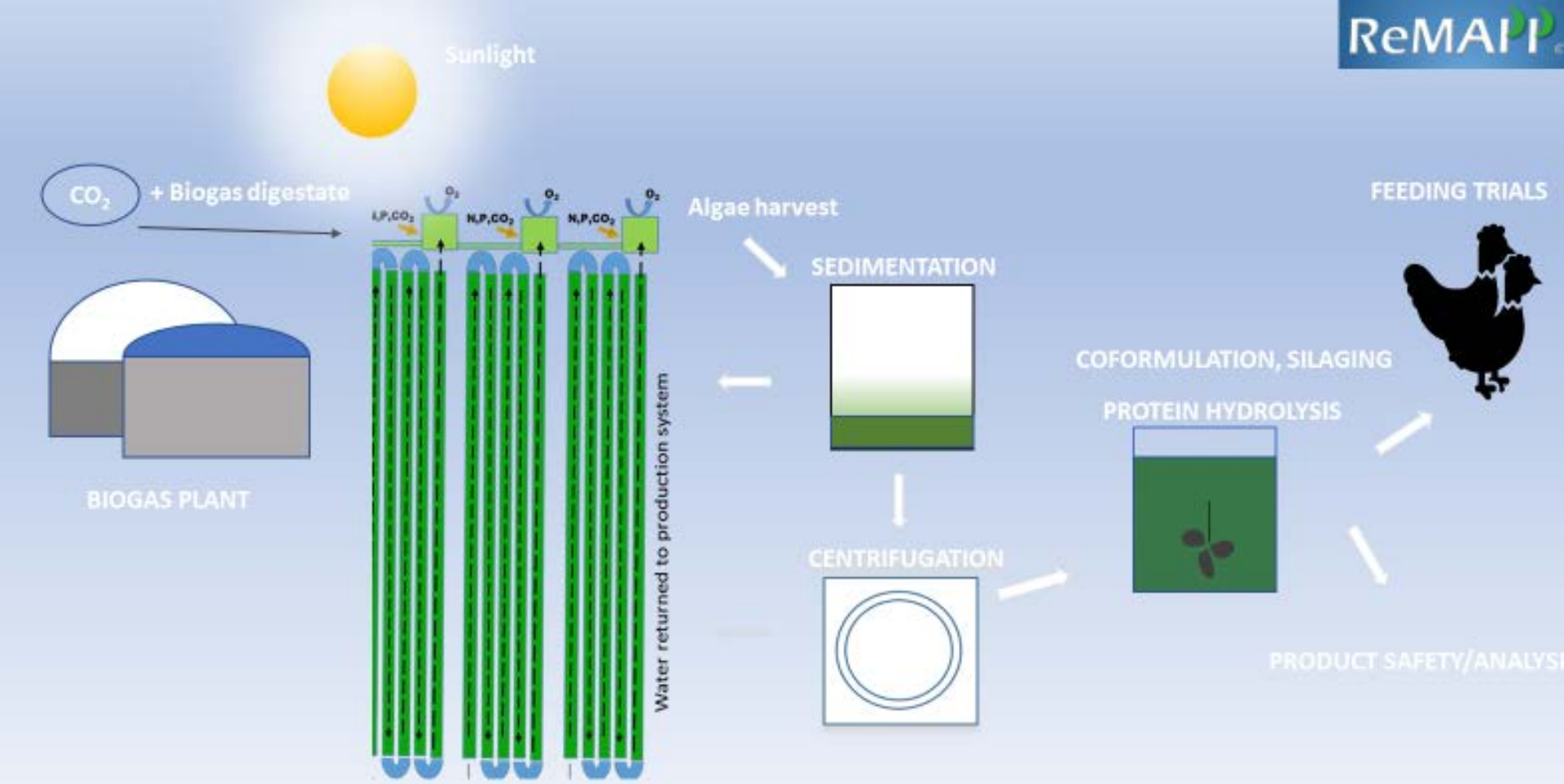
Cultivation of microalgae

ReMAPP

Resource Efficient Microalgae Protein Production

Malene Lihme Olsen, DTI
27-6-19

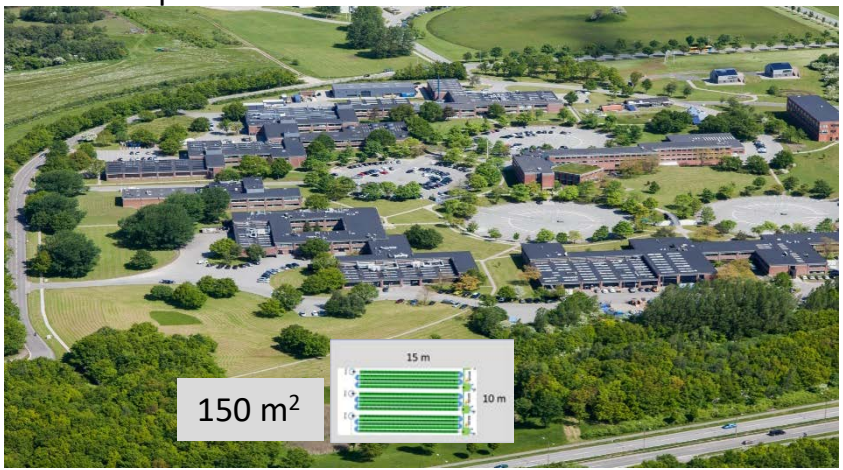
Partly funded by the Innovation Fund Denmark (IFD)
Oct 2018-dec 2022



Focus on the entire process, including storage, bio availability and safety

DANISH
TECHNOLOGICAL
INSTITUTE

