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Digestate – Algae – Fischfeed

Kultivierung von Algen auf Abwasser und Gärrest zur Herstellung von Fischfutter

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Areas active in algae research

Area 4 Cross Cutting Topics

Sub-Area 4.1
Sustainable Supply & Value Chains

Sub-Area 4.2
Automation and Control

Sub-Area 4.3
Modelling & Simulation

Sub-Area 4.4
Microgrids

Com

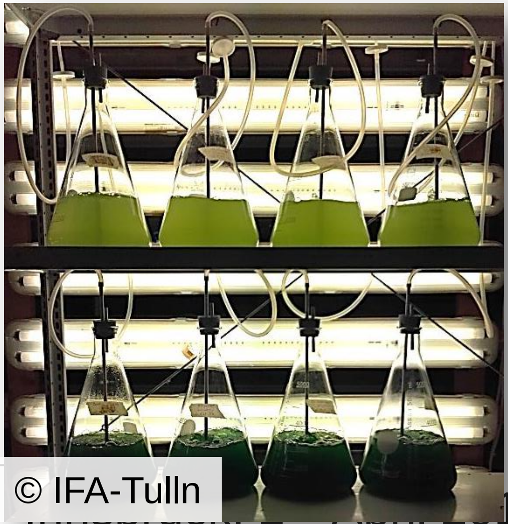
Area 2
Biomass
ification Systems

Area 3
Bioconversion & Biogas Systems

Infrastructure: Lab Services

Algae Cultivation Systems

- Photoautotroph:
  - CO_2-incubator
  - Illuminated shelfs
  - Bubble columns
  - PBRs (5L, 15L, 200L)
- Hetero-/Mixotroph
  - INFORS System
  - 100L-Reactors



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Algae Cultivation Systems

Troscl et al. (2017)

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Digestate
Algae
Fish feed

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Fish feed – state of the art

- Fish is often fed with fish meal or oil, due to high PUFA concentrations including EPA, DHA, AA (Norambuena et al., 2015)
  - PUFAs beneficial for human health

    (Iersel and Flammini, 2010; Marks, 2000)
  - Leads to overfishing (Spruijt, 2017),
  - Org. pollutants accumulate in wild fish (Balk et al., 2010)
- Utilisation of terrestrial crops – e.g. soy
  - Different PUFA profile → Changes PUFAs of fish
  - Causes inflammation of the intestine by fish

  (Barone et al., 2018; Patil et al., 2007)
- → Demand of alternative nutrient sources

Fish feed – perspective

- Utilisation of algae as fish feed
  - Biomass contains essential amino acids and PUFAs
  - Improvement of liver functions

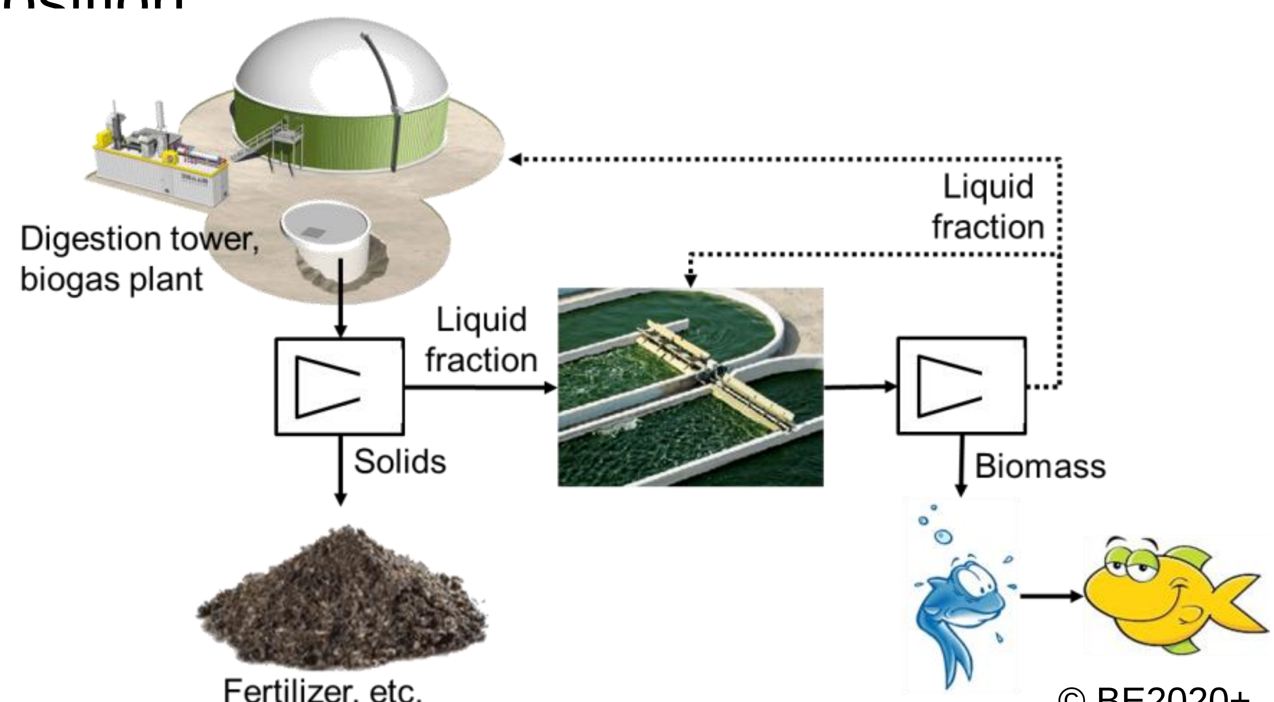
(Barone et al., 2018; Fleurence, 1999; Güroy et al., 2011)

