trans algae

Treating wastewater with the help of microalgae

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Kempestiftelserna Arctic Seaweed
Österbottens förbund Pohjanmaan liitto
Nordland FYLKESKOMMUNE
bodø KOMMUNE
Landstinget Västernorrland
Länsstyrelsen Västerbotten

Project leaders & Partners

Project leader

Swedish University of Agricultural Sciences (SLU)
Department of Wildlife, Fish and Environmental Studies

Partners

BioFuel Region AB

Nattviken Invest - Hugo Wikström

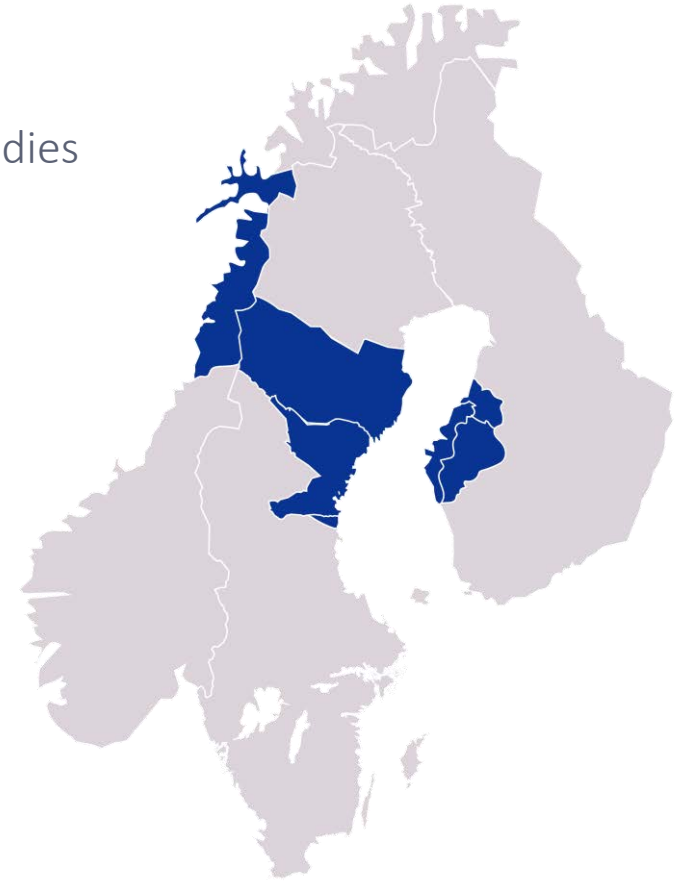
NIBIO Bodö

Mid Sweden University

Novia – University of Applied Science, Vaasa
University of Vaasa

Financiers

Botnia-Atlantica, Länsstyrelserna i Västerbotten och Västernorrland, Österbottens förbund, Kempestiftelserna, Arctic Seaweed, partners



