

# Future European League 4 Microalgal Energy

FUEL4ME e-bulletin Nr.5, December 2015



Welcome to our fifth e-bulletin! You will find information about the progress made by the partners of FUEL4ME. Time is running fast, and we have put a lot of effort in developing a sustainable integrated process for biofuel production in the last two and a half years. The progress in FUEL4ME is visible; the pilot plant in Huelva Spain is running and shows a great potential for cultivation of microalgae.

The new edition of FUEL4ME e-bulletin contains information about fundamental research on microalgae and the one step production of lipids, the activities carried out for outdoor production of microalgae, and basic information about the downstream process for conversion of biomass to biofuels and the optimization of harvesting, cell disruption and extraction processes.

DG Energy from the European Commission invited JOANNEUM RESEARCH to the 3rd European Workshop on Life Cycle Analysis of Algal based Biofuels & Biomaterials. This workshop showed future possibilities of biobased and renewable biofuels and biomaterials of algae. It showed as well the importance of Life Cycle Analysis (LCA) to assess the environmental impacts of production of biofuels and biomaterials from algae over the whole value chain. This event took place on 11<sup>th</sup> May 2015 in Brussels. During the meeting, JOANNEUM RESEARCH presented the modeling approach within the sustainability assessment in FUEL4ME project and gave information about up-scaling issues in algae systems.

Furthermore we had our 5<sup>th</sup> project meeting in May 2015. It was fruitful meeting in the nice surroundings of Seville. During this meeting we visited the pilot plant in Huelva, which was very impressive and we got a great insight on the facilities there.

Enjoy reading our e-bulletin!

FUEL4ME partners in the pilot plant in Huelva visiting  
NIELS-HENRIK NORSKER installations in the last  
General Assembly in May 2015



### Fundamental research on microalgae

#### One step production of lipids

Previously in this project, a strategy for one-step lipid production in *P. tricornutum* was designed and tested at lab scale (1.7L flat-panel photobioreactors). Simultaneous growth and lipid accumulation was reached in nitrogen limited turbidostats operated under day/night light cycles, thereby providing a proof of principle of one-step lipid production in *P. tricornutum*. Optimization of this process is needed to further increase lipid content and productivity. Currently, samples are being analysed on differences in expression on transcript, protein and metabolite level to get a better understanding of the key pathways involved in lipid production during the one-step process.

This study also showed that a one-step process could be competitive to the traditional two-step batch cultivation strategies. Nevertheless, photosynthetic efficiencies decrease significantly under such nitrogen limitation. This results in dissipation of a large part of the supplied light energy. Thus, lipid productivity could be improved if such dissipation would be prevented. In an effort to do so, follow up research will be done to find the right balance between light intensity and nitrogen feed rate in these one-step processes.

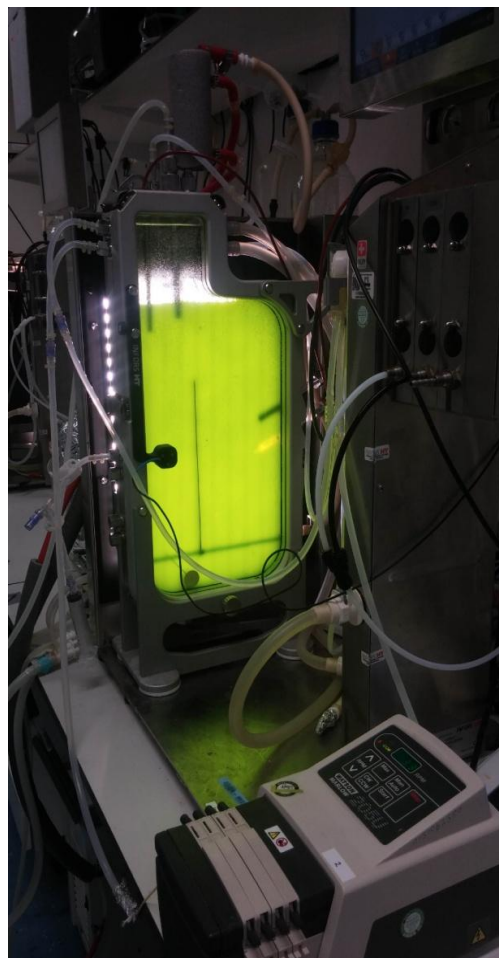


Figure 1. Simultaneous growth and lipid accumulation



## Translation to outdoors and production

### Outdoor production of microalgae

Fuel4me partners have dedicated last months in performing new outdoor tests at pilot and demo scales.

Biomass and fatty acids productivities and inputs for the **LCA analysis** were compared at different nitrogen regimes, seasons and locations.

Winter/Spring tests were conducted at BGU under nitrogen sufficiency with both strains selected in the project.

**Spring/Summer starvation and limitation tests** were conducted outdoors at F&M with both strains selected within the project. The trials allowed the collection of input data for WP5 with cultivation done both in batch and in semi-continuous modes. New tests will be conducted in Autumn and Winter in order to have a full year recordings of biomass and fatty acid productivities and input data required.