  - Less space than land plants (Henry, 2012; Xia and Murphy, 2016)
  - Large amounts of fresh water and nutrients (Murphy et al., 2015)
- → alternative nutrient (N, P) sources
  - Agricultural side- / waste streams
  - Industrial side- / waste streams
  - Municipal Waste water

Aims and Objectives

Evaluation of…

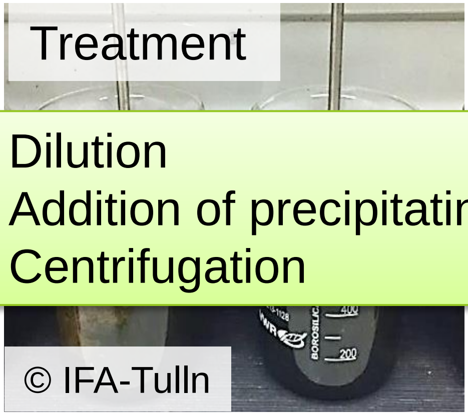
- Treatment procedures necessary for cultivating algae
- Algal growth
- Biomass composition
- Biomass processing
- Legislation & Economics



Experimental set-up

Digestate / WW

- WW after chamber filter press
- WW of primary clarifier
- Agricultural digestate
- Food waste digestate



Treatment

- Dilution
- Addition of precipitating agents
- Centrifugation

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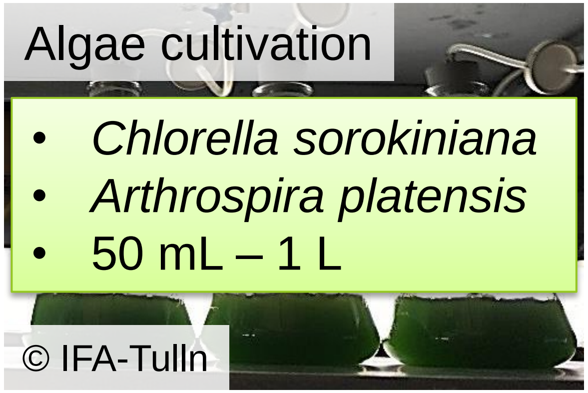