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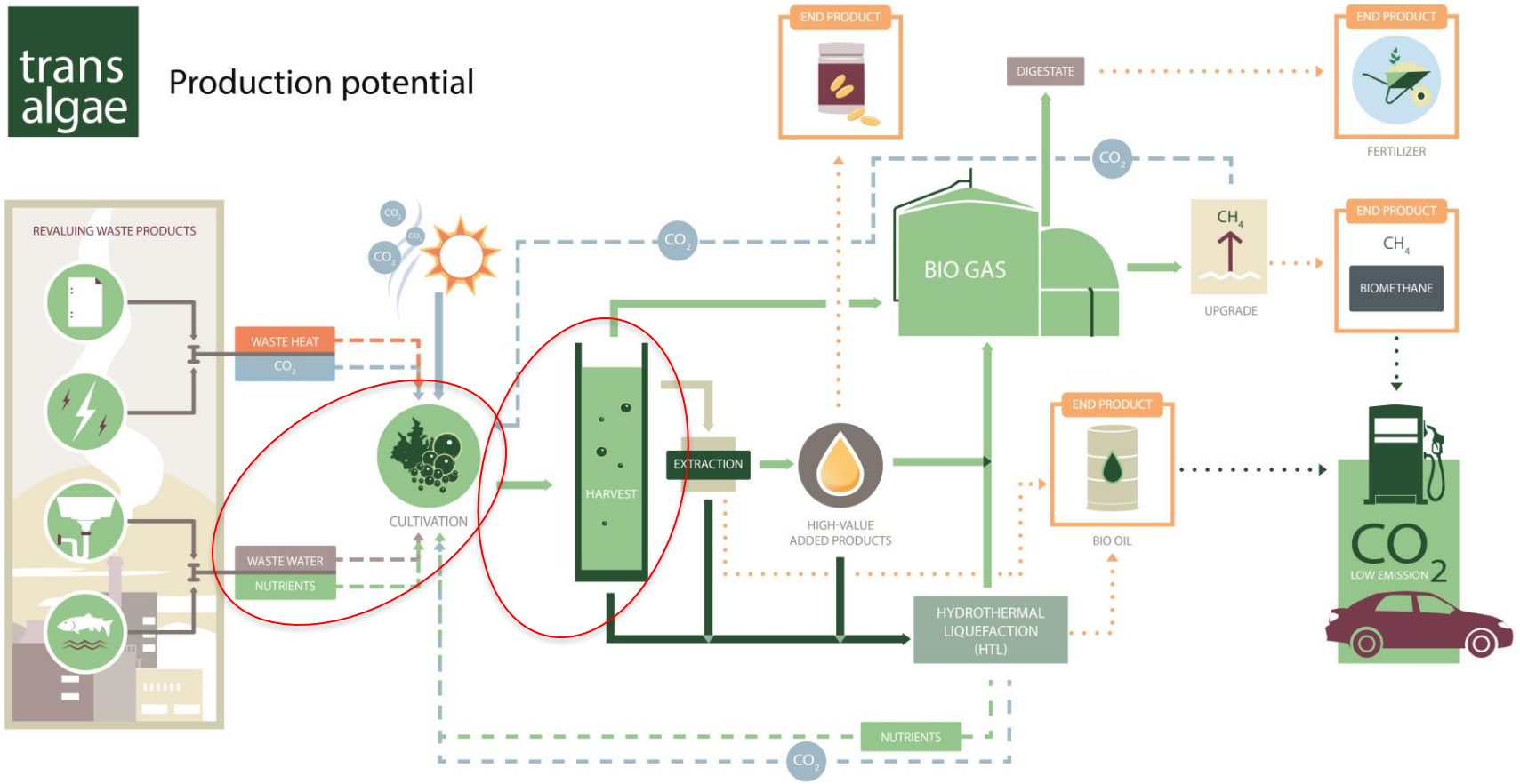
Production potential



PROJECT COURSE

REVALUATION OF WASTE PRODUCTS | CULTIVATION | HARVEST | TRANSFORMATION | SYSTEM ANALYSIS

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Why cultivate microalgae in wastewater?

In order to grow:

- Algae need nutrients: nitrogen N, phosphorous P, carbon C and several more micronutrients

In order to cultivate microalgae in controlled conditions:

- the addition of N, P, C and micronutrients is needed

Wastewaters have to be treated before they can be released to other water bodies:

- contents of N, P and organic compounds have to be reduced
- there are regulations on cleaning efficiencies and acceptable levels of nutrients in cleaned water

Ergo: the ”unwanted” nutrients in wastewater treatment could be beneficial in microalgae cultivation

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What do we need to know about microalgae growing in wastewater?

- Which algae species is growing best in the wastewater?
- Climate conditions: do they grow in the temperature and light intensity that there are in a wastewater treatment facility in Nordic climate? Or can these be adjusted?
- Wastewater quality varies at different points of the wastewater treatment process (ammonium-rich vs. nitrate-rich waters) -> effect on microalgae growth?
- What is the purpose: cleaning wastewater or producing algae biomass? -> scale

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End product: clean water or produce algae biomass?

To be considered:

In order to clean wastewater with the help of microalgae

- How quickly do algae reduce nutrients - below the acceptable limits?
- How much area do you have / need to treat the wastewater with microalgae?

In order to produce algae biomass

- Optimize the growing conditions
- Optimize the biomass quality with regard to the end purpose (e.g. biodiesel)

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Cultivation and harvesting experiments at UVA

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What have we tested at UVA?

- different water qualities from the process of a municipal wastewater treatment facility: ammonium-rich vs. nitrate-rich

  -> are there differences in algae biomass production?

  -> are there differences in efficiency of nutrient reduction?