DTI Tåstrup



Integrated pilot facility at NatureEnergy Holsted

In 2019, a pilot scale cultivation system was established at DTI in Taastrup.

In 2021, a second system will be implemented at Nature Energy biogas plant in Holsted.

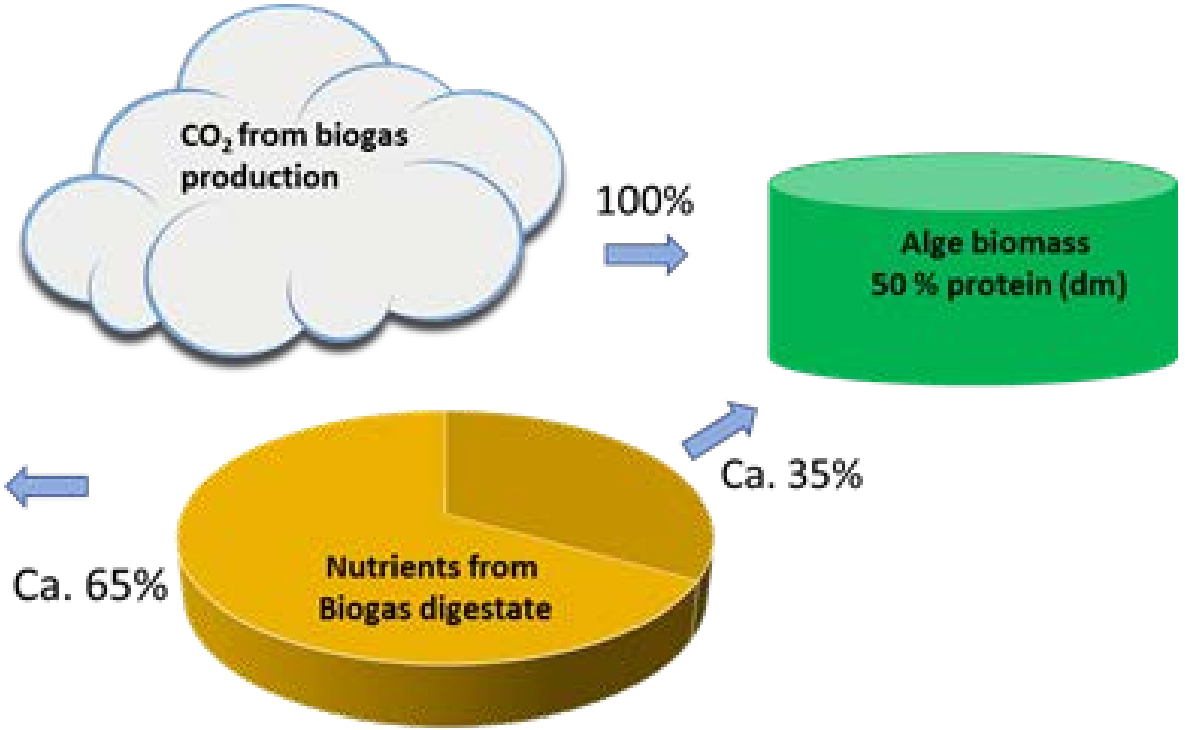
The final size of the systems will have a production capacity of about 180 kg and 900 kg algae protein/yr, respectively.

