Selected robust *Tisochrysis lutea* strains for high-value products industrial production

Fengzheng Gao

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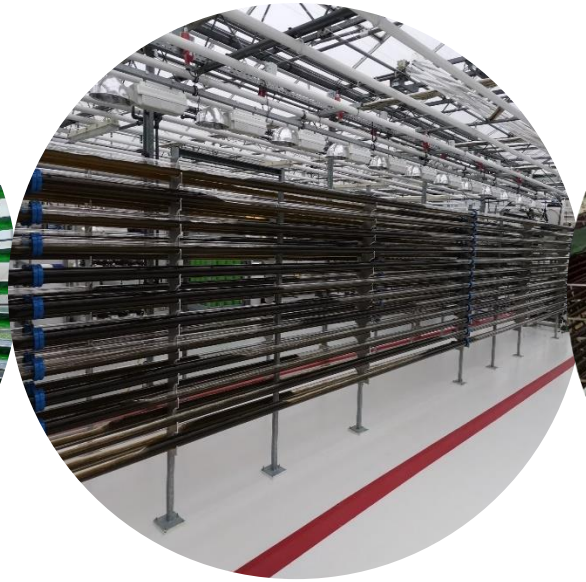
European Union - Young Algaeneers Innovation Award

European Commission

ALGÆUROPE2021
07-10·DECEMBER·ONLINE

EABA EUROPEAN ALGAE BIOMASS ASSOCIATION






WAGENINGEN UNIVERSITY & RESEARCH

AlgaePARC

Bioprocess Engineering

MAGNIFICENT

Selected robust *Tisochrysis lutea* strains for high-value products industrial production

MAGNIFICENT

Microalgae As a Green source for Nutritional Ingredients for Food/Feed and Ingredients for Cosmetics by cost-Effective New Technologies