- to take into account climatic variation during the year:

  -> algae cultivation in wastewater at different temperatures and light intensities

- in cooperation with SLU: lipid and fatty acid production by microalgae in 3 different wastewater qualities

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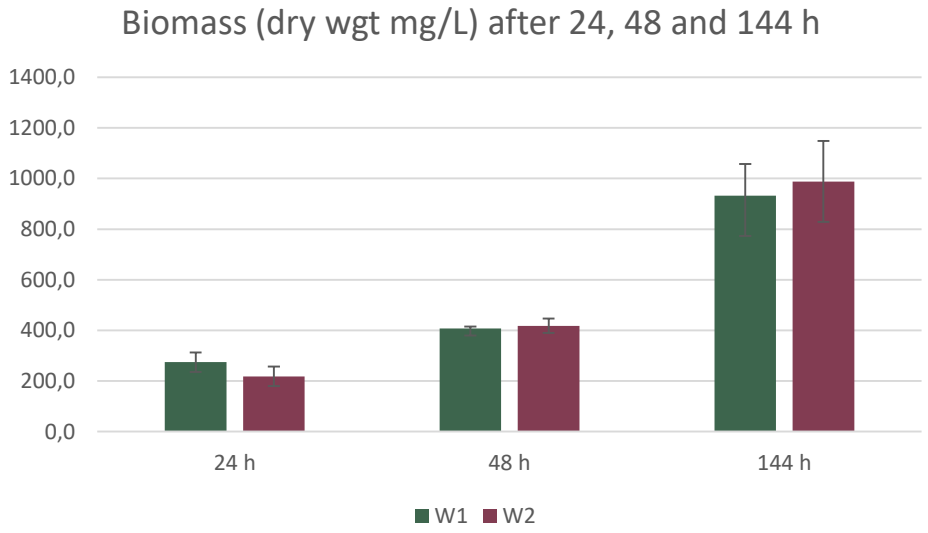
Example: cultivation in 16 °C

Water from after the pre-sedimentation (W1) and the sedimentation (W2) (autoclaved, illuminated 24 h, aerated with air, mean pH 8.6 over first 48 h)



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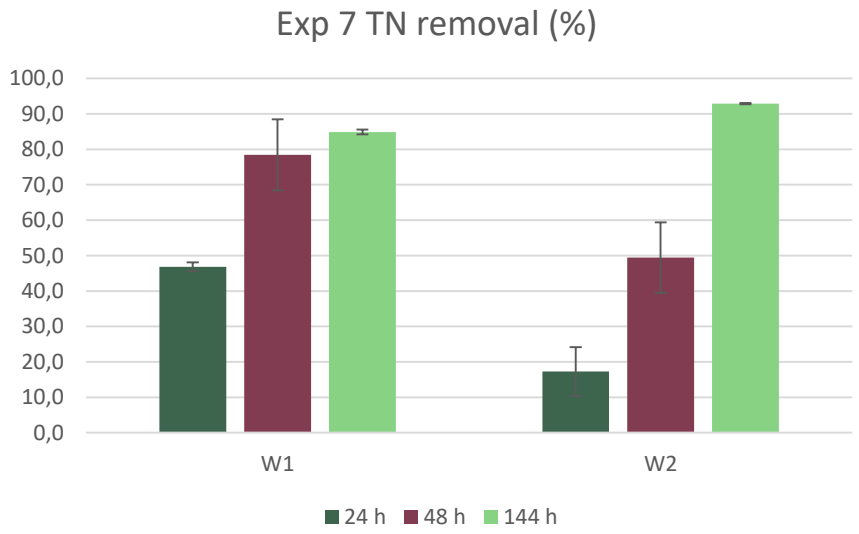
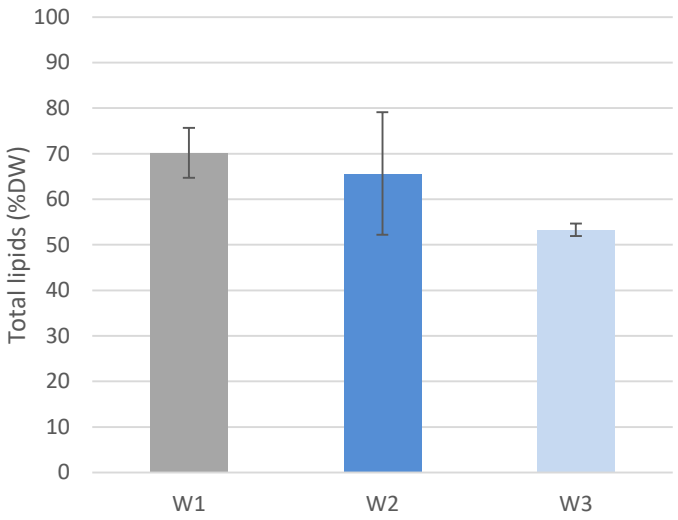
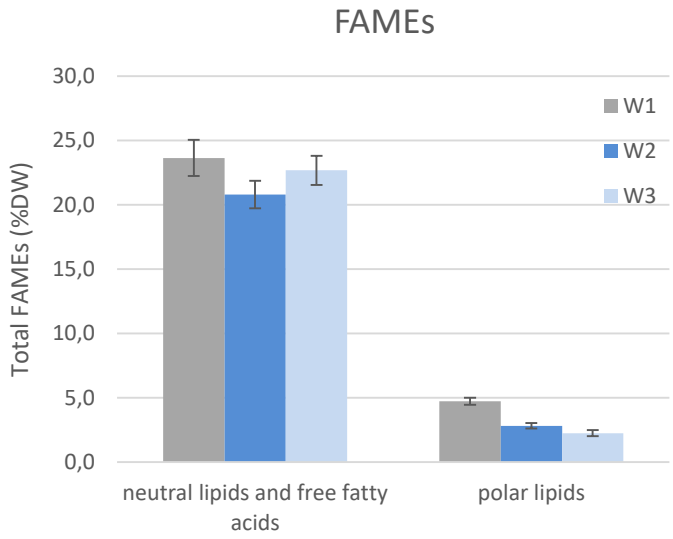
Example: cultivation in 16 °C

