



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

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ABACUS project in brief...

The 3-year ABACUS project aims to provide a range of new molecules synthesized from microalgae and therefore to bring competitive innovative ingredients based on terpenes for fragrances markets and carotenoids for cosmetics and nutraceuticals markets.

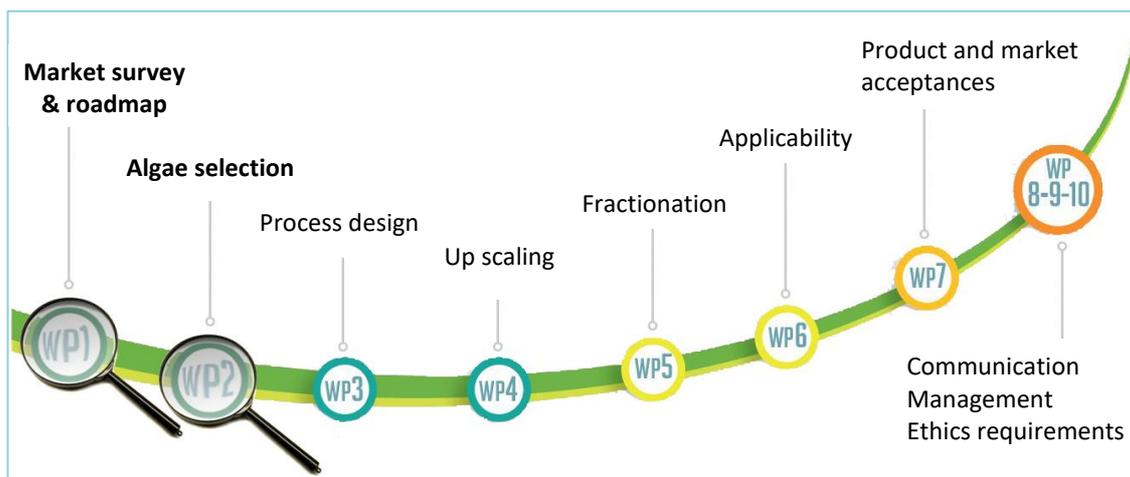
The concept of ABACUS project associates several interdisciplinary approaches in order to support a high-value product market development stemming from:

- Selection and biological engineering of microalgal strains and oriented photosynthesis of terpenoids;
- Technological development of algae biomass production systems to optimize cultivation and photosynthesis of terpenoids;
- Technological development of the downstream processing steps to reduce time and costs, and to optimize environmental acceptability;
- Market development based on new algae-derived ingredients and structuration of new bio-based value chains.

To reach its targets, ABACUS takes benefits from a wide range of expertise by gathering 2 large industrial partners (Proteus and Sensient Cosmetics Technologies), 3 algae SMEs (Algafuel, Microphyt and Subitec) and 4 RTOs (CEA, SAMS, CSIC and KIT). Since May 2017, a cooperative work has unfolded between all consortium members whose work is distributed in 10 defined work packages, altogether tailored to reach the objectives by the end of the project. With this second issue of our project's newsletter, we are pleased to introduce WP1 & WP2 achievements to date.

In this issue-----

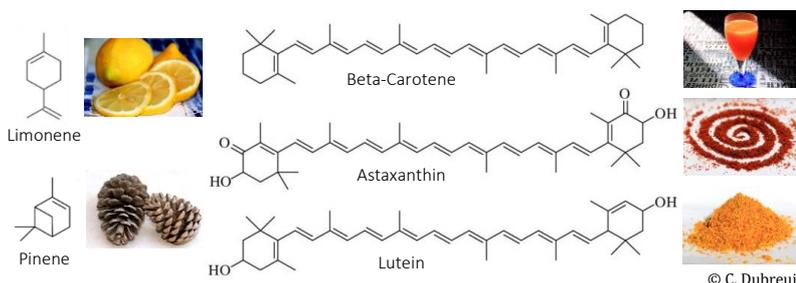
- ABACUS project in brief
- Focus on WP1 & WP2
- Events of interest



WP1: Solidification of market opportunities and products specifications

Two market studies for terpenoid and carotenoid molecules were performed during the first three months of the project. Four criteria were defined to analyse and segment the markets: the type of terpenes (limonene, pinene, myrcene ...) or carotenoids (beta-carotene, astaxanthin, zeaxanthin, lutein, lycopene ...) considered, their sources (natural vs. synthetic), application fields (nutraceuticals, food/feed, cosmetics and fragrances) and the dynamics of markets (emerging new hot spots over the world). By combining the results obtained with a field market survey including key stakeholder interviews, our investigation highlighted the major trends in both terpenes and carotenoids markets. In addition to the market segmentation, the industry trends of the terpenes and carotenoids were also explored (value and supply chain analysis) to define the innovation challenges and technical specifications of the products.

