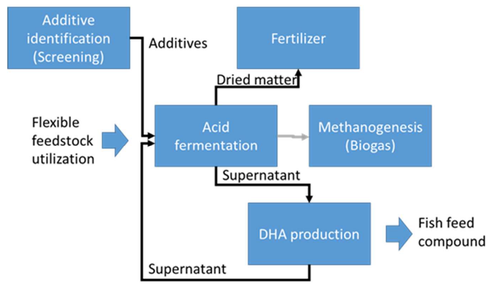
PASS-BIO
Plug flow reactor –based Acid fermentation for Small-Scale BIOrefineries

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Background:

Acid fermentation has a great potential to use any undefined feedstock mixtures and convert it to building blocks, which then are converted to products of higher value. The project PASS-BIO aims to investigate and optimize acid fermentation in plug flow bioreactors. By the addition of additives, especially enzymes, which are identified in automated screening, the application of gradient measurements along the plug-flow reactor, and polarizability measurements to assess the activity of microorganisms, a robust process shall be achieved. The supernatant shall be applied in heterotrophic algae cultivation for polyunsaturated fatty acid production.



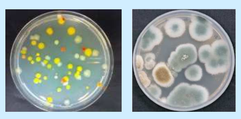
Concept and Results

Screening for tailored additives

Université de Lille, REALCAT

Egon Heuson, Roxane Roulo, Vincent Phalip, Sébastien Paul

Selection of feedstock
Isolation of microorganisms from each specific feedstock

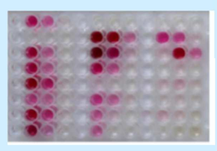


Microorganisms of interest

- Anaerobic bacteria – the plug-flow reactor process will not be sparged with oxygen, the selected microorganisms shall be able to grow in an anaerobic/microaerobic environment.
- Filamentous fungi – microorganisms that produce enzymes that will help to degrade feedstock.

High-throughput selection of anaerobic bacteria strains using an automated colony picker.

Selection of the fungal strains based on their enzyme activities to degrade feedstock.



High-throughput screening based on anaerobic bacterial growth on the selected feedstock with and without enzyme cocktails produced from selected fungi.

Goals

- Identify the best bacterial and fungal degraders for the different feedstock.
- Design a new strain selection methodology that can be applied to any type of feedstock in an automated manor.

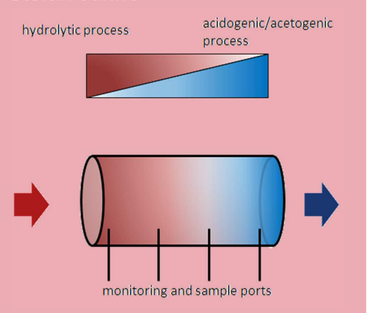
Lab-scale plug-flow acid fermentation

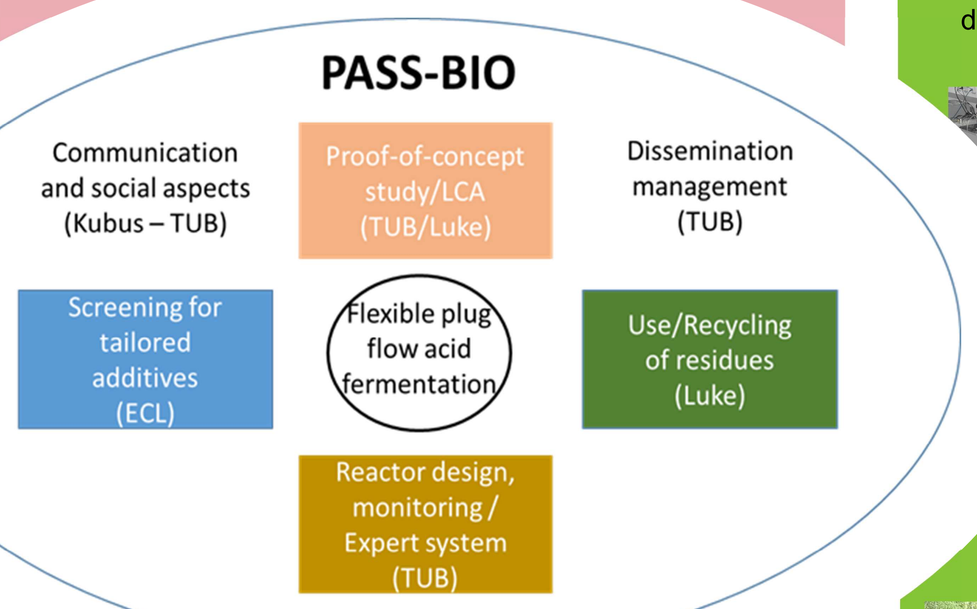
TU Berlin, Institute of Biotechnology, Technische Universität Berlin, Bioprocess Engineering