- Reduction of total nitrogen TN (%) appeared to be quicker in ammonium-rich water than in nitrate-rich water
- However, efficiency (%) over 6 days similar



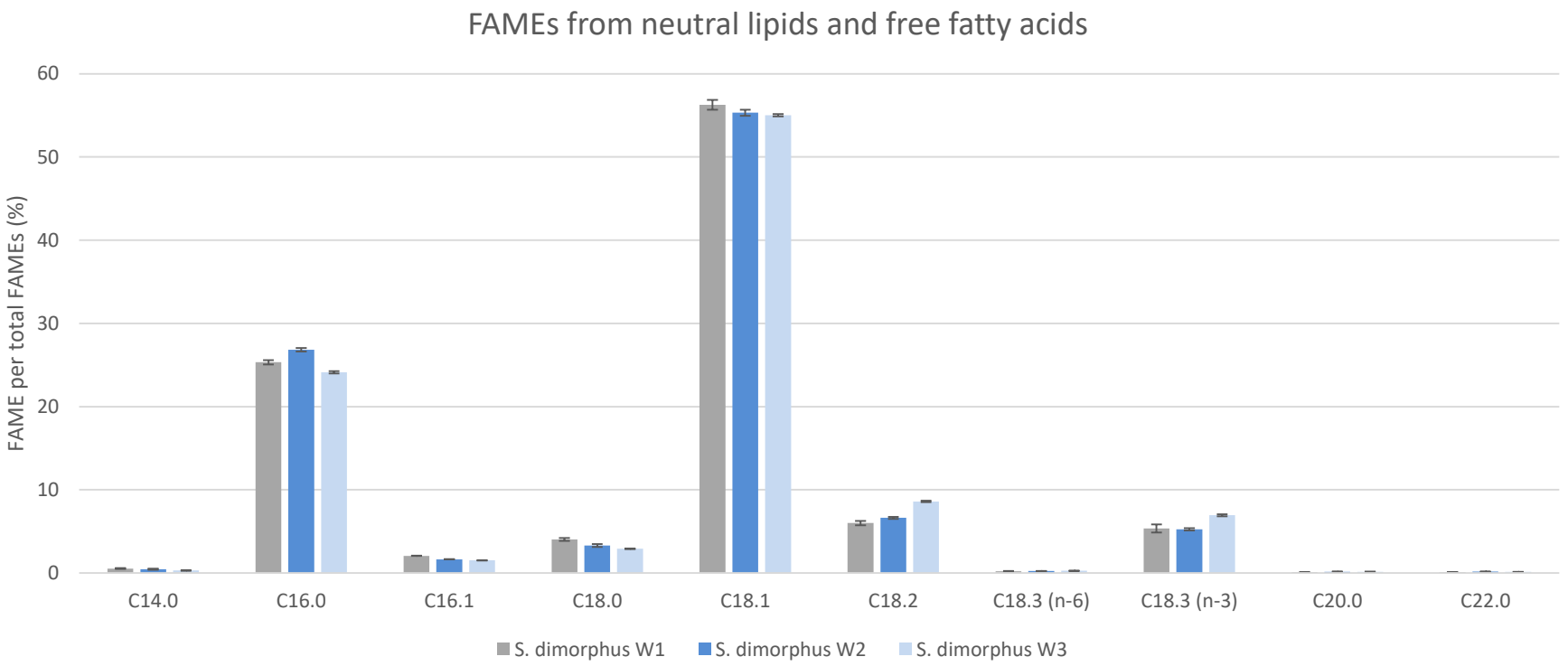
Lipid and fatty acid production by *Scenedesmus dimorphus* (SLU & UVA)





