CIRCALGAE

Food • Feed • Cosmetic

Microalgae production for cosmetics and more

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Co-funded by the European Union

CIRCALGAE
Food • Feed • Cosmetic

IGV

Analytics

Department Planttech
12 employees

Food Technology

Microalgae*
Cultivation at IGV
(few hundreds kg dw per year)

Extract Development & Production

Cosmetics Development & Production

Microalgae from partners
(more hundreds kg dw per year)
+ herbs & plants

Extracts
from microalgae + herbs & plants
> 90% **for use in cosmetics**

Cosmetic products

Research projects
- CIRCALGAE
- NeuroActive
- SynKos
- FucoHyEx
- OptiFood

Microalgae is including cyanobacteria in this presentation.

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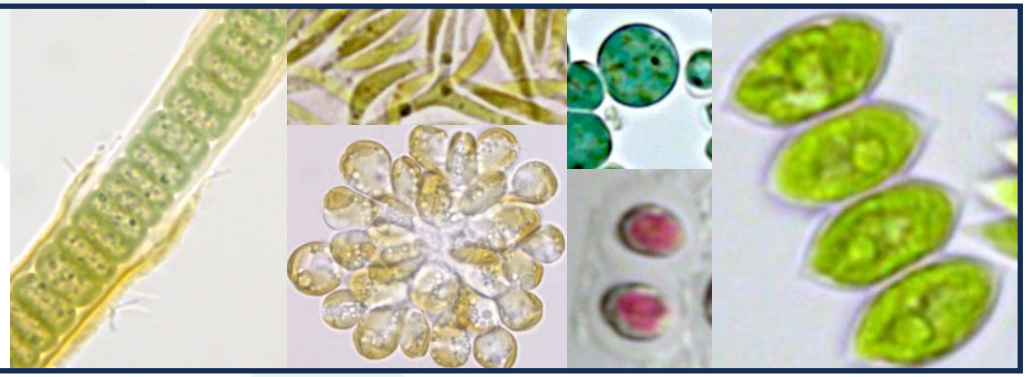
What is interesting in IGV´s microalgae production

Variety of non-food microalgae cultivated

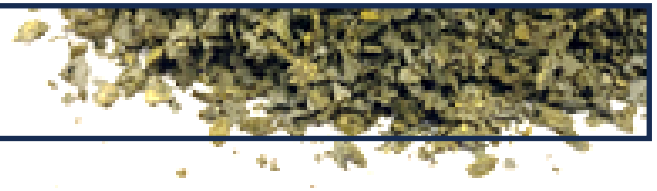
- Filamentous Cyanobacteria: Nostocales and others
- Diatoms: *Phaeodactylum,* Fresh water diatoms
- Red algae: *Porphyridium, Cyanidium, Galdieria*
- Many others: *Tetradesmus, Scenedesmus, Nannochloropsis*



Pilot scale cultivation systems

- Tubular photobioreactors - produced until 2013
- Other experimental photobioreactors