BBI JU | Bio-based Industries Consortium

ID: 745754
Budget: 5.89 M€

Dr. Fengzheng Gao

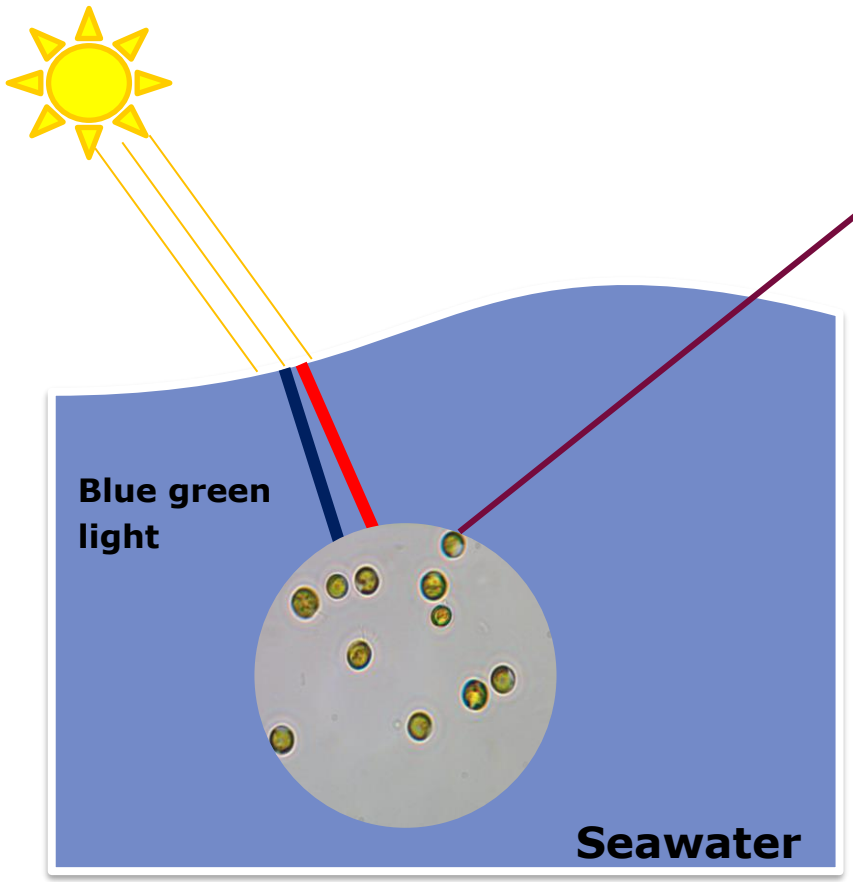
Promotors

Prof. Maria Barbosa

Prof. Rene Wijffels

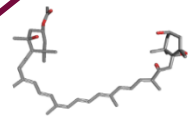
Dr. Iago Teles

Brown microalga *Tisochrysis lutea*



High-value compounds

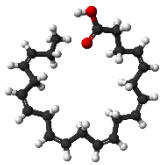
Fucoxanthin (40 000-80 000 USD/kg)



- Anti-obesity
- Antioxidant
- Antidiabetic
- ...

Market

- Food
- Feed
- Cosmetics
- Pharmaceuticals



Docosahexaenoic acid
(DHA; 25-75 USD/kg)

- Promoting fetal development
- Improving cardiovascular function
- ...

Current feedstock

❖ Fucoxanthin

Seaweeds
(500 tons/year; Low content, high production cost)

Alternative feedstock: *Phaeodactylum tricornutum*

Minimum production cost for purified fucoxanthin (>90% w/w) was 32,042 €/kg *(Derwenskus et al., 2020)*

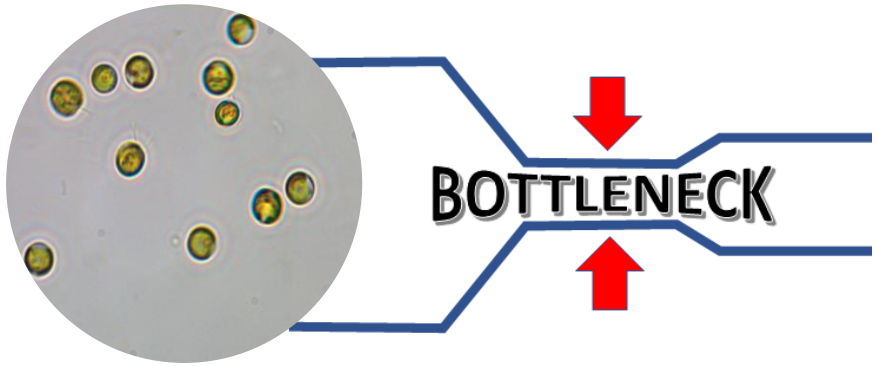
❖ Docosahexaenoic acid

Cold-water oceanic fish
(4 000 tons/year; Shortages due to overfishing and global warming)

New feedstock

Microalgae
Tisochrysis lutea

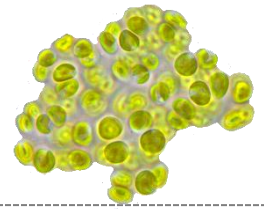
- ❑ Fast growth rate
- ❑ High fucoxanthin and DHA content
- ❑ No cell wall (low extraction cost)

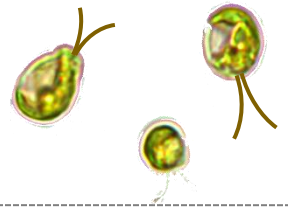


I. **Low productivity**
II. **Limited production period (<6 months in temperate climates, optimum cultivation temperature 25-30 ℃)**