As a result, the most promising markets for terpenes are cosmetics and fragrances, whereas cosmetics and nutraceuticals stand out for carotenoids. The red pigment astaxanthin confirms its leadership as the new natural carotenoid in several application fields.



Examples of terpenes and carotenoids used in several application fields.

In parallel, a full literature survey was performed to define specifications of both terpene and carotenoid products (productions, applications and markets) and associated cyanobacteria/microalgae (biotechnology, product exploitation) to define a scope for the technical development of the project. An extensive selection of target products and corresponding algae species allowed to sketch the initial roadmap of the project.

From this long-list of potential scenarios, five product-strain pairs were ultimately chosen by consensus and fully defined the work unfolded in the experimental WPs (2-7). Among them, volatile terpenes are produced by engineered cyanobacteria and carotenoids are produced by 4 proprietary microalgae strains.

PROTEUS by SEQENS

PROTEUS is a French biotechnology company and a subsidiary of SEQENS group, a 25-year experienced chemical company. SEQENS is present in life sciences and chemical markets by producing and selling chemical compounds and Active Pharmaceutical Ingredients (APIs) whereas PROTEUS is more focused on sustainable industrial processes using enzymes/biocatalysts and microbial strains. <http://www.proteus.fr/en/>

Role in the project: Leader of WP1, Proteus is also involved in WP2 as a provider of strains with a strong industrial potential thanks to its 15-year old microalgae strain culture collection.

WP2: Adaptation and selection of algae

The objectives of WP2 follow the WP1 activities by **selecting and characterizing the best algae strains for terpenes and carotenoids production**.

Based on **microalgae strain collections** available from 3 partners (Proteus, SAMS and Microphyt) a **screening process** was applied to select the most promising strains with high productivities in biomass and products of interest. To carry out this task, **methods and protocols** with standardized and robust efficiency were defined for algal cultivation and biochemical analysis. In parallel, **genetic engineering approaches** were used to maximize terpene and carotenoid production in cyanobacteria and microalgae.



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Screening of >100 mutants of rhodophytes from Proteus strain library.

A total of 22 standard methods and protocols suitable for the screening process were selected. This compilation covers algae culture media, microalgal growth determination, determination of biochemical composition. A list of methods related to genetic engineering approaches for microalgae and cyanobacteria was also compiled (available on the ABACUS website).

*A list of 30 candidate microalgae and cyanobacteria species entered into the screening process. For the rhodophyte specie that was chosen, more than 100 variants of the holotype specie, stemming from Proteus library, were screened for biomass productivity and biochemical productivity. Model cyanobacteria were also **genetically engineered** to generate efficient light terpene production.*

⇒ The most promising strains selected in WP2 are now being cultivated in **photobioreactors** (PBRs) to **optimize process parameters** for biomass and terpenes/carotenoids productivity in a pre-pilot scale.

SAMS

Located in Oban, the Scottish Association for Marine Science is a non-profit association leading innovative research in marine sciences, especially in marine microorganisms, to provide strong resources for a productive and sustainably managed marine environment. <https://www.sams.ac.uk/>

Role in the project: By leading WP2, SAMS focuses its activities on adaptation and selection of algae to provide a selection of the most promising strains and a wide-range of methods for further algae characterisation and mutagenesis approach for terpenes and carotenoids production.

CEA-I2BC

A part of the research at the Institute of Biology and Technologies in Saclay (France) of CEA is to investigate the metabolism and stress responses of cyanobacteria. <https://www.i2bc.paris-saclay.fr/>

Role in the project: The implication of CEA-IBITEc is mainly related to WP2 by engineering modified cyanobacteria with a synthetic biology approach for biosynthesis of light terpenes.

In the next issue

Focus on WP3 and WP4 activities: **Process design and up scaling of production systems for biomass and terpenes/carotenoids production.**

- ⇒ How to optimize the biomass production processes and production systems at a pre-pilot scale?
- ⇒ How to design and implement new monitoring tools and procedures on photobioreactors for improved process management?
- ⇒ How to scale up the production systems for algae culture and terpenes/carotenoids production at the industrial scale?

Find us at

- **27th EUBCE 2019**
27th European Biomass Conference and Exhibition
27-30 May 2019
Lisbon, Portugal
Meet: 
- **SETAC 2019**
29th annual meeting of Society of Environmental Toxicology and Chemistry
26-30 May 2019
Helsinki, Finland
Meet: 
- **EPC7**
7th European Phycological Congress
25-30 August 2019
Zagreb, Croatia
Meet: 

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