Prices of various microalgae *at 100s kg scale*



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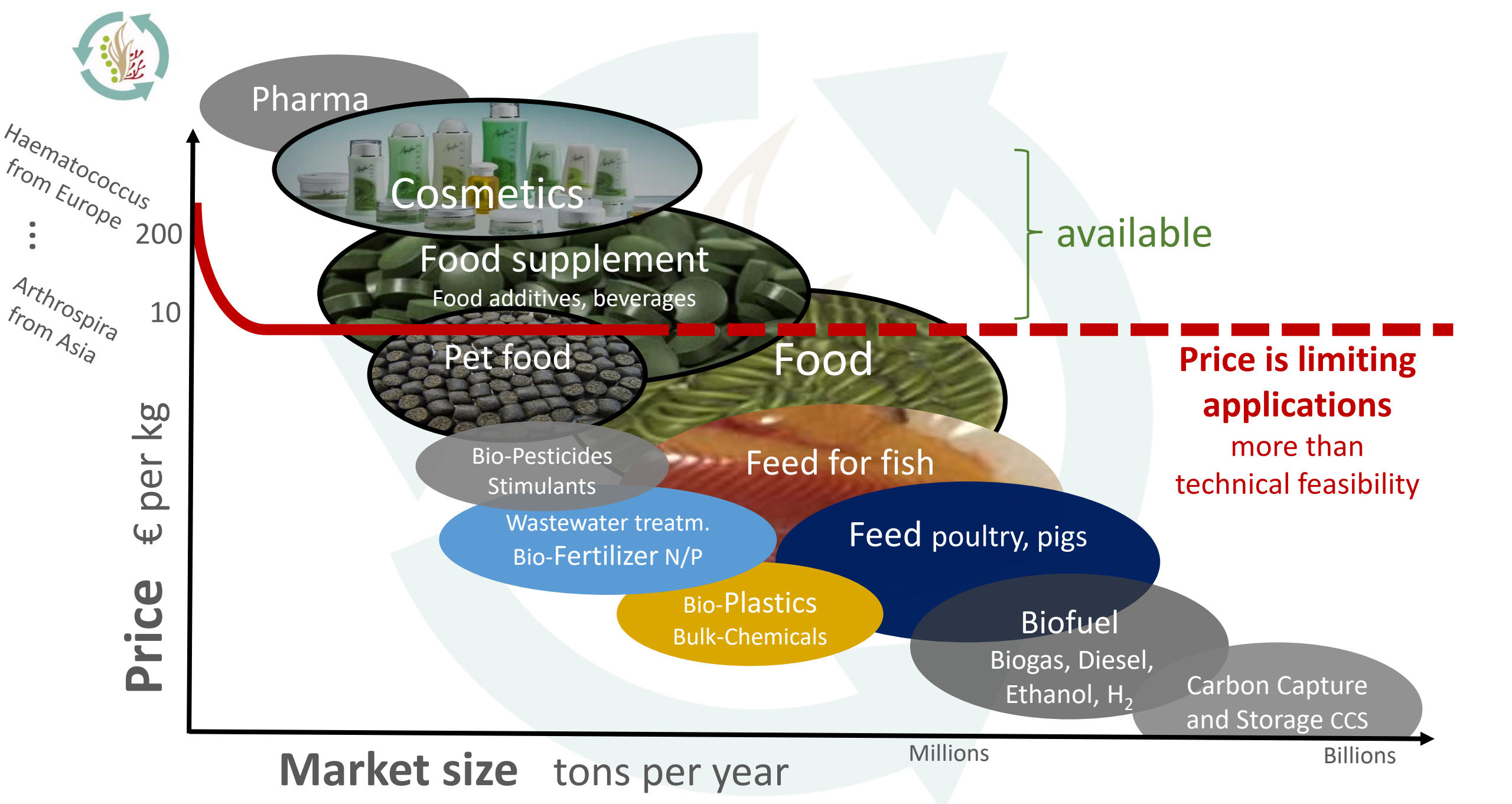

The red line is simplified, price depends strongly on algae species, quality, region and scale of production.