Algae cultivation

- *Chlorella sorokiniana*
- *Arthrospira platensis*
- 50 mL – 1 L

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Harvest

- Centrifugation
- Lyophilisation

Biomass Analyses

- DM,
- Proteins
- Lipids, PUFAs

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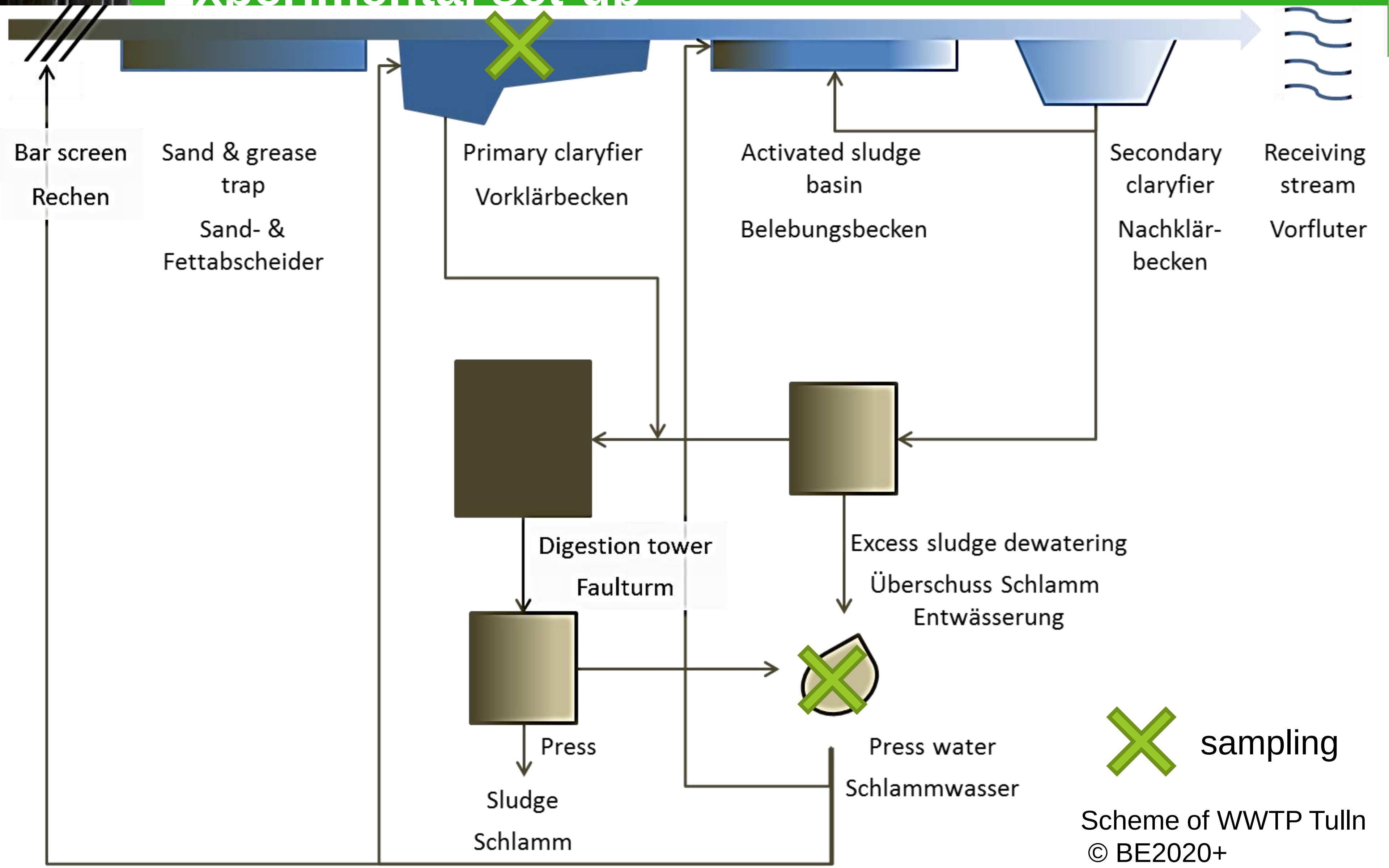
Experimental set-up



