How to concretely access industrial sectors with microalgae production based on industrial ecology concept

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ALGOSOURCE, France
Who are we?

Our Expertises

- Heat
- Water/Nutrients
- Light
- CO2

Nutraceuticals
Food / Feed
Active ingredients
Cosmetics
Personal care & Pharma

www.algosource.com
Who are we?

Technical innovation & Diversity in production tools

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Our approach

Industrial ecology

with Microalgae
Why thinking industrial ecology?

Microalgae and market access

Maximum biomass cost (€/kg) and minimum quantities (tonnes) to enter the corresponding markets.

Cost of intrants in heterotrophy

Existing opportunities <-> The future to Shape
We are deeply engaged in a circular economy/sustainable development vision with our microalgae

4 concrete axis:

• CO\(_2\) capture
• Bio-asphalt
• Methanation
• Smart cities...
Autotrophy (or mixotrophy) and joint-economy required a network of industrial activity interconnected.
Capture of CO₂ and production of microalgae with the flue gas produced by a cement plant

Gargenville plant, France

Challenge / opportunity =>

CO₂: coproduct of the cement industry
(≈ 700 kg CO₂ / t of cement) no valorization !!
**CO₂**

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**Artificial light**

- Plastic tubes airlift photobioreactors
- Flat panel airlift photobioreactor

**Sunlight**

- This pilot is composed of two identical tubular photobioreactors in order to compare the productivity. The first photobioreactor is supplied with pure CO₂ and the second with flue gas. Artificial light is used as energy source and the temperature of the system is 25°C with a pH of 7.5.
- This PBR is flat, it has a rectangular shape with a thickness of 1.5 cm. The culture conditions are similar than the other photobioreactor, except the use sunlight as energy source. A pH sensor with a pH meter is used to measure the pH. A luminometer is used to measure the quantity of sunlight in order to make a dose model.

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**Diagram pH control and supply of carbon dioxide**

The regulation of pH is a very important parameter to maintain a optimum pH. During the photoautotrophic growth, cells take up the dissolved CO₂ and the pH increases. When the pH is above the setpoint value (it's 7.5 for our experiment), the flue gas or the pure CO₂ are injected into the photobioreactor. When the pH is below the setpoint value, the injection is stopped.

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**Growth with flue gas or pure CO₂**

- Microalgae can grow with the flue gas
- The growth between the culture with pure CO₂ is almost identical to the culture with flue gas

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**Outlook**

- **Industrial applications of microalgae**
  - **Short-term**
    - Nutrition
    - Cosmetic & Health
  - **Mid- and long-term**
    - Environment
    - Energy
  - **Human**
    - *Antioxidant*
    - *Carotenoids*
    - *Fatty acids*
    - *Omega 3 & 6*
  - **Animal**
    - *Biofuel*
    - *Biogas*

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*CTG Italcementi Group*
Methanation

Study on industrials’ effluents capture and their valorization with microalgae production

Revenue 1

Biomass’ P° + bonus energy
Revenue 2 + 3
**Smart cities**

**Issues**: climate change, ecological footprint of the city, global food challenge, end of resources and fossil energy

**Solution**: associate microalgae cultures to the building

**Why**: it exists a complementarity between microalgae cultures and building functioning

- CO₂ capture from boilers
- treatment of local effluents
- valorization of fatal heat and building heat loss
- production of algae biomass for the health, cosmetic and food sectors
- renewable energy

Urban algae culture serving Sustainable City
**Smart cities**

Prototype demonstrator on the roofs of the University in Saint-Nazaire => First result of interest:

- Reducing the use of air conditioning
- Development of algal models with extraction of high added-value molecules

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Microalgae biomass value

- Essential amino acids pattern similar to food
- Polysaccharides (starch, glucose, sugars)
- Pigments (chlorophyll, carotenoids - β-carotene and astaxanthin - phycobiliproteins)
- Essential vitamins (A, B1, B2, B6, B12, C, E, nicotinate, biotin, folic acid and panthothenic acid)
- Lipids
- Carbohydrates
- Other compounds
- PUFAs (ARA, EPA, DHA)
Our methodology

Step 1: Identification of the value (market study)

Step 2: Topological analysis

Step 3: Conceptual process and flow sheet design

Step 4: Economic pre-validation

Step 5: Experimental validation

Step 6: Techno-economic analysis
**Spirulina biorefinery**

- **Exo metabolites** → **Product 1**
- **Fresh Biomass**
  - **Aqueous extraction** → **Spirulysat** (Product 2)
  - **Lipidic extraction** → **Product 3**
  - **Additional treatment** → **Product 4**
- **Final residue**

*Example: Lipidic extraction, Aqueous extraction, Exo metabolites*
Example of market development

Spirulina extract valorization

Blooo tonic, the spiruline-based tonic water!

Beverages, Functional drink etc.
bio-asphalt

*Spirulina* residue valorization

Hydrothermal liquefaction as a route to transform microalgae residues in bio-asphalt
Results
- Feasibility is shown
- A process has been identified
  • Viscoelastic properties can be tuned
- A Patent has been filed

Outlook:
- To work on durability
- To optimize the process
  • Understand more deeply HL
- Collaboration with industry
Simulation study to predict the plant size and evaluate its rentability
Microalgae: culture in greenhouses

Example of Spirulina production plant after realization of a simulation study on the basis of the effluent available to define the appropriate size...

...and after training people to microalgae culture and quality management.

Easy to build + low price + low biomass output overcomes by the rooftop / greenhouse and the waste recycling (heat, CO2...) process.
AlgoSource provides tools for any stage of your project: from lab scale study to mass production.
R&D tools

The biggest R&D facility in Europe to run industrial programs
R&D tools

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We are here
Saint-Nazaire, France

Our green team
Thank you for your attention

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“Microalgae at the heart of your future projects”