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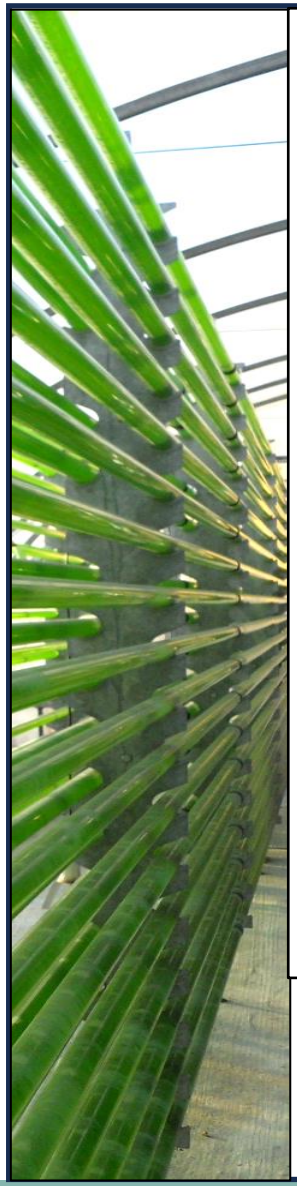
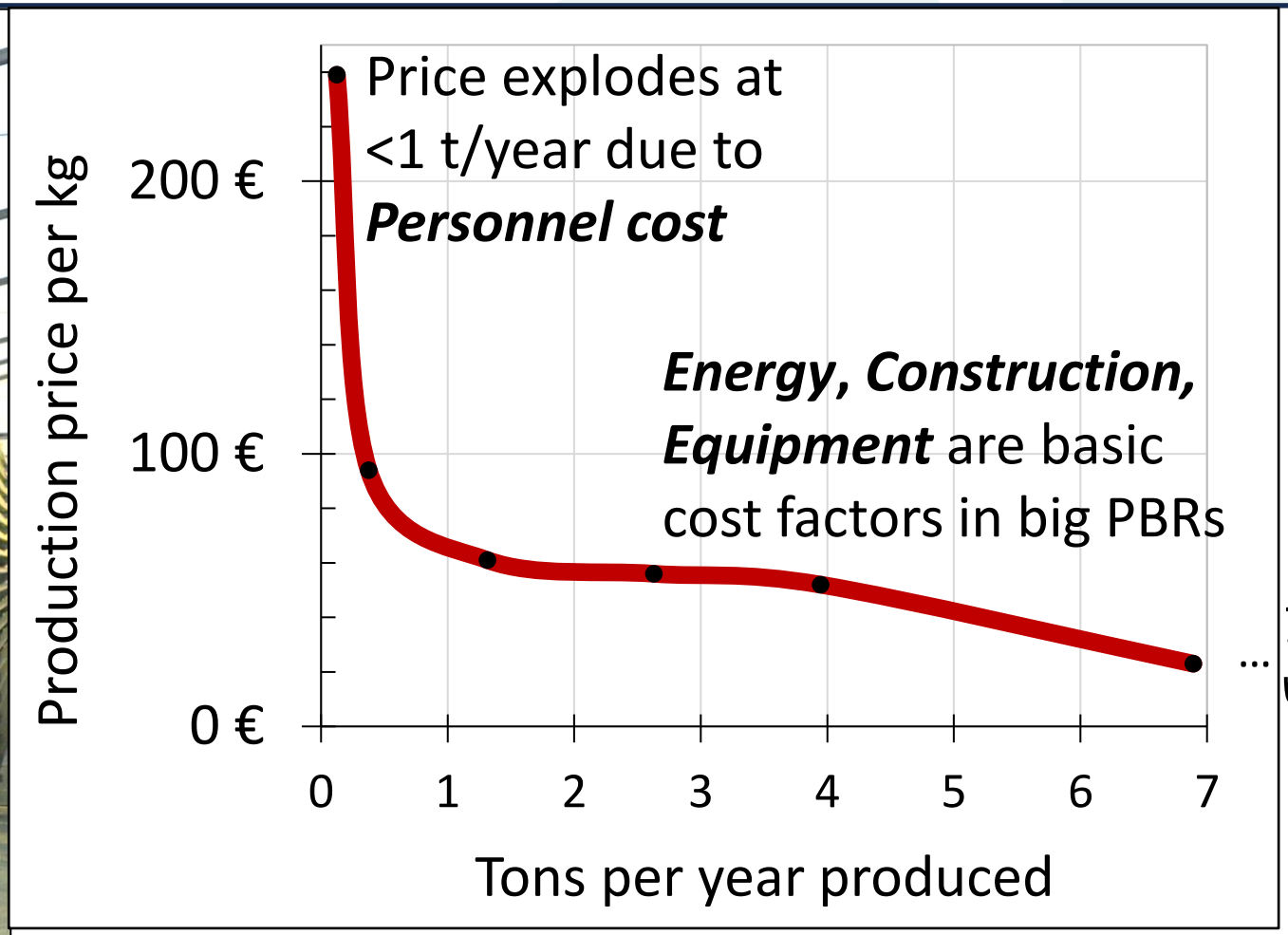
Making algae cheaper: upscaling





Price of 1 kg of an example microalgae in tubular photobioreactors without artificial light. Adapted from P.C. Oostlander, J. van Houcke, R.H. Wijffels, M.J. Barbosa, Microalgae production cost in aquaculture hatcheries, Aquaculture, Volume 525, 2020, 735310, ISSN 0044-8486, https://doi.org/10.1016/j.aquaculture.2020.735310. https://www.sciencedirect.com/science/article/pii/S0044848619319398

... Biggest PBRs of EU { Lisbon + Pataias } ...