DLO-FBR started the testing phase with batch cultivation of *N. Oceanica* outdoors.

A small (2 bag units) and large (20 bag units) Demo plant, based on the Proviron technology, were installed at Huelva (south of Spain). The small demo was used for outdoor test with *N. oceanica* and *P. tricornutum*, while the large one will be used for biomass production to be delivered to WP3.

A methodology to be followed for the extrapolation of data obtained in pilot plants to ideal plant of different commercial scales was defined.



Figures 2 and 3. GWP®-III reactors at F&M pilot plant (Florence-Italy) and horizontal tubular for outdoor microalgae cultivations at AlgaePARC (The Netherlands)

## Downstream process for conversion to biofuels

### Optimization of harvesting, cell disruption and extraction processes

The results obtained during last months on the different algae downstream processes, where collected for a further study of the whole process.

**For harvesting**, a second version of the Evodos T 10 machine was installed at Wageningen. Extra tests were done at a higher G force (4000 G vs 3000) obtaining the same separation efficiency (> 95%). For the demo site in Spain, the new improved Evodos machine T 25 with a water recycling unit was already delivered to Biotopic premises. With this equipment large amounts of biomass can already be harvested for further downstream process

**Meanwhile cell cracking** tests has been done by Cellulac with the SoniqueFlo equipment. These tests were done for *Nannochloropsis* paste received from Biotopic. Tests were conducted by run in re-circulation mode and ramping up temperature to 95 °C exit. The system was operated at atmospheric pressure. Algae was diluted to 10% solids and cells were disrupted through different rig passes. Different analytical methods were developed to measure the lipid release of the algae after the process to quantify the cell cracking efficiency. Additional work has been done on alignment of theoretical and actual algae output. i.e due to dilution from steam and other factors. Next steps will be providing FeyeCon with cracked cells to study its effect on extraction efficiency.

**For the extraction and fractionation**, *Phaeodactylum* biomass was extracted by means of supercritical CO<sub>2</sub> technology with the best conditions found for *Nannochloropsis*. The extraction yield was 64% of the total fatty acids in the biomass and the analysis showed that almost all neutral lipids were efficiently removed. Currently larger amounts of biomass are being extracted for characterization.

**Fractionation** of PUFAs by supercritical CO<sub>2</sub> has been greatly improved by FeyeCon. A tuning of the process was done by feeding the column with a ethyl esters oil. PUFAs content was increased from 50 to more than 85% with a recovery of more than 80% in the raffinate. The amount of CO<sub>2</sub> required was optimized by running the column continuous mode. Further tests showed that this fractionation technology can be used not only to purify omega 3 PUFAs from short chain fatty acids, but also isolation of individual omega 3 PUFAs, such as EPA. By increasing slightly the pressure it was increased the EPA content from 35% to 63%. As the EPA is obtained in the distillate, it would be free of the other contaminants that could be in the *Nannochloropsis* or *Phaeodactylum* oil. The resulting high purity EPA product would be very valuable in the market, making the biofuel more economically competitive.

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## Upcoming activities

### ALGAE EUROPE CONFERENCE 2015

1-3 December 2015, Lisbon (Portugal)

<http://algaecongress.com/>

**Aim:** ALGAE EUROPE offers a unique opportunity for the exchange between academia and industry. It will be established in a networking based environment that will allow to discuss the evolution of the Algae Biomass sector worldwide and understand the role of the main European Players.

### European roadmap for an Algae-Based Industry

6-8 April 2016, Olhão (Portugal)

**Aim:** The aim is to connect the different European projects on microalgae and from that identify new targets for future research and development. One of the goals of this meeting is to report the highlights from the different projects with the objective of developing a white paper on industrial algae biotechnology in Europe.

The focus should be on technology development and Innovation (strain development, process strategies, scale up, LCA, economic models).

### 24th European Biomass Conference & Exhibiton

6-9 June 2016, Amsterdam (The Netherlands)

<http://www.eubce.com/home.html>

**Aim:** The EUBCE is the event in which the members of the bioenergy community can get a broad picture of the situation and trends emerging in today's market.

The Conference provides a high-level scientific programme and parallel events which attract participants from a wide-ranging background: researchers, engineers, technologists, standards organisations, financial institutions, policy makers and decision makers.

This event is supported by European and international organizations. The Technical Programme is coordinated by DG Joint Research Centre of the European Commission.



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## FUEL4ME goal and motivation

**FUEL4ME's main objective is to develop a sustainable, scalable process to produce biofuels and valorize the by-products by 2017.**

Fuel4me is driven by the urgent need of transforming our energy model into a sustainable one, which pursues the European and global energy goals reducing CO<sub>2</sub> emissions, finding alternatives to fossil fuels and fostering the renewable energies. Microalgae are one of the most attractive sources of biodiesel, since they can produce energy-rich molecules. Fuel4me aims at developing and demonstrating an integrated and sustainable process for continuous biofuel production from microalgae, and thereby making the second generation of biofuels competitive alternatives to fossil fuels.

## FUEL4ME partners



If you are interested in FUEL4ME activities you are also welcome to visit us in [www.fuel4me.eu](http://www.fuel4me.eu)