DANISH
TECHNOLOGICAL
INSTITUTE

Pilot plant at DTI Tåstrup, phase 1

DANISH
TECHNOLOGICAL
INSTITUTE

Balance between conventional agriculture and microalgae cultivation

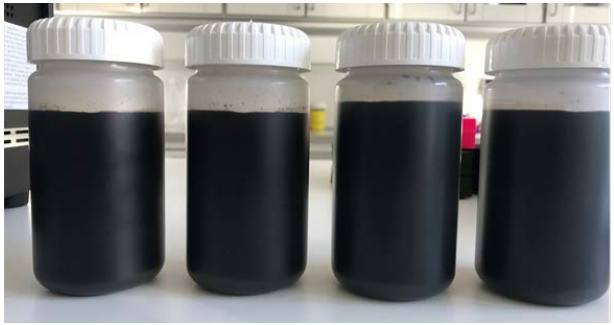


DANISH
TECHNOLOGICAL
INSTITUTE

Digestate pretreatment

- Digestate from thermophilic biogas production 52° C for 21 days

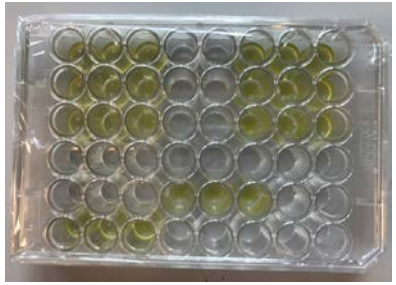
- Require separation, filtration and heat treatment 70° C



DANISH
TECHNOLOGICAL
INSTITUTE

Bio prospecting

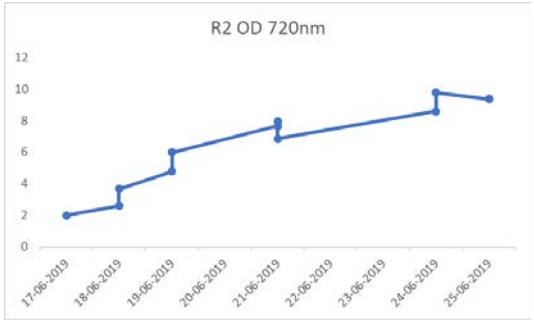
- Obtaining polycultures of local microalgae
- Isolating and screening single strains for protein production
- Working with the biology