Still the cheapest:
Arthrospira
Example of an Asian plant with **700 t/year** in **68 ha** ponds

Reference: Lu, YM., Xiang, WZ. & Wen, YH. Spirulina (Arthrospira) industry in Inner Mongolia of China: current status and prospects. J Appl Phycol 23, 265–269 (2011).

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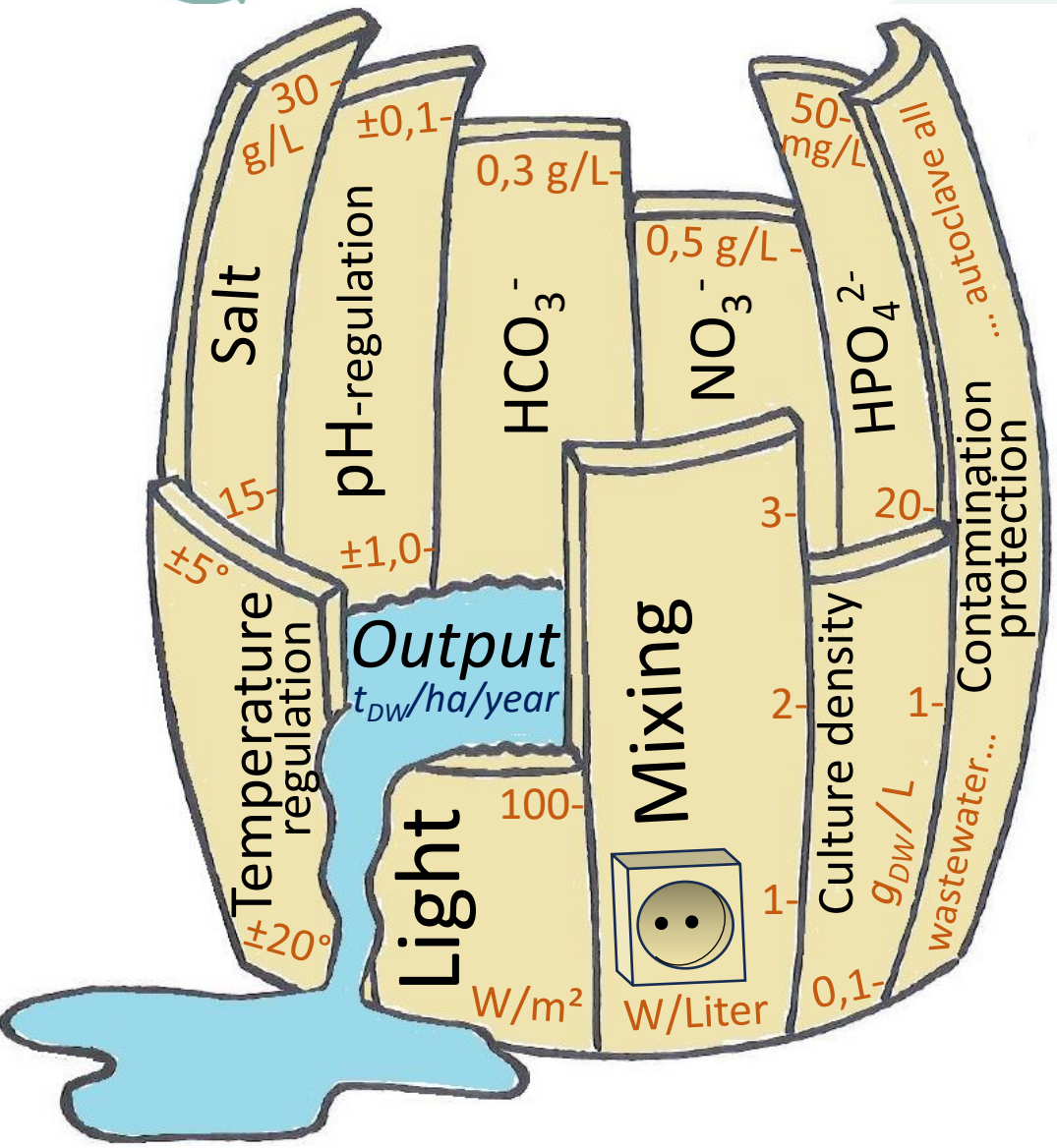
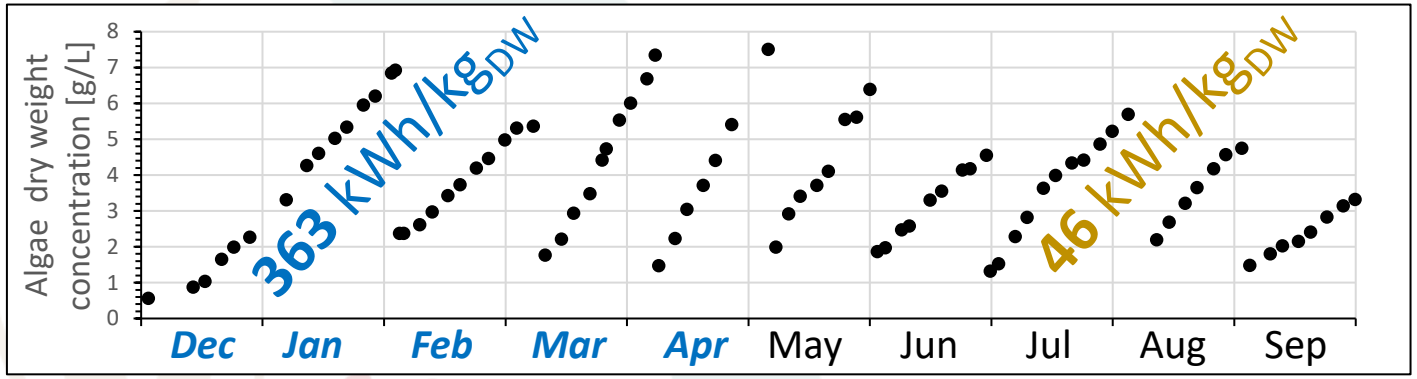
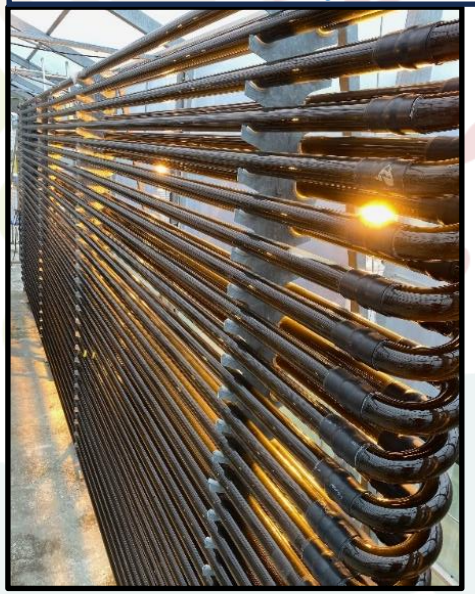
Making algae cheaper: improving production - more output *vs.* less input



