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VALORIZATION OF AGRICULTURAL WASTEWATER STREAMS INTO AN ALTERNATIVE PROTEIN SOURCE DUCKWEED

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Problem 1

- Protein supply for animal feed applications in the European Union (EU) relies mainly on the import of soybean meal
- This causes CO_2-emmissions and great distance nutrient flows
- As a result, there is an increasing demand for alternative protein sources produced in the EU

Problem 2

- Abundance of nutrient rich wastewaters and great diversity between and within sectors
- Nutrient management is necessary to reduce environmental impact of wastewaters
- This nutrient management is a cost for the farmer
- As a result, there is a need for valorization of wastewater management

Objective

- Valorizing different agricultural wastewaters by producing alternative proteins in the form of duckweed

Did you know that:

- The protein content of duckweed is 30 – 45 %
- 90 – 94% of the fresh weight is water
- Duckweed is one of the fastest growing angiosperms and can double its biomass every 2-3 days in optimal conditions
- In Europe an outside growing potential of 10 to 20 ton ha^{-1} y^{-1} is expected

Overall focus of the research

1. Screening and characterization of different wastewater streams for duckweed growth and test their potential in Europe

2. Determining the value of duckweed for feed by analyzing variation of productivity, amino acid composition and protein content on different media

1) Screening and characterization of different agricultural wastewater streams

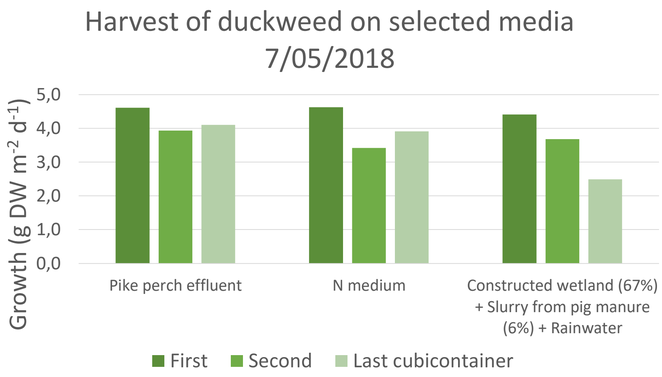
In a first step, different wastewaters from different agricultural sectors were analyzed in order to select potential growing media for duckweed. The composition was compared with optimal and maximal ranges in literature. Based on relevance and composition we selected the following growing media for this season – 1) effluent from Pike perch production 2) a mix coming from a pig manure treatment facility 3) a standard optimal mix. This growing season growth three cubicontainer cascades (1.2 × 1.2 × 1.2 m) with three cubicontainers in outside conditions were set up for duckweed production. The first cubicontainer is filled with the agricultural effluent while the second and third cubicontainer are filled with the effluent of the previous cubicontainer.

SECTOR		pH	EC µS/cm	NO_3 - N mg/l	NH_4 - N mg/l	N_{totaal} mg/l	P_{total} mg/l	K mg /l
Fruits	Blackberry drain	6,2	1610	169	0,6	169	37	95
Floriculture	Storage pond recirculation water	6,8	429	1,8	0,1	1,8	1,2	11
Aquaculture	Pike perch – effluent	7,9	1087	26	2,1	30	2,5	9,8
	Omega perch – growing medium	7,2	2420	297	1,4	236	15	93
	Omega perch – effluent	8,1	1707	120	2,1	95	9,1	67
Algae	Spirulina PCG	9,5	19800	323	2,8	326	84	501
	Spirulina AnKo Projects	9,7	10665	46	0,0	65	47	593
	Spirulina – rinsing	8,8	5595	87	2,4	90	14	212
Swine production	Effluent after activated slurry bed	8,3	26150	NA	2710	2711	29	1706
	Influent constructed wetland	7,2	10558	208	13	221	0,6	1909
	Intermediate lagune in constructed wetland (VZ)	7,7	11396	385	46	432	0,3	1916
	Scrubberwater - stable	2,4	262000	NA	34500	34500	0,0	0,0
	Liquid fraction digestate of pig manure (literature)	8,7	20000	0,0	3600,0	3600	27	3000
	Pig manure (literature)	7,9	28000	ND	3300	5600	2100	3300
Dairy sector	Milk whey	5,5	6580	105	19,4	125	198	
	Rinse water milking robot	4,2	3375	0,0	7,3	7,3	74	1291
Potato sector	Struvite – processing	7,3	930	240	970,0	1210	93000	9100
Digesters	Liquid fraction digestate co-digestion	8,1	33000	0,0	4100,0	4100	1200	4400
	Mineral concentrate	8,2	40500	NA	6450,0	6450	NA	7,0
	Solid fraction digestate	8,5	ND	NA	2006,3	5350	2100	3600
	Digestate	8,2	39000	NA	2200,0	5150	1500	6350
Nature	Natural occurrence	7,2	760	5,7	0,1	5,8	1,7	20
Nmedium	Standard medium	7,0	ND	140	0	140	4,6	319
Ranges	Minimum	3,5	10	7	7	7	0,31	20
	Maximum	10,4	10900	1400	1050	2101	1550	3910

2) Determining value of duckweed for feed – Ongoing

Growth in outside conditions on cubicontainer cascade on 3 selected media
The following parameters are being determined on a weekly basis:

- Productivity
- Protein content
- N uptake
- P uptake
- Amino acid composition



3) Discussion

The latest results show, a growth rate of 2.5 – 4.6 g DW m^{-2} d^{-1}. This is comparable with the growth rate (3.1 g DW m^{-2} y^{-1}) observed on a 4% swine wastewater on lab-scale in Lisbon (Pena, 2017). Last season there were 182 growing days so the productivity is estimated between 4,5 and 8,4 tonnes DW ha^{-1} y^{-1}. In this week we also observed a N uptake between 85 and 274 mg N m^{-2} d^{-1} and a P uptake between 8 and 74 mg P m^{-2} d^{-1}.

REFERENCES

Pena, L., Oliveira, M., Fragoso, R., & Duarte, E. (2017). Potential of Duckweed for Swine Wastewater Nutrient removal and Biomass Valorisation through Anaerobic Co-digestion. Journal of Sustainable Development of Energy, Water and Environment Systems, 5(2), 127-138.

CONCLUSIONS

- DUCKWEED HAS THE POTENTIAL TO BE USED AS AN ALTERNATIVE PROTEIN SOURCE IN EUROPE
- MOST AGRICULTURAL WASTEWATER STREAMS ARE NOT SUITED FOR DIRECT USE AS A GROWING MEDIUM, THUS MODIFICATION IS NECESSARY

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