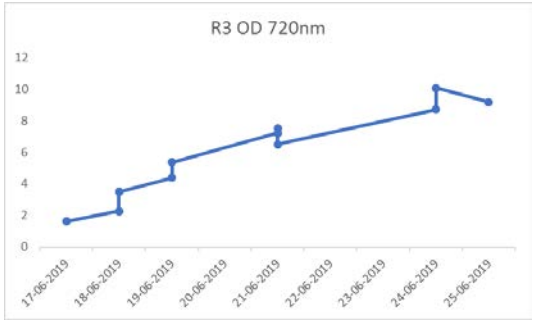


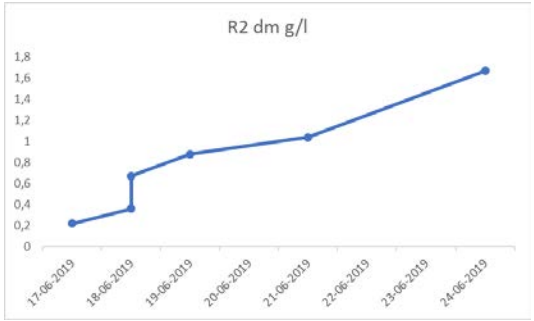
DANISH TECHNOLOGICAL INSTITUTE

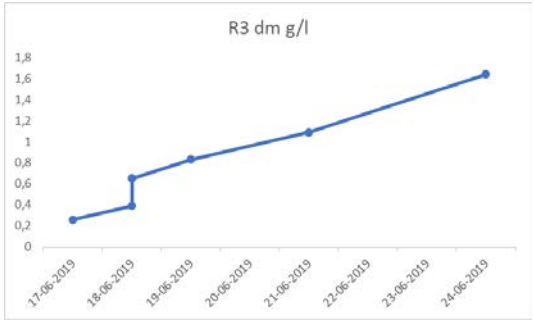
Biomass productivity, summer 2019

preliminary results, DTI pilot june 2019









Biomass productivity ReMAPP strain

Pbr R2: 0,207g/l/d dm

48 t dm/ha/yr

24 t protein/ha/yr

Pbr R3: 0,197 g/l/d dm

46 t dm/ha/yr

23 t protein/ha/yr

Yield 1 ha: 770.000 liter pbr, 300 days of cultivation.

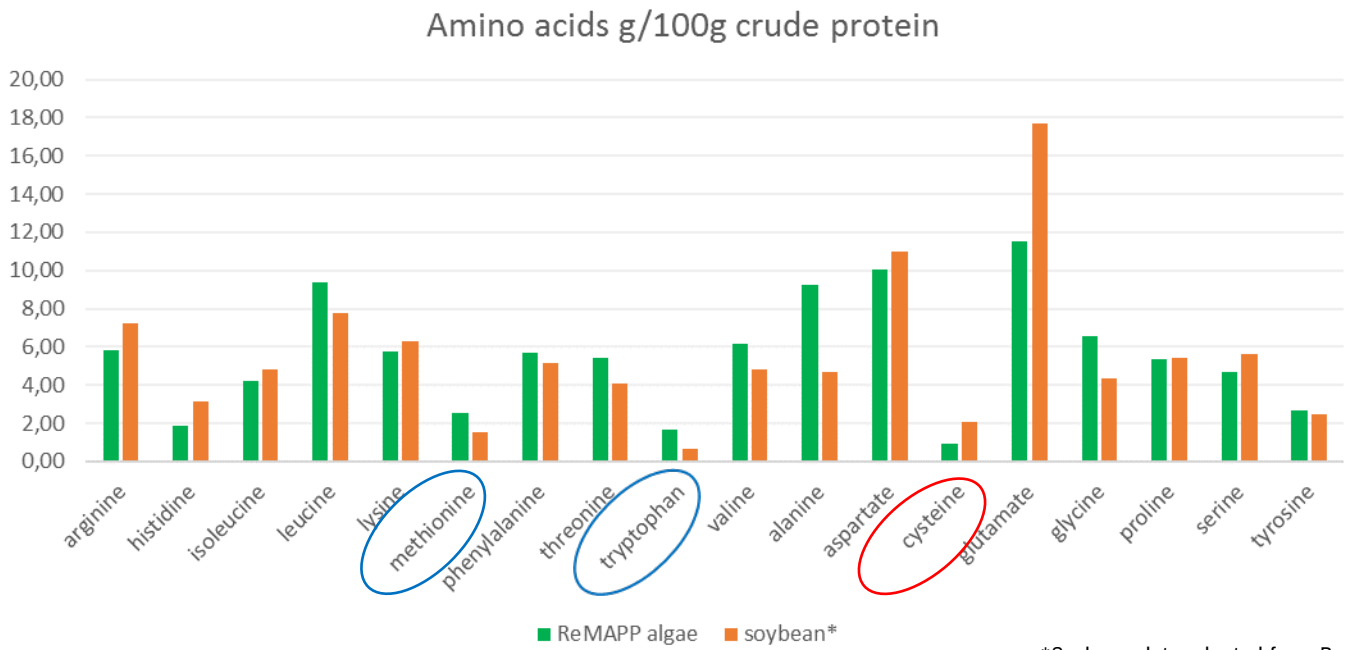
Estimates based on cultivation during summer

