in the known genomes of carboxydotrophic organisms. Recently, genetic tools for *C. ljungdahlii* were developed, making this organism the ideal carboxydotrophic candidate for metabolic engineering. The utilization of other carboxydotrophic organisms, such as *Acetobacterium woodii*, as host for the alkane synthetic pathway will be considered as a contingency plan.

Methodologies

- NMR spectroscopy;
- Cultivation of anaerobes;
- Genetic manipulation of non conventional microorganisms;

Contact

Luís G Gonçalves (lgafeira@itqb.unl.pt; 214469561).