Development of a platform yeast for the production of sustainable aviation fuels from biowaste

Summary

Aviation has brough several benefits to modern society. It plays a central role in increasing global connectivity, allowing for faster exchange of information and technological advancements, increasing the reach of good ideas for a better society. Airborne transport is also key for humanitarian efforts that require a quick response, such as natural disasters. At the same time, this means of transportation has the highest carbon footprint per passenger-kilometer and still heavily relies on fossil fuels, setbacks that must be dealt with so the benefits of this technology can be harnessed in a long-term timeframe without compromising the environment. One of the efforts made in this direction is the development of Sustainable Aviation Fuels (SAF). Those can be produced from materials' such as food or agricultural waste by employing microbial cell factories that can convert the carbon present in the former into molecules with high energy density like fatty acids or terpenes. However, yield and efficiency for the conversion of biowaste carbon sources into those molecules are still low, something that must be overcome to produce economically viable SAF.

Research field:	Chemistry and biotechnology
Supervisor:	Prof. Dr. Petri-Jaan Lahtvee
Availability:	This position is available.
Offered by:	School of Science Department of Chemistry and Biotechnology
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

This study aims to generate a platform yeast strain that can efficiently grow in agro-industrial waste and convert its carbon into a metabolic precursor of both fatty acids and terpenes. *Rhodotorula toruloides*, a non-conventional yeast already possessing the metabolic apparatus to produce those molecules and known for its natural resistance to inhibitors in biowaste, will be the starting point of the experimental work. This Ph. D. project will be divided in two main tasks:

Metabolic engineering for substrate uptake in agricultural waste

Targets *R. toruloides* genes involved in growth inhibition tolerance in selected waste streams will be identified through *omics* tools. Once identified these targets may be subject to protein engineering and overexpressed for the generation of an *R. toruloides* strain with, preferably, improved growth in various agricultural wastes. This strain can be further improved for increased uptake of the carbon sources present in the same substrates. This will be done by the identification of key enzymes involved in the early steps of each uptake, followed by the engineering of their kinetic capability and overexpression in the tolerant strain.

Metabolic engineering for increased pool of fatty acid and terpenes precursor

Omics tools will also be used for the identification of bottleneck metabolites limiting the production of fatty acids and terpenes, especially those that intersect with the central carbon metabolism. Key enzymes within the identified pathways will be selected for engineering to improve their catalytic efficiency, substrate specificity, and expression levels. The engineered enzymes will be integrated into *R. toruloides* genome, and flux balance analysis will be conducted to ensure that the pathways are properly balanced. The engineered strains will be tested for their ability to grow in various agricultural waste streams and produce high yields of fatty acid and terpene precursors. Metabolite analysis will be performed to quantify the production levels and identify any remaining bottlenecks.

Supervisor: Prof. Petri-Jaan Lahtvee

Co-supervisor: Dr. Juliano Sabedotti De Biaggi

Research group: Food tech and Bioengineering (Dep. of Chemistry and Biotechnology)

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