Source: http://biofuelregion.se/projekt/transalgae/ Infosheet No 11

FAME profile (SLU & UVA)



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Results

- Only minor differences in algae biomass production between different water qualities from the process of a municipal wastewater treatment facility (duration 7-9 days).
- Tested microalgae seem to prefer ammonium-rich water over nitrate-rich water in the short run.
- Microalgae can also affect negatively on COD (Chemical oxygen demand).
- As expected, lower nutrient removal at lower temperatures.
- Lipid and fatty acid production were comparable in three different wastewater qualities: comparably high lipid contents could be achieved.

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Some preliminary conclusions

Wastewater treatment

- With the tested algae species and concentrations so far, the nutrient removal / reduction rates ask for a longer retention time than 24 hours (usually wastewaters are treated within ca. 24 hours at the treatment facility)

  -> demand for larger land area for open ponds

End product: biomass and lipids and fatty acid methyl esters

- High microalgae lipid and fatty acid production could be achieved in experimental conditions

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Harvesting

- Microalgae have small size (only some µm)
- Concentration in cultures usually low -> algae cells have to be removed from the water and concentrated

Harvesting methods:

- Sedimentation
- Centrifugation
- Filtration
- Dissolved air flotation
- Flocculation (with chemicals or natural polymers)
- Magnetic

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Harvesting – work by Dr. Liandong Zhu, UVA

Magnetic materials

Zhu et al. Environmental Technology
https://doi.org/10.1080/09593330.2017.1415379

Chitosan – natural flocculant

Zhu et al. Biotechnol Biofuels 2018(11):183

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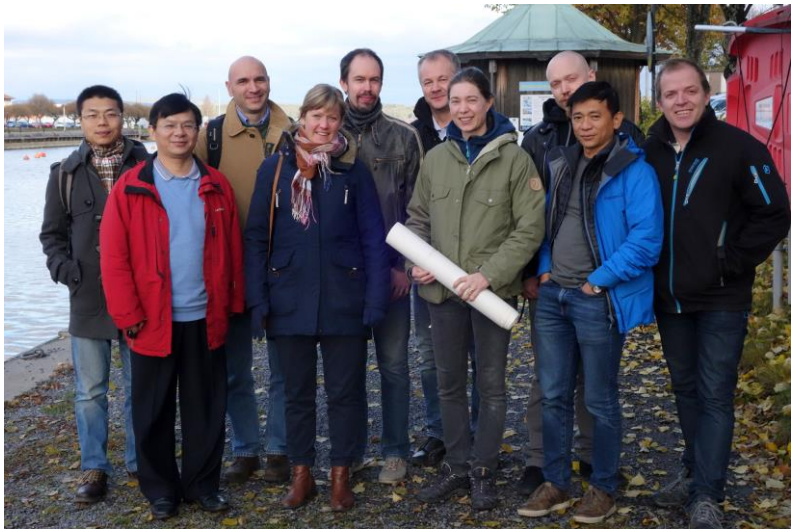
www.biofuelregion.se/transalgae



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