



Bio-based Industries  
Consortium



Horizon 2020  
European Union Funding  
for Research & Innovation



ALGAE FOR A BIOMASS  
APPLIED TO THE  
PRODUCTION OF ADDED  
VALUE COMPOUNDS

# NEWSletter

Issue n° 3  
JAN. 2020

## “Alg’in Provence” workshop, a successful event...

The European workshop “Alg’in Provence” took place on October 1-2 in Arles, South of France. The event was organised by CEA as part of the ABACUS project.

The event gathered more than 100 participants representing industrials (from large groups to SMEs), R&D and technology providers, equipment manufacturers for algae culture, academics and stakeholders, from 7 countries (France, Germany, Spain, UK, Portugal, Chile, Morocco).

During these 2 days, 23 speakers shared knowledge and news on applied algae technologies, algae R&I and algae-based bioeconomy opportunities around 5 topics: Algae biorefineries for added value ingredients, Blue biomaterials, Research & Innovation, Circular blue bioeconomy and Bioeconomy opportunities in the Sud-PACA region (please see the program below). In addition to oral presentations, participants had the opportunity to exchange and develop new collaborations around 23 poster presentations and 9 exhibitions on photobioreactors and monitoring equipment for algae cultivation, algae-based innovative ingredients and algae R&I.



## In this issue-----

- **Back to “Alg’in Provence” workshop 1-2 Oct 2019 – Arles**
- **Focus on WP3 & WP4**



On the 3rd of October, a site visit was organised at the LUMA foundation in Arles to introduce the cultural project of the Maja Hoffmann’s foundation. A special focus was put on the cross-disciplinary centre “Atelier LUMA” where the activities of the “Algae Platform” were presented. The project combines research and creativity to highlight the potentials of algae by using algae bio-materials for producing art items or replicas of archaeological objects.



1-2 October 2019  
Arles, France

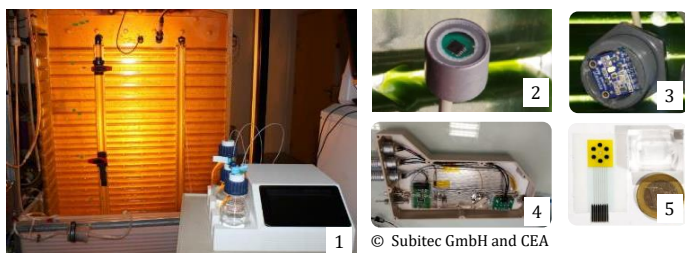
**Algae as a biomass with high  
potential for blue bioeconomy**

[http://www.abacus-bbi.eu/Pages/Workshop\\_with%20event%20report.aspx](http://www.abacus-bbi.eu/Pages/Workshop_with%20event%20report.aspx)

## WP3: Process design (PBR & specific process function)

As a reminder... “The solidification of **market opportunities** was first established for **terpenes/carotenoids** molecules and the specifications was defined for target molecules and **producing cyanobacteria/microalgae strains** to select **five product-strain pairs** to be exploited within the project (WP1). The **most promising strains** with **high productivities** (biomass & products) were **selected** from three private microalgae collections and by genetic engineering approaches and therefore **characterized** (WP2).”

In addition to **optimizing process parameters** for high biomass and product productivities by cultivating the selected strains in PBRs at pre-pilot scale, **WP3** aims at developing and integrating **new sensors for online process monitoring and control** of microalgae cultures.



Online sensors for monitoring and control microalgae cultivation processes. 1- Optofluidic system, 2- Turbidity probe, 3- RGB probe, 4- Micro GC, 5- Electrochemical platform.

For this purpose, complementary approaches were implemented. An **optofluidic system** (online LED-spectrophotometry) and a non-invasive **turbidity probe** (reflective infrared technology) were developed to **monitor algae growth** during cultivation. The successful implementation on PBRs confirmed their efficiency. Moreover, the accumulation of products of interest, as **carotenoids** and **light terpenes**, was followed online by a non-invasive **RGB probe** (colour sensing photodiodes) and **micro GC** (gas chromatography based system), respectively. In addition to standard parameters ( $T^{\circ}$ , pH,  $CO_2$ ), **nutrients** available in the culture medium could be quantified by an **electrochemical platform** (ion sensitive electrodes) for automated growth parameter adjustment.

As a proof of an **advanced control-command system** for OPEX reduction, a **demonstrator** composed of 16x FPA28L was developed and validated by Subitec with microalgae culture. The unit is fully automated with double-side LED illumination and equipped with new monitoring devices. It is also used to generate data for LCA within the project.

### SUBITEC GmbH

Based in Stuttgart (Germany) where it was created as a spinoff of the Fraunhofer IGB, this SME has industrialized the flat-panel airlift (FPA) PBR technology. It provides process engineering expertise for microalgae cultivation for several application fields from laboratory to industrial scale.

<https://subitec.com/en>

Role in ABACUS: As WP3 leader, Subitec draws the link between WP2 and WP4, providing both, PBRs and optimization skills for microalgae cultivation at pilot-scale. Subitec is involved in developing and integrating new sensors (turbidity & RGB probes) for online monitoring and control.

### CEA - French Commission of Alternatives Energies and Atomic Energy

CEA is a French RTO with 9 research centres and 7 regional technological platforms oriented towards research, development, innovation and technology transfer to industries.