Scheme of WWTP Tulln
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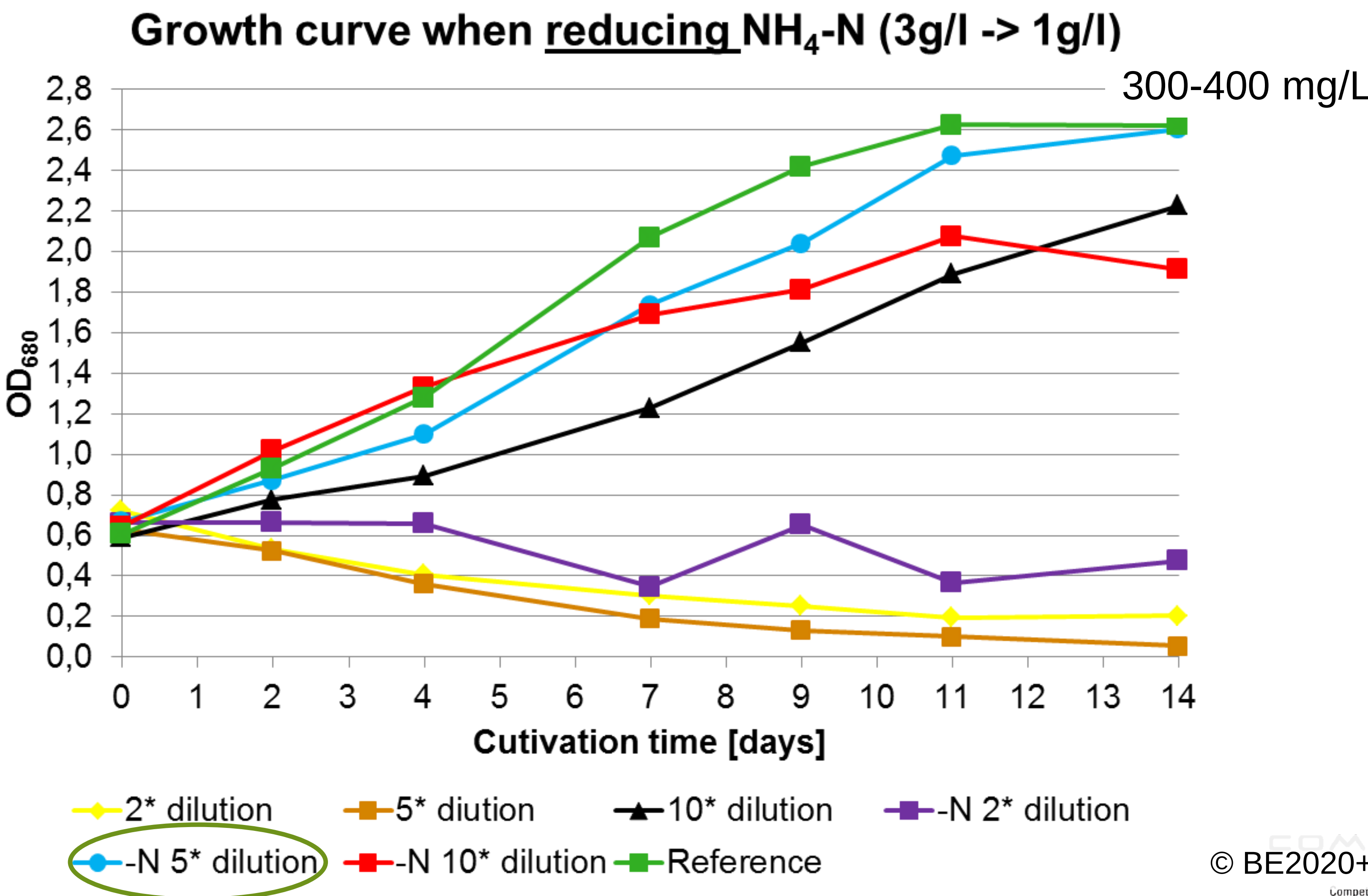
Results – Waste water

- Press water
  - Contained precipitating agents inhibited growth
- Primary clarifier – best growth
  - *C. sorokiniana* – undiluted WW
  - *A. platensis* – dilution 1:2, but lower than *C. sorokiniana*
- Additional nutrients increased growth of *A. platensis*
- Proteins and lipid higher in WW than in reference
- Legislation
  - WW no suitable resource for feed production

Results – Digestate

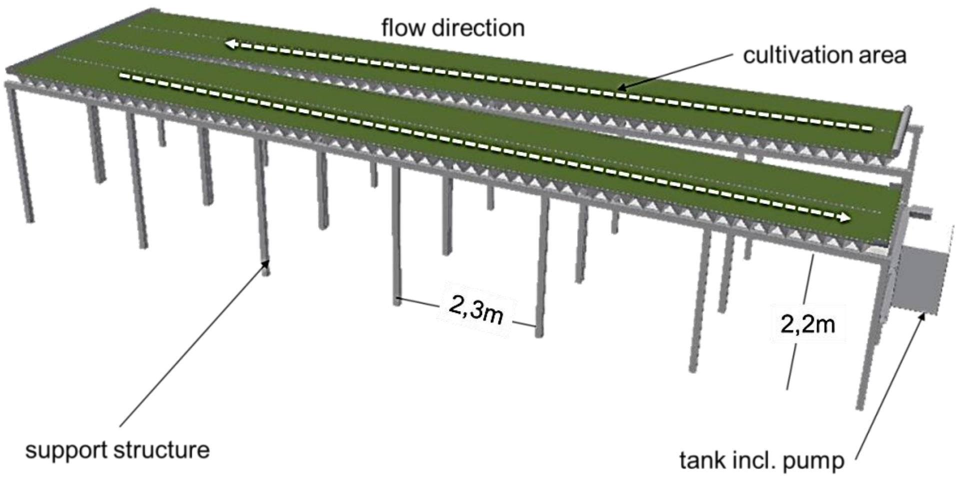
- Agricultural digestate
  - TS: 6.0%, NH_4-N: 4.2 g/L, NO_3-N: 22 mg/L, PO_4^{3}-P: 260 mg/L
  - Dilution 1:20, $FeCl_3$
    - 218 mg/L, 27% lipids, C16:1: 5 mg/L, C18:1/2/3: 15/16/11 mg/L
- Food waste digestate
  - TS: 2.0%, NH_4-N: 3.1 g/L, NO_3-N: 4.8 mg/L, PO_4^{3}-P: 82 mg/L
  - Dilution 1:5, $FeCl_3$
    - 223 mg/L, 24% lipids, C16:1: 3 mg/L, C18:1/2/3: 9/17/15 mg/L
  - Dilution 1:10
    - 245 mg/L, 24% lipids, C16:1: 0 mg/L, C18:1/2/3: 2/15/15 mg/L
- Reference
    - 324 mg/L, 30% lipids, C16:1: 1 mg/L, C18:1/2/3: 2/20/21 mg/L

