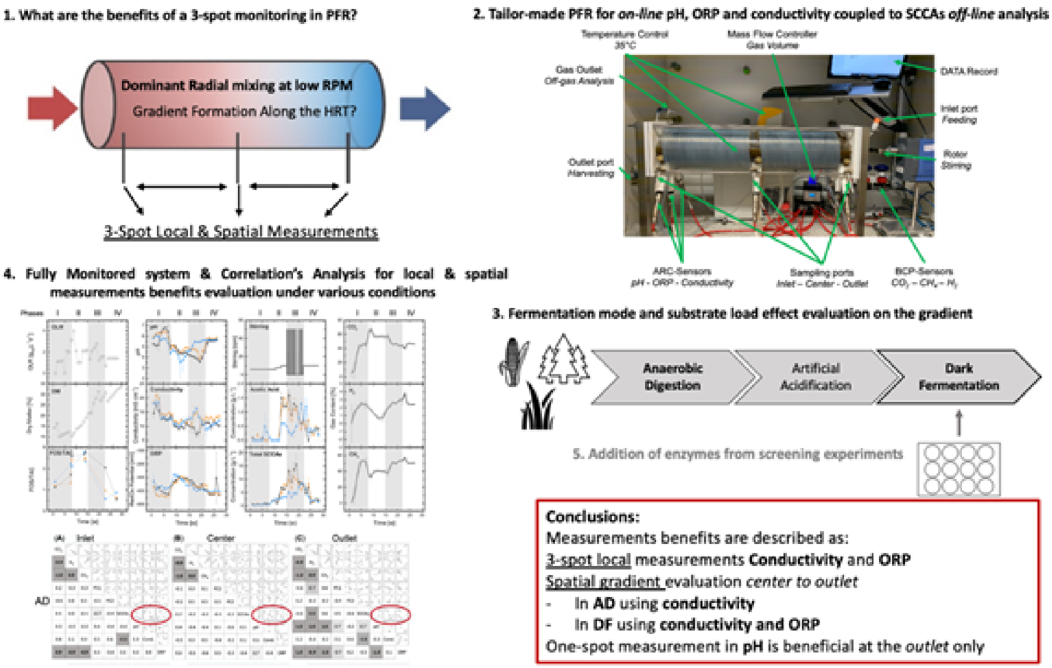
PASS-BIO

PLUG FLOW REACTOR –BASED ACID FERMENTATION FOR SMALL-SCALE BIOREFINERIES



2° Call:	2017
Project period:	07/2018 – 12/2021
Topic:	Small Scale Biorefieneries
Keywords:	Short-chain carboxylic acid valorization, feedstock flexibilization, dark fermentation, gradient monitoring
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Total funding:	600.000 €
Website:	projects.au.dk/faccesurplus/research-projects-2nd-call/pass-bio

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

PASS-BIO
plug-flow acid fermentation

BACKGROUND

Many renewable feedstock resources for bioprocesses become expensive or are difficult to access once the scale of operation becomes large and is worldwide applied. An increase in the share of residual material can resolve this problem, especially if a flexibility for using different feedstock is achieved. Then an integration into local biogenic residue cycles become possible. Anaerobic digestion is naturally a process with a high feedstock flexibility. If this is operated as acid fermentation / dark fermentation, a coupling of anaerobic digestion with a material use of biomass instead of rather an energetic use is feasible. The acids can be applied in subsequent monocultivation processes for valorization, which is aimed here for the production of the polyunsaturated fatty acid docosahexaenoic acid (DHA) as food and feed additive.

OBJECTIVE

The multidisciplinary PASS-BIO project aims to establish a bioreactor module for the flexible conversion of a wide variety of feedstock following a plug-flow principle. Although this technology is not new, it's full potential in terms of process robustness in comparison to the common stirred tank reactor concept is not used. The application of residues as fertilizer and the use of products as nutrients in other bioprocesses like for DHA production was investigated to perform a proof-of-concept study for a new, low-cost and easy-to-operate module for a sustainable small-scale biorefinery, including and economic and ecologic evaluation.

METHODOLOGY

Several probe installations in the liquid phase along the length of the reactor were used to investigate gradient formation and its potential for monitoring and control. Feedstock pre-treatment methods were applied and adjusted to the requirements of the process. The partners TU Berlin and LUKE applied the lab-scale plug-flow bioreactor in continuously operated dark fermentation at flexible feedstock load, including residual side streams. The partner Université de Lille established a small-scale screening system methodology to allow the rapid identification of the most suitable microorganism consortia along with its operating conditions for enzyme addition to the reactor concept. The main objective was to define the best catalysts to use for the treatment of different biomass sources including microbial consortia for bioaugmentation or enzyme cocktails. A workflow was developed how to isolate organisms directly from the feedstock and how to rapidly investigate and optimize the subsequent fermentation process for the individual feedstock composition with the help of the gradient monitoring concept. The remaining, acid-containing supernatant of the culture broth will be applied to heterotrophically grown microalgae for the ability to produce DHA.

RESULTS

Firstly, the workflow for the screening and isolation of microorganisms was implemented to achieve microorganism and enzymatic cocktails that were added to the plug-flow based fermentation. The majority of the enzymes were produced from isolated fungi found on the applied grass silage and wood chips. For digestion, an organic loading rate (ORL) of between 2 and 10 gVS/Ld was used a hydraulic retention time (HRT) of between 5 and 20 days. The process was acidified for short-chain carboxylic acid accumulation. The gradient formation of the pH-value, redox potential and conductivity was continuously monitored. In most of the conditions, the gradient formation of the conductivity was linearly correlated with the acid accumulation and the vitality of the organisms, while it was found that the pH-value measurement at all spots isn't providing much more information than the traditional one-spot measurement. The adjusted monitoring concept stabilizes processes at dynamic feedstock loading with complex to degrade substrate.