Protein content vs. Protein quality

DANISH TECHNOLOGICAL INSTITUTE

Amino acid profile

ReMAPP algal protein vs. soy protein



*Soybean data adapted from Becker 2004 and Kong et al. 2014

DANISH TECHNOLOGICAL INSTITUTE

Source[1]	Essential amino acids, % total protein	Leucine, % total protein	Lysine, % total protein	Methionine, % total protein
Plant sources				
Spirulina[2]	41	8.5	5.2	2.0
Mycoprotein[3]	41	6.2	6.7	1.5
Lentil[2]	40	7.9	7.6	0.9
Quinoa[2]	39	7.2	6.5	2.6
Black bean[2]	39	8.4	7.3	1.6
Maize[2]	38	12.2	2.8	2.1
Soy[4]	38	8.0	6.2	1.3
Pea[5]	37	7.8	6.3	1.6
Rice[2]	37	8.2	3.8	2.2
Oat[2]	36	7.7	4.2	1.9
Hemp[6]	34	6.9	4.1	2.3
Potato[2]	33	5.2	5.7	1.7
Wheat[7]	30	6.8	2.8	1.9
Animal sources				
Whey[8]	52	13.6	10.6	2.3
Milk[8]	49	10.9	8.6	2.7
Casein[8]	48	10.2	8.1	2.7
Beef[8]	44	8.8	8.9	2.5
Egg[9]	44	8.5	7.1	3.0
Cod[10]	40	8.1	8.8	3.0
Human muscle[8]	45	9.4	8.7	2.2

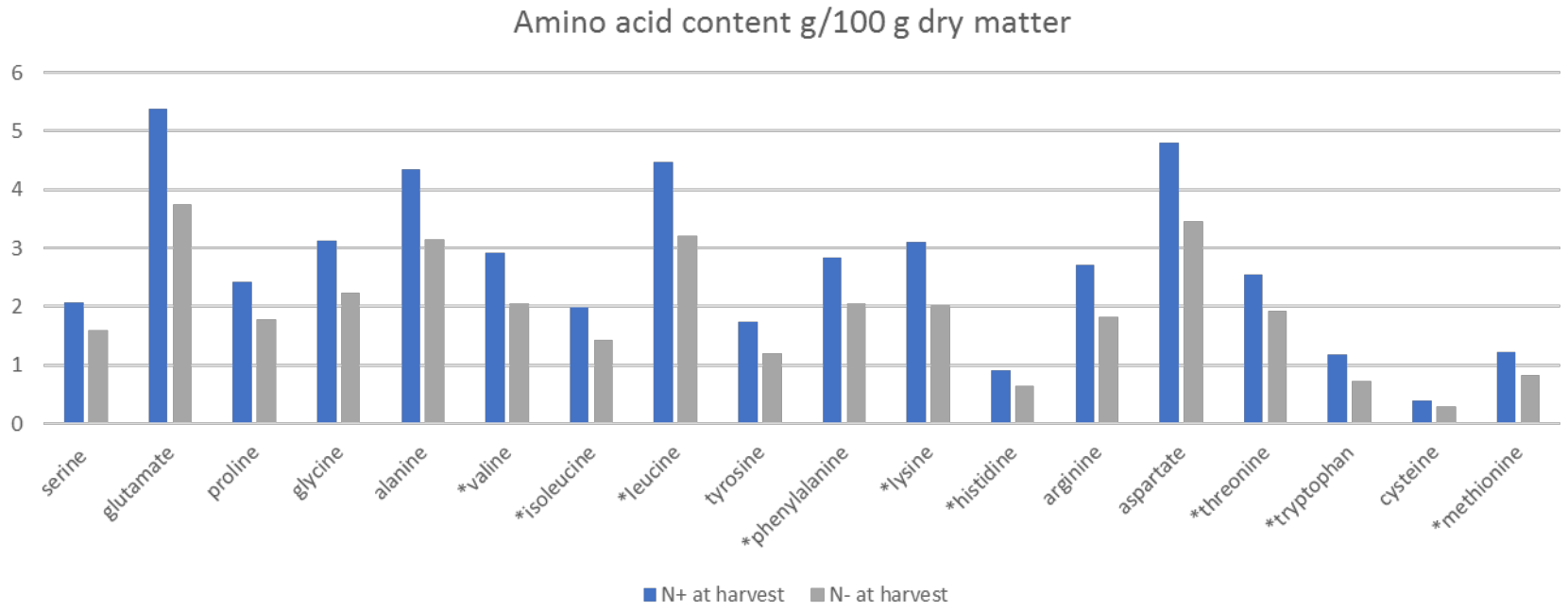
ReMAPP microalgae
average g/100g crude protein

