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CULTIVATION OF *NANNOCHLOROPSIS OCEANICA* F&M-M24 AND *TETRASELMIS SUECICA* F&M-M33 IN THE TWO 0.5-HA BIOFAT PILOT PLANTS FOR BIOFUEL PRODUCTION

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Abstract:
The EU FP7 BIOFAT project aimed to demonstrate at pilot and then demo scale the feasibility of biofuel production from microalgal biomass using two marine strains belonging to the Collection of Microalgae and Cyanobacteria of Fotosintetica & Microbiologica S.r.l., the lipid producer Nannochloropsis oceanica F&M-M24 and the carbohydrate producer Tetraselmis suecica F&M-M33, as models. Two 0.5 ha BIOFAT Pilot Plants were built, one in Camporosso (Imperia, Italy) (BCPP) and one in Pataias (Portugal) (BPPP). BCPP comprises two 250-m2 modules of GWP®-II photobioreactors (WO 2011/013104 to F&M) for inoculum production, two 530-m2 raceway ponds for growth and two 1,250-m2 raceway ponds for starvation trials. BPPP comprises 3-m2 GWP®-I photobioreactors for inoculum production, 270-m2 tubular photobioreactors for growth and two 1500-m2 cascade ponds for starvation. BCPP was in operation from March 2015 until the end of the project in April 2016, BPPP started operations in June 2014. In BCPP growth and starvation trials were performed for 4 or 6 days with both N. oceanica F&M-M24 and T. suecica F&M-M33. The starvation phase was performed in seawater without nutrient addition. From these trials annual productivities were estimated. For N. oceanica F&M-M24 the estimated average annual productivity is of 9.5 g m-2 land area d-1 in the GWP®, and of 14 and 8 g m-2 d-1 in the raceway ponds under nutrient replete and starved conditions, respectively. Total lipids reached about 40% of biomass dry weight, with a fatty acid composition sub-optimal for biodiesel production (but with high EPA content). Detailed fatty acid composition will be illustrated. T. suecica F&M-M33 in the ponds attained a carbohydrate content of about 35%, lower than what achieved in GWP®-II

reactors (50% dry biomass). Starved biomass was delivered for biofuel production.
In BPPP, located in Portugal near Lisbon, and with an average annual radiation of 17 MJ m-2 d-1. N. oceanica was cultivated both under Nitrogen replete and depleted conditions, and both in Tubular Photobioreactors (TPBRs) and Cascade Raceways (CRWs), with very similar performances. In N-replete conditions, the average annual productivity was estimated based on the data obtained for the two systems, and is equivalent to 9 g m-2 d-1. The starvation stage was performed with artificial seawater, without nutrient addition. In N-depleted conditions N. oceanica the areal productivity obtained for an average radiation of 9 MJ m-2 d-1 was 7 g.m-2 d-1, achieving a total lipid composition that includes a FA content of 33% per DW after 6 days. Detailed fatty acid composition will be illustrated.
BIOFAT evidenced the necessity to combine biofuel production with high-value product recovery from the extraction panel (biorefinery approach) to achieve economic sustainability. To this end, optimisation in plant design and operation must be performed, and this process was applied to the design of the BIOFAT DEMO Plant. The two-stage strategy (high quality inoculum production under nutrient replete conditions followed by nitrogen starvation in large ponds) proved to work, although storage product accumulation during starvation was not as effective in raceway ponds as in GWP® photobioreactors. Raceways ponds of two different improved design provided expected performance in both pilot plants in terms of areal productivity and culture stability.
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About the authors:

Natascia Biondi, PhD in Microbial Biotechnology, is a researcher at the Department of Agrifood Production and Environmental Sciences of the University of Florence, working in the group led by Prof. Mario Tredici. She has 20 years experience in microalgae and has participated to several EC funded projects (FP4, FP7, H2020).

Luis Costa is a Biological Engineer and Chemical Engineer PhD by IST/TU Lisbon. After joining the company A4F in 2009, he has been involved in R&D activities at lab and pilot scale, engineering photobioreacotrs and production units, cultivation unit operation management and project management. He is currently Chief operation Officer.

About the company/institute:

The Department of Agrifood Production and Environmental Sciences of the University of Florence includes seven sections, among which the Microbiology Section, to which the group led by Prof. Mario Tredici belongs. The research topics of the research group are: design and realisation of pilot and industrial photobioreactors (in collaboration with F&M S.r.l., a UNIFI spin-off); microalgae culture for biofuel production; microalgae culture for food/feed production; bioactive molecules from cyanobacteria and microalgae for agro-industry, cosmetic and pharmaceutical applications; selection and culture of PUFA-rich and carotenoid-rich microalgae; live and preserved microalgae as feed for fish and mollusks.

A4F-Algae For Future, is a bioengineering company with 20 years of accumulated experience in research, development, design, implementation, operation and transfer of industrial projects for microalgae production, as well as biomass and/or co-products selling.