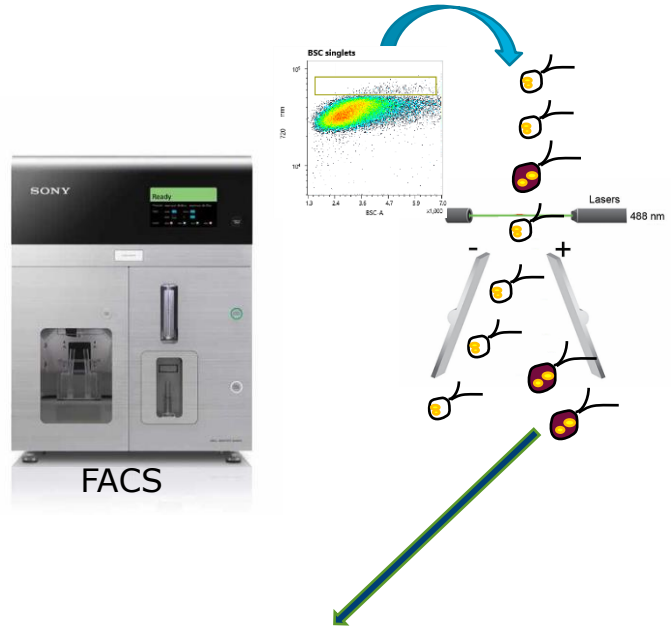
❖ Solution: select improved strains for industrial production

	Low light (50 µmol m^{-2} s^{-1})	Low temperature (15 °C)
Continuous cultivation	2	2
Selection criteria	Top 0.8% fucoxanthin fluorescence	Top 5% fucoxanthin fluorescence
Improved strains	Flagella-less phenotype	Winter strain
Performance	Highest ever reported outdoor fucoxanthin productivity	High growth rate at 15 °C



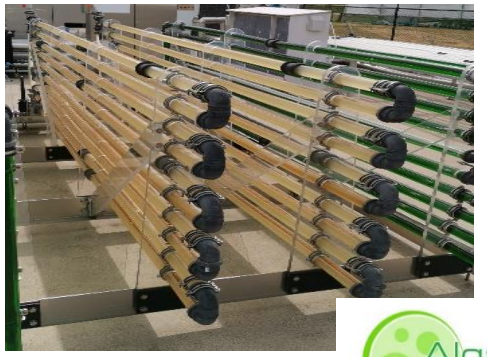


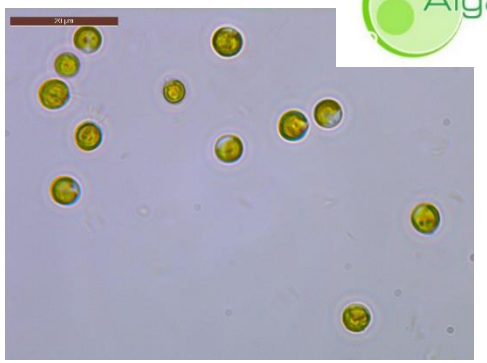
Fluorescence-Activated Cell Sorting: Single cell selection