Marion Longis, Anja Lemoine, Sebastian Riedel, Peter Neubauer, Stefan Junne

In close cooperation with the other partners, various conditions are applied to investigate:

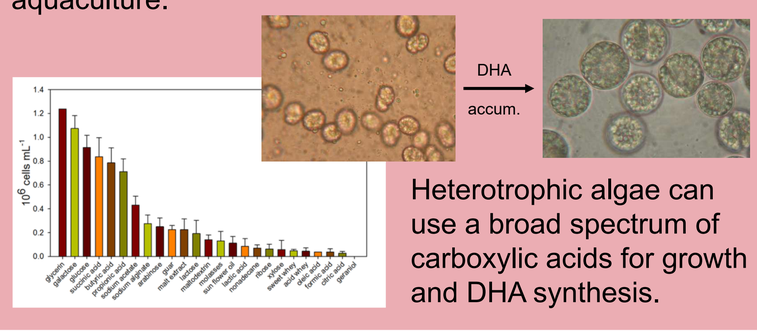
- The relation between gradient formation, process performance, and microbial viability.
- The importance of gradients as measured at various ports (fig. at right side) for process monitoring and control.
- The flexibility of the process for various feedstock.





Value-addition of carboxylic acids

- The liquid phase of the acid fermentation will be used as feed in the intracellular production phase of heterotrophic algae cultivation (fig. at the right bottom side) to produce the polyunsaturated fatty acid docosahexaenoic acid (DHA) , which replaces fish oil as fish feed additive in aquaculture.



Heterotrophic algae can use a broad spectrum of carboxylic acids for growth and DHA synthesis.

Lab-scale testing

Luke Natural Resources Institute Finland

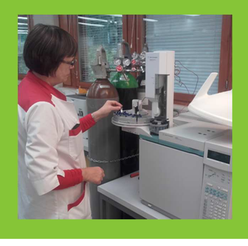
Saija Rasi, Markku Vainio

Different feedstock is tested in collaboration with TUB:

- Liquid circulation optimization in plug-flow mode.
- Carboxylic acid production enhancement.
- Purification of carboxylic acid stream.

Proof of concept

- Transfer of monitoring concept from TUB to Luke
- Monitoring of lab and full-scale plug-flow digester as scale up study.



Recycling and utilisation of nutrients

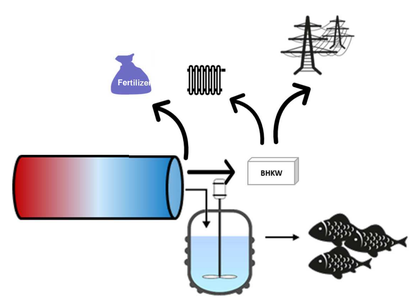
- Assessment of amounts of nutrients in liquid and solid streams from plug-flow reactor digestate.
- Estimation on the need of post-treatment of digestate
- Optimization of nutrient recycling.

Energy and material flows

- Energy and material flows of plug-flow based acid fermentation compared to methane production in LCA studies.

Expected results:

- Methodology to rapidly identify enzymes and enzymatic cocktails to support feedstock degradation. A microbioreactor (BioLector®) will be used to to test the ability of selected microorganisms for feedstock degredation. The most suitable enzymatic cocktail is used for further biomass valoriztion in lab scale and pilot scale.
- Robust plug-flow based acid fermentation with and expert system is implemented for gradient-based process control.



Dissemination actions:

- Economic and ecologic evaluation of the concept, if coupled to single-cell oil production as case study.
- Proof-of-concept in an eco-village for public demonstration and in a pilot plant in Finland.
- Science cafès in France and Germany to demonstrate potentials for a sustainable aquaculture.

Further Information

TU Berlin, Chair of Bioprocess Engineering: http://www.bioprocess.tu-berlin.de

Université de Lille, Realcat: http://realcat.ec-lille.fr/en/

Luke Research: https://www.luke.fi/en/

https://projects.au.dk/faccesurplus/research-projects-2nd-call/pass-bio/

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