electricity input example



Growth of phototrophic microalgae in a 1500 Liter photobioreactor under sunlight *plus seasonal addition of electric light*. Direct electricity input excluding heating is compared



input example

for marine species without medium recycling

	kg per kg_{DW}
Salt (NaCl)	5
Other medium components	3
Water medium, cooling, cleaning	500
CO_2	10 (<2 in DW)
H_2O_2 desinfection	1

Liebig's minimum model applied to microalgae in a tubular photobioreactor under sunlight. Cutting excess in non-limiting factors reduces production cost. e.g. energy cost for mixing can be saved when pumps are adjusted to the light. Biomass yield is higher if the limiting factor is improved (here additional light) however total cost per biomass can be higher. DW = algae Dry Weight

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Improving the production of *Phaeodactylum*

Task 1.2

- Less salt in medium saving money for medium, wastewater and corrosion
- Higher pH suppresses contamination for avoiding expensive desinfection of PBRs
- Optimal light per biomass ratio reduces chlorophyll in favor of fucoxanthin pigment

Disc separation + drying

CO_2-extraction

Lipid extract

Side stream

used in other CIRCALGAE tasks

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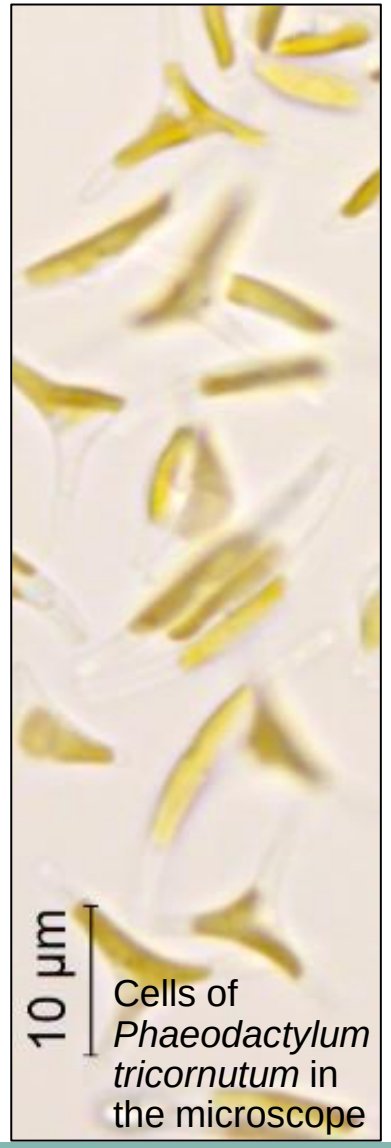
Why to improve the production of *Phaeodactylum*



Cells of *Phaeodactylum tricornutum* in the microscope

- Promising future food supplement due to fucoxanthin and EPA
- Promising model diatom for future antibody-production and more
- Price of >150 €/kg is limiting potential applications
- Industry is interested: novel food applications made for extracts

  FDA accepted

  EFSA rejected stating

  *”a consistent and safe production process has not been demonstrated” **

Details on algae industry including cosmetics and *Phaeodactylum* can be found in CIRCALGAE´s public report D1.1
https://doi.org/10.5281/zenodo.13375431

www.circalgae.eu

* https://efsa.onlinelibrary.wiley.com/doi/full/10.2903/j.efsa.2023.8072

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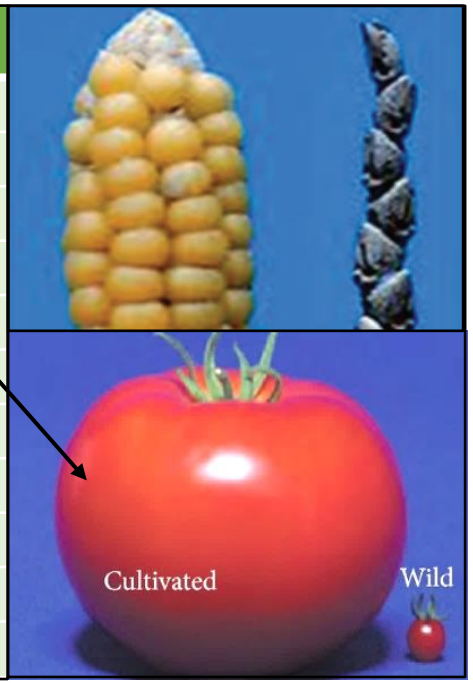
The future of microalgae production

- ***Strain improvement***
  - Color, taste, smell, digestibility
  - Ingredient content + yield
  - Contamination/pesticide resistence
  - Tolerance: heat, cheap medium
  - Metabolic pathways for new products, heterotrophy

Genus (Name)	Years Domestication	
Ovis (sheep) *Sus* (pig)		11 000
Triticum (wheat), *Bos* (cow)		10 000
Glycine (soy)		7500
Zea (corn)		6700
Saccharomyces (**yeast**)	1 Mt/year EU	3500
Solanum (**tomato**, potato)	6 Mt/year EU	2500
Cyprinus (fish)		800
Agaricus (mushroom)		300
Chlorella		135
Haematococcus		65
Arthrospira (Spirulina)*		60



Reference: Chaudhary, Bhupendra. (2013). Plant Domestication and Resistance to Herbivory. International journal of plant genomics. 572784. 10.1155/2013/572784.

- ***Species-specific*** *cultivation systems and methods for growing + harvesting + processing*
  - Massive use of renewable energy for algae production: solar + geothermal
  - Coupling with industrial emitters of pure CO_2 but no CCS
  - Increase in heterotrophic production, automation

- ***Production on areas that are unsuitable for other crops****: sea + barren land + buildings*

* years from strain isolation, first consumption earlier

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