leucine	9,37
lysine	5,78
methionine	2,57

Table from Vliet et al. 2015

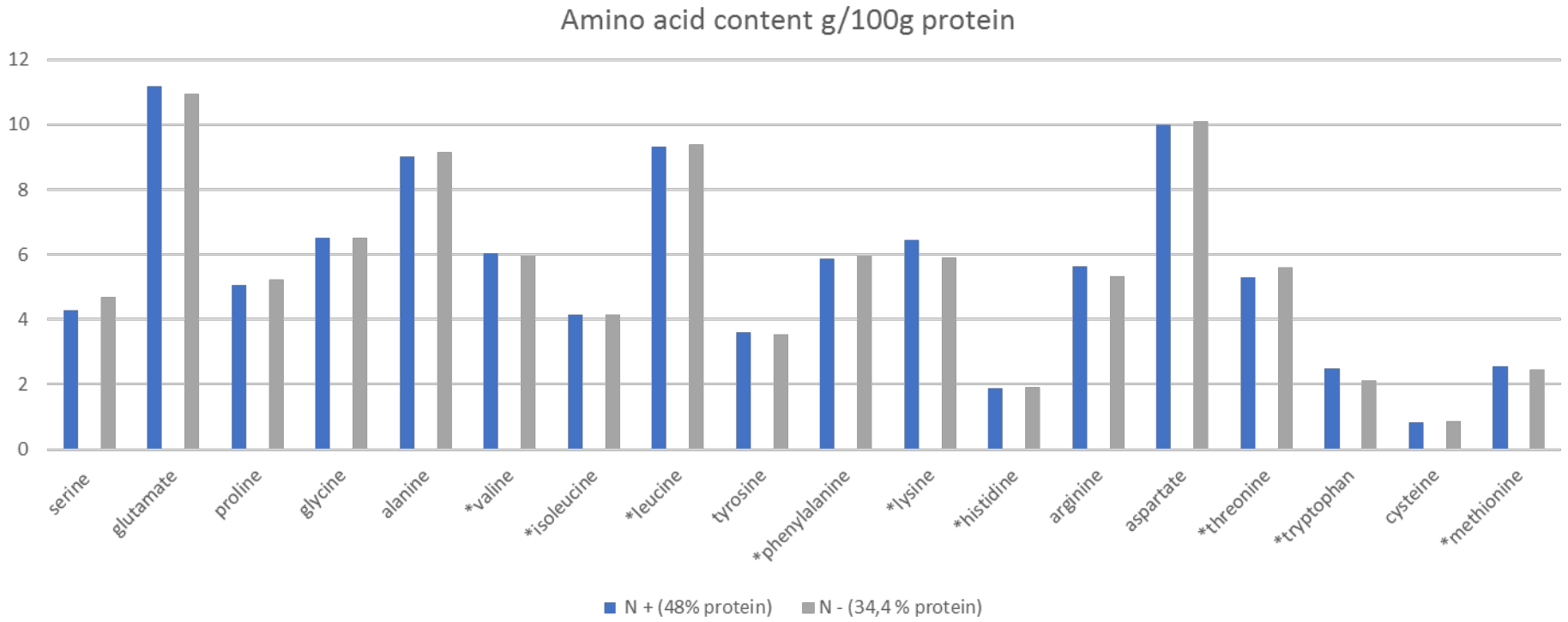
DANISH
TECHNOLOGICAL
INSTITUTE

Protein content and quality



DANISH
TECHNOLOGICAL
INSTITUTE

Protein content and quality

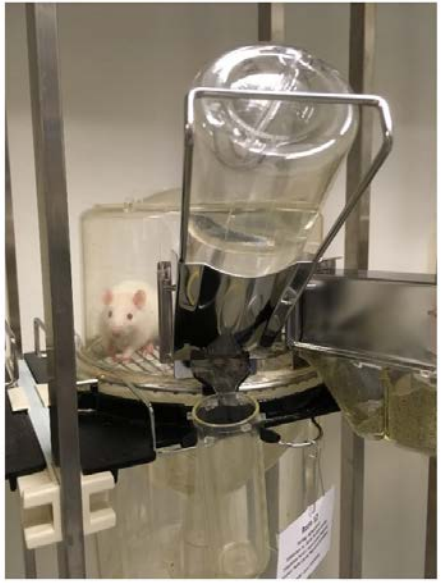


DANISH
TECHNOLOGICAL
INSTITUTE

Initial digestibility trial with rats

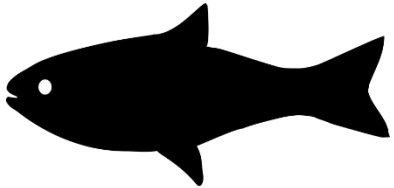
Four treatments:

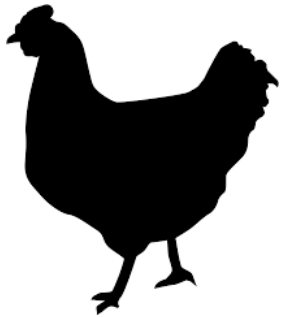
- Untreated
- Mechanically treated
- Enzyme treated 1
- Enzyme treated 2



Next

- Further enzymatic and mechanical treatments
- Chemical hydrolysis
- Fish feeding trials
- Chicken feeding trials
- Cultivation of a 2nd algae strain

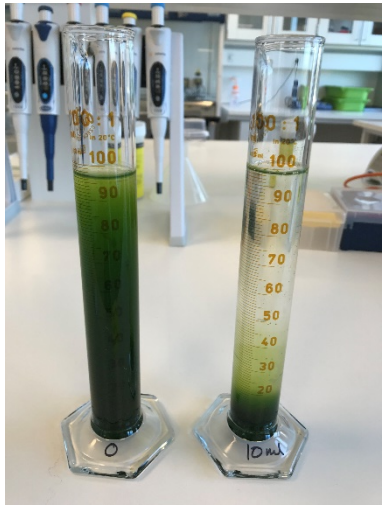




DANISH
TECHNOLOGICAL
INSTITUTE

Algae harvesting and water recycling

- Flocculation, sedimentation and centrifugation



Filtration – how often?

DANISH
TECHNOLOGICAL
INSTITUTE

ReMAPP in brief

✓Focus on algae protein production for feed purposes

✓Utilizes nutrient side streams from biogas industry

✓Large protein yield (15-20 t/ha/yr) with excellent amino acid profile

✓Unique robust algae culture, working *with* the biology

✓Detaches protein production from arable land area

✓Minimal impact on nature and environment

✓Focus on the entire process, including storage, bio availability and safety

Green transition or business as usual?

References

- Becker, Wolfgang. "18 microalgae in human and animal nutrition." *Handbook of microalgal culture: biotechnology and applied phycology*. Vol. 312. 2004.
- Kong, C., et al. "Ileal digestibility of amino acids in meat meal and soybean meal fed to growing pigs." *Asian-Australasian journal of animal sciences* 27.7 (2014): 990.
- van Vliet, Stephan, Nicholas A. Burd, and Luc JC van Loon. "The skeletal muscle anabolic response to plant-versus animal-based protein consumption." *The Journal of nutrition* 145.9 (2015): 1981-1991.