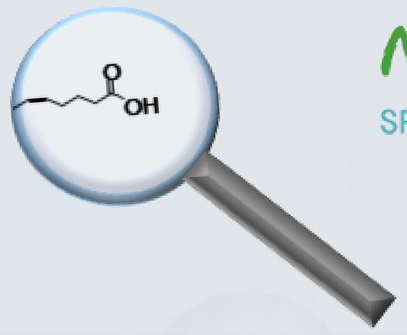
Bioprospecting North Atlantic microalgae with fast growth and high EPA/DHA content



MIRACLES
SPECIALTIES FROM ALGAE

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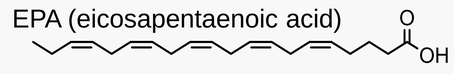
Microalgae could provide a sustainable alternative to fish oil as a source for the omega-3-fatty acids EPA and DHA. However, growing microalgae on a large scale for fatty acid production is still more expensive than fish oil production. Thus, finding new, robust and fast-growing strains with high EPA/DHA content is essential in order to reduce production costs. Microalgae from northern high latitudes are expected to be promising candidates, as low growth temperatures can increase fatty acid unsaturation. We developed a screening pipeline to prospect North Atlantic microalgae to be used in biotechnological applications targeting the production of EPA & DHA.

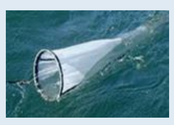
EPA (eicosapentaenoic acid)

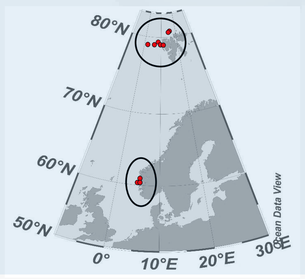


DHA (decosahexaenoic acid)

Pipeline

Sampling



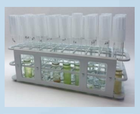


Isolation

Single cell isolation by flow cytometry into 96 well-plates with nutrient enriched medium

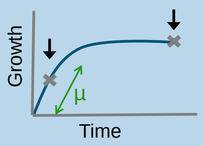
Cultivation

- Upscale colonies to 10 and 50 mL
- Select fastest growing strains in stock culture for screening



Screening

- Grow batch cultures of strains
- Measure growth rate (μ d^{-1}) and analyze EPA & DHA content in exponential and stationary phase



Selection

Strains with

- Growth rates ≥ 0.7 d^{-1}
- EPA/DHA content ≥ 3% DW

Results

- Cultivation: **149 clonal cultures** were established (2% of all sorted cells)

  From Arctic: 93 clonal cultures, 100 % diatoms

  From Fjords: 56 clonal cultures, 89% diatoms, 9% green algae, 2% cyanobacteria

- Screening: **30 strains** were screened for growth and EPA/DHA content (Fig 1)

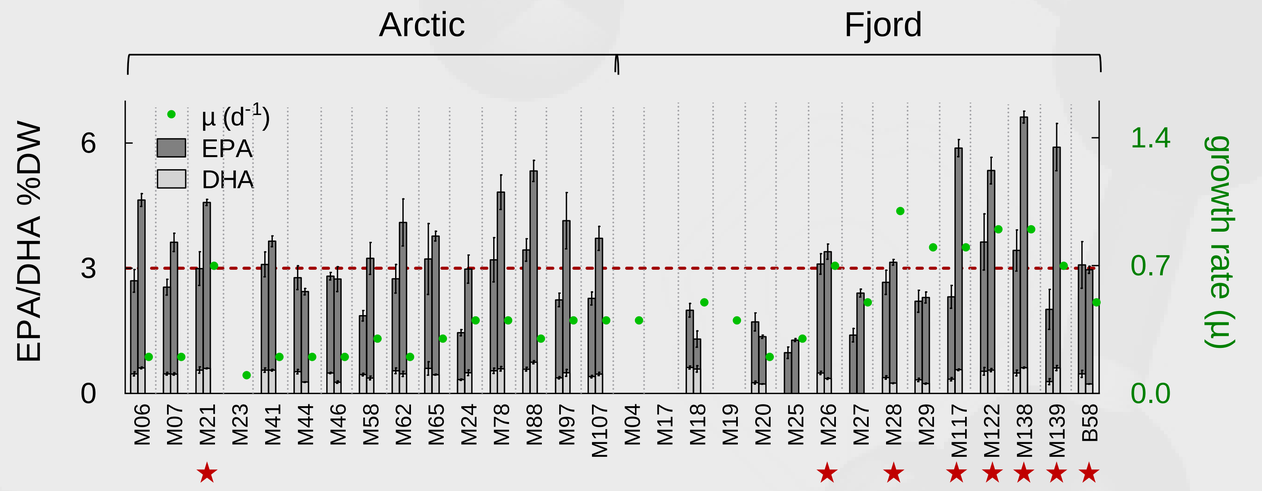


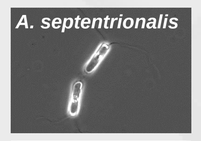
Fig. 1. Superimposed EPA & DHA content (%DW) in the exponential (first bar) and the stationary growth phase (second bar) and growth rates (μ, green circles) of thirty strains during the batch experiment. Red dotted line marks the benchmark level for growth rate (0.7) and EPA /DHA content (3%DW). Red stars indicate selected strains that reached both benchmark levels.

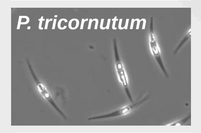
- Selection: **8 strains** (diatoms) with μ ≥ 0.7 d^{-1} and EPA ≥ 3% DW

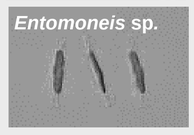
  - One strain *Attheya septentrionalis* (M21, Arctic)

  - Three strains *Phaeodactylum tricornutum* (B58, M26, M28, fjord)

  - Four strains *Entemoneis* sp. (M117, M122, M138, M139, fjord)





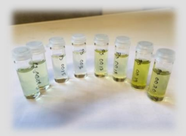


Conclusion

- North Atlantic habitats are promising for prospecting microalgae with high EPA
- EPA content was predominantly higher in the stationary phase
- First report on a high EPA content for *A. septentrionalis* and *Entomoneis sp*.
- EPA contents of > 6% DW in stationary phase are higher than typically found
- Further evaluation of production potential is necessary

Methods

Batch cultures (300 mL) were grown with continuous illumination (120 μmol photons m^{-2} s^{-1}) and constant temperature (10°C Arctic strains, 15° Fjord strains) and were bubbled with 1% CO_2-enriched air. Fatty acids were derivatized to fatty acid methyl esters, analyzed on GC and identified by GC-MS.



Abbreviations: **DHA**: Docosahexaenoic acid; **DW**: Dry weight; **EPA**: Eicosapentaenoic acid; **FA**: Fatty acids; **GC**: Gas chromatography; **GC-MS**: Gas chromatography - mass spectrometry

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References: P. Steinrücken, S.R. Erga, S.A. Mjøs, H. Kleivdal, S.K. Prestegard, Bioprospecting North Atlantic microalgae with fast growth and high polyunsaturated fatty acid (PUFA) content for microalgae-based technologies, Algal Res. 26 (2017) 392–401.