Results – Digestate



Economics

- Main influential factors
  - Biomass productivity
  - Land requirement
  - Digestate treatment procedures
  - Price of fish feed



- Open cascades (Masojídek and Prášil 2010) most promising
  - CAPEX, OPEX comparable with open ponds
  - Land requirement lower than open ponds and similar to tub. PBR

Conclusions

- Cultivation of algae in WW / digestate possible
- Legislation: WW not allowed to be used for feed production
- Food waste digestate most promising
  - Fewest treatment steps required
  - Biomass suitable for fish feed, but no EPA, DHA
- Reduction of N lowers required dilution and shows best growth
- Agglomeration of biomass or proper feeding
- Open cascades most suitable

Outlook

- Test of further algae strains
  - Improvement of PUFA composition
- Test of further substrates
  - Heterotrophic cultivation of algae
- Scale up and continuous algae cultivation with alternative nutrient sources
- Continuous fish feeding experiments

Thanks to ...

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Thank you for your attention!

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References

- Balk, S.J., Einstein, A., Carpenter, D.O., Corra, L., Diaz-Barriga, F., Farlane, R. Mac, Sly, P., Ehrenstein, O.S. Von, Tirado, M.C., 2010. Persistent Organic Pollutants Impact on Child Health. World Heal. Organ.
- Barone, R.S.C., Sonoda, D.Y., Lorenz, E.K., Cyrino, J.E.P., 2018. Digestibility and pricing of Chlorella sorokiniana meal for use in tilapia feeds. Sci. Agric. 75, 184–190. https://doi.org/10.1590/1678-992x-2016-0457
- Fleurence, J., 1999. Seaweed proteins: biochemical, nutritional aspects and potential uses. Trends Food Sci. Technol. 10, 26–29.
- Güroy, D., Güroy, B., Merrifield, D.L., Ergün, S., Tekinay, A.A., Yiğit, M., 2011. Effect of dietary Ulva and Spirulina on weight loss and body composition of rainbow trout, Oncorhynchus mykiss (Walbaum), during a starvation period. J. Anim. Physiol. Anim. Nutr. (Berl). 95, 320–327. https://doi.org/10.1111/j.1439-0396.2010.01057.x
- Henry, E., 2012. The use of algae in fish feeds as alternatives to fishmeal. Int. Aquafeed 1–27. https://doi.org/10.2139/ssrn.1666916
- Iersel, S. Van, Flammini, A., 2010. Algae-based Biofuels: Applications and Co-products, Algae.
- Masojídek, J., Prášil, O. (2010) The development of microalgal biotechnology in the Czech Republic. Journal of Industrial Microbiology & Biotechnology (2010) 37: 1307. pp 1307–1317. https://doi.org/10.1007/s10295-010-0802-x

References

- Murphy, J.D., Drosg, B., Allen, E., Jerney, J., Xia, A., Herrmann, C., 2015. A Perspective on algal biomass. IEA Bioenergy. https://doi.org/10.13140/RG.2.1.4268.7127
- Norambuena, F., Hermon, K., Skrzypczyk, V., Emery, J.A., Sharon, Y., Beard, A., Turchini, G.M., 2015. Algae in fish feed: Performances and fatty acid metabolism in juvenile Atlantic Salmon. PLoS One 10
- Patil, V., Källqvist, T., Olsen, E., Vogt, G., Gislerød, H.R., 2007. Fatty acid composition of 12 microalgae for possible use in aquaculture feed. Aquac. Int. 15, 1–9. https://doi.org/10.1007/s10499-006-9060-3
- Spruijt, J., 2017. Algae: our original omega-3 source. PUFAChain.
- Troschl, C; Meixner, K; Drosg, B; (2017): Cyanobacterial PHA Production-Review of Recent Advances and a Summary of Three Years" Working Experience Running a Pilot Plant..Bioengineering (Basel). 2017; 4(2):
- Xia, A., Murphy, J.D., 2016. Microalgal Cultivation in Treating Liquid Digestate from Biogas Systems. Trends Biotechnol. 34, 264–275. https://doi.org/10.1016/j.tibtech.2015.12.010