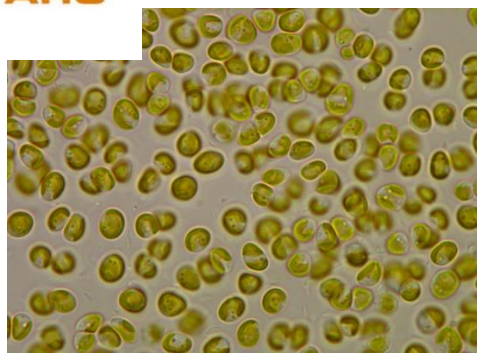


Two novel strains

❖ Novel flagella-less *Tisochrysis lutea*



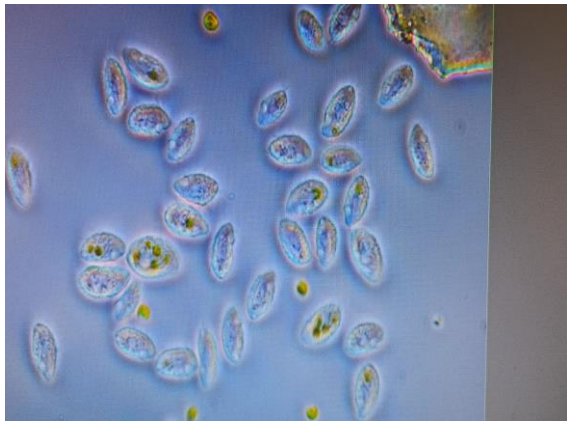




Wildtype strain

Flagella-less strain

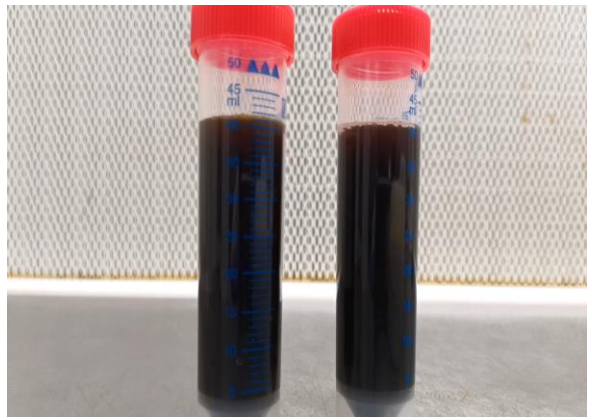
[1] Improved biomass (4.5x), fucoxanthin (3.1x), and DHA (1.6x) outdoor productivities compared to wildtype strain



Contamination problem with wildtype strain

[2] Low contamination risk (self-aggregating cells with mucus layer, 2 month' continuous production without contamination)

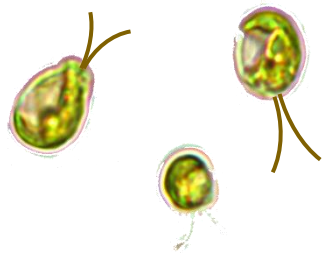
Wildtype Flagella-less



Self-settling of flagella-less strain

[3] Lower harvest costs, as the culture settles spontaneously in less than 60 min, due to its large size and lack of flagella.

❖ Winter *Tisochrysis lutea* for fucoxanthin and DHA production at low temperatures



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Tisochrysis lutea **winter production** **for the first time.**

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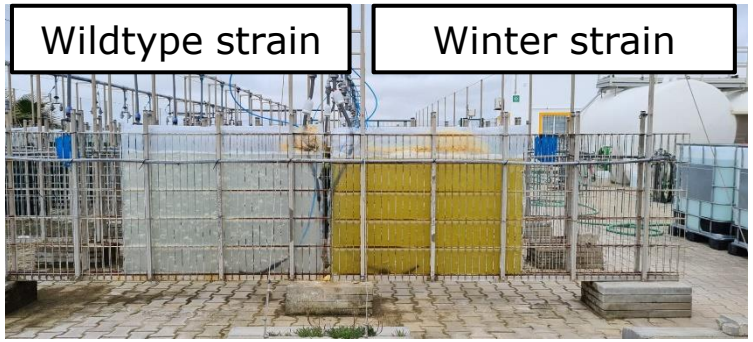

100 L, April (8-20 ℃), Portugal

A **year-round production** could be achieved with this winter strain in industry.

40 L, November (15 ℃) , The Netherlands

1000 L, summer (20-33 ℃), Portugal

❖ Industrial production of robust *Tisochrysis lutea* strains

Biomass production in large tubular photobioreactors (19,000 L)

Biomass production in Green Walls (1000 L)

Biomass of wildtype and two novel *Tisochrysis lutea*

A lower fucoxanthin and DHA production cost can be expected using these two novel strains.

All publications are open access!

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Magnificent Algae

•High-effective pharmaceuticals

•Sustainable cosmetic

•Healthy food

•Cheaper feed

Thank you very much for your attention!

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