<http://www.cea.fr/>

Role in the project: Besides its coordination role, CEA is present in all WPs. CEA Tech Region PACA builds the bridge between research done for algae selection (WP2) and industrial microalgae production (WP4). In line with Subitec, CEA LETI is focused on designing and developing new sensors (optofluidic system, microGC based system and electrochemical platform).

# WP4: Up scaling culture of algae and biomass production

WP4 integrates results obtained in WP3 for microalgae cultivation processes and technological innovations and implements them at the **industrial level**. The five scenarii (product-strain pairs, see below) selected in the project roadmap are the guidelines used to **upscale production to industrial systems**. First objective is to **provide multi-kgs batches** of algal biomass as feedstock for extraction and fractionation into active ingredients (WP5). Also, WP4 aims at **demonstrating the production processes on representative pilot lines** and **provides data for Life Cycle Analysis (LCA) and Techno-Economic Assessment (TEA)** done in WP7.

Given the specificities of the five selected algae species, **PBR technology** and **mode of operation** were defined and validated for each strain. Specific PBR systems (closed systems) based on **vertical flat panel (FP)**, **uni/multilayer horizontal tubular PBR (UHT/MHT-PBR)**, **cascade raceways (CRW)** and **flat panel airlift (FPA)** were implemented by the SME partners (A4F, Microphyt and Subitec). Biomass and carotenoid productivities were recorded on significant periods of time. The **semi-continuous mode**, a partial periodic harvest, was chosen for all the cases. For some fragile strains, the **harvesting step** was deeply optimized to decrease carotenoid losses during solid/liquid separation.



1- ©A4F

2- @Microphyt

3- @Subitec

*PBR technologies used for large scale cultivation of microalgae. 1- Green wall panel PBR by A4F, 2- Camargue multilayer horizontal tubular PBR by Microphyt, 3- 16x FPA28L PBR by Subitec.*

The carotenoid production at large scale is now validated with ① *Dunaliella salina* (+14 kg produced so far) for **β-carotene** (650 mg/m<sup>2</sup>/d), ② *Tisochrysis lutea* (+3,5 kg) for **fucoxanthin**, ③ *Haematococcus pluvialis* for **astaxanthin** (40mg/L/d), ④ *Porphyridium cruentum* (+10kg) for **zeaxanthin**. So far, ⑤ *Synechocystis spp6803* (genetically modified for **light terpenes** production) has only been cultivated at pre-pilot scale.

- ⇒ Multi kg samples of dry biomass were sent for carotenoids fractionation and characterization (WP5).
- ⇒ Some samples are already sent for applicability test (WP6).
- ⇒ Data based on different production processes are already integrated into LCA and TEA (WP7).

## A4F – Algae for future

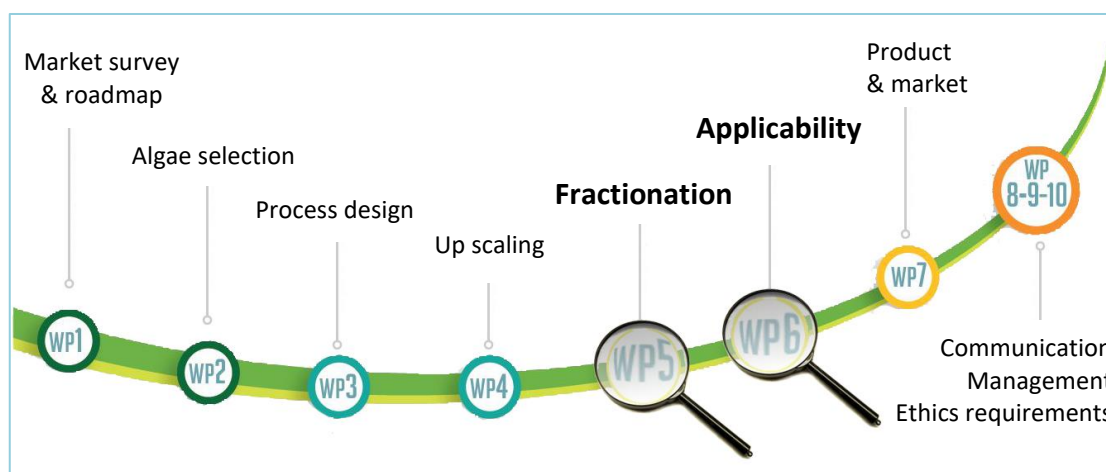
Located in Lisbon, Portugal, A4F is a biotechnology company with more than 20 years of experience in microalgae R&D, process development and production up to industrial scale. A4F designs, builds, operates and transfers commercial-scale microalgae production units, using different technologies. <https://a4f.pt/en>

Role in the project: Leading WP4, A4F joins forces with Microphyt, Subitec and CEA to upscale cultivation protocols optimized in WP3. The company also shares with the consortium its pioneering experience and infrastructure on GMO legislation for improved strain cultivation and practice in the microalgae industry.

## In the next issue

Focus on WP5 and WP6 activities: **Fractionation and Applicability**.

- ⇒ How to demonstrate a cost-in-use acceptance of algae fractions (targeted products and by-products) for targeted applications? **WP5** reveals breakthroughs in green fractionation processes.
- ⇒ How to test the extracted target compounds for regulation aspect and market acceptance? **WP6** focuses on applicability test of ingredients formulated with our targeted compounds.



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