CONFERENCE PROGRAM

WEDNESDAY, 14 DECEMBER

09:00 - 09:10 Opening Session

09:10 - 09:40 Key note:
EU Perspectives for Algae research beyond 2020
Szilvia Bozsoki, European Commission, Directorate-General for Energy

09:40 - 11:00 Session 5:
Breakout to commercialization: 'Algae Cluster' and other 'Lighthouse' projects
Chair: Kyriakos Maniatis, European Commission, Directorate-General for Energy

FP 7 All-gas project: Demonstration scale under construction
Zouhayr Arbib, FCC Aqualia, SA, (Spain)

InteSusAl – The project's history and findings
Tom Bradley, Charles Parsons Technology Centre

Cultivation of Nannochloropsis oceanica F&M-M24 and Tetraselmis suecica F&M-M33 in the two 0.5-ha BIOFAT Pilot Plants for biofuel production
Natascia Biondi – Luis Costa, University of Florence/ A4F (Italy/Portugal)

The H2020-project Photofuel: Biocatalytic solar fuels for sustainable mobility in Europe
Hilke Heinke, Volkswagen (Germany)

11:00 - 11:30 Coffee break

11:30 - 12:50 Session 6:
Value chains in commercialization: EU biorefinery and added-value products
Chair: Olivier Lépine, AlgoSource

Sustainable integrated Algae Biorefinery for the production of bioactive compounds for Agriculture aNd Aquaculture (SABANA)
Gabriel Acien, University of Almeria, (Spain)

Production of specialties for food, aquaculture and non-food applications via multi-product biorefinery of microalgae: Progress of the EU FP7 project MIRACLES
Hans Reith, Wageningen University (the Netherlands)

Submerged Membrane Based Water Recycling & Harvesting for Microalgae Cultivation
Leen Bastiaens, Flemish Institute of Technological Research (VITO) (Belgium)

CO2Algaefix: Biofixation of CO2 from industrial flue gases by microalgae and its transformation into added-value products
Federico G. Witt, AlgaEnergy S.A. (Spain)

12:50 - 14:10 Lunch

14:10 - 15:30 Session 6 continued

COST Action ES1408: European Network for Algal-Bioproducts
Cristina Gonzalez-Fernandez, IMDEA Enegy (Spain)

Lipid production by Nannochloropsis oceanica at large scale: energy balance and techno-economic analysis
Liliana Rodolfi, University of Florence, (Italy)

Sustainable PoLymers from Algae Sugars and Hydrocarbons (SPLASH): lessons learned
Lolke Sijtsma, Wageningen Food & Biobased Research (the Netherlands)

Biobased polyurethanes from microalgae
Philip Sellars, University of Warwick (UK)

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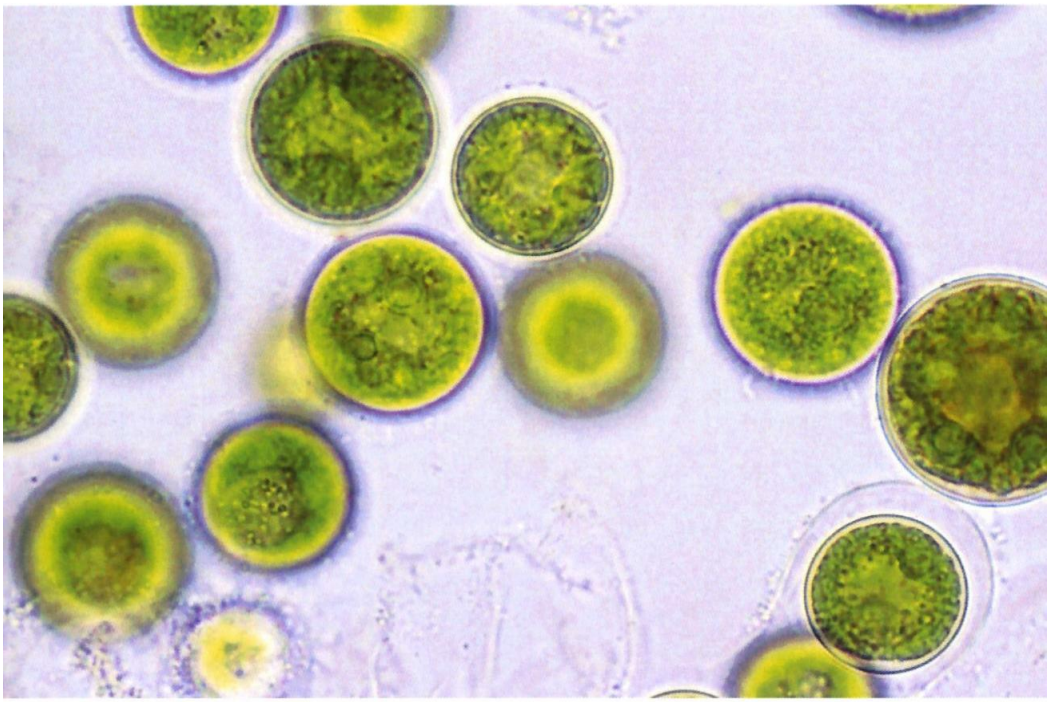

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