MICROALGAE TO REMOVE NITROGEN FROM AGRO-DIGESTATES: THE MICROGATE PROJECT

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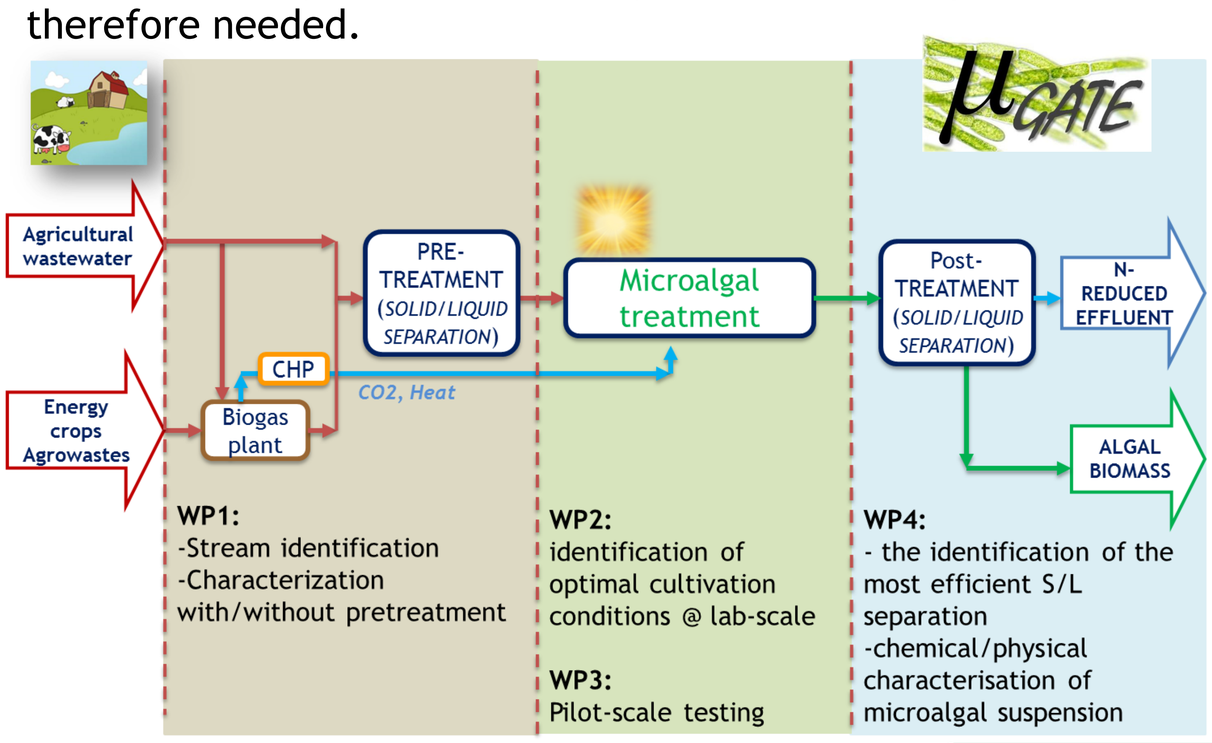
The context

- In Lombardy (North of Italy) biogas plants treating animal manure and energy crops have spread remarkably in the last years.
- Anaerobic digestion has ensured an improved environmental sustainability of animal breeding
- Excessive nitrogen (N) discharge into this nitrate sensitive area remains an issue.
- To reduce the N load to the fields, farms are forced to use expensive technical solutions, thus increasing production costs.

Environmentally and economically sound technologies to reduce the N load in agricultural wastewaters are therefore needed.



The **Microgate** project: *Use of MICROalgae to mitiGATE nitrogen pollution from agricultural wastewaters*.

It intents to validate the feasibility to use microalgae to remove ammoniacal nitrogen from the liquid phase of digestates from animal manure anaerobic digestion.

Microalgae require few simple elements such as light, carbon dioxide and nutrients, have fast growth rates, are very efficient in sequestering organic contaminants and inorganic nitrogen.

This solution is technically simple and has a low energy requests since it exploits solar energy and it allows for the valorization of waste heat streams and CO2 that are available in biogas plants, resulting in an effective process integration and in the reduction of the carbon footprint of the agricultural sector.

First results

Wastewater sampling and characterization

Tested wastewaters sampled before and after the solid/liquid separation (S/L).

W1: swine manure, from a farm breeding 20.000 pigs; S/L: rotating sieve and dissolved air flotation;

W2: digestate from a full scale digester fed on the solid fraction of swine manure, maize silage, poultry manure and cheese whey. S/L: centrifugation;

W3: digestate from a full scale digester fed on swine and dairy manure, maize silage, and minor contributions of poultry manure and cheese whey. S/L: screw-press.

Three sampling were performed in May-July 2015.

Table 1. Wastewater characteristics of raw samples (TQ) or liquid fractions after solid/liquid separation (L).

	W1 TQ	W1 L	W2 TQ	W2 L	W3 TQ	W3 L
TS (g/L)	5±1	2±0.3	67±7	9±2	60±2	53±0.7
VS (g/l)	3±0.6	0.74±0.1	47±5	4±3	38±1.5	32±0.4
pH	7.4±0.2	7.3±0.08	7.7±0	7.4±1	7.8±0.06	8.2±0.08
N-NH4 (mg/l)	216±113	195±80	2200±400	960±400	2250±170	2250±210
P-PO4 (mg/l)	28±15	17±7	100±47	34±11	178±109	234±70
Turbidity (FAU)	194±90	202±23	9600±7500	1600±320	2800±2000	3500±2200
Soluble COD (g/l)	1.3±0.2	1±0.1	4.7±0.7	7.2±7.5	22.4±31.0	5.0±0.18
Total COD (g/l)	4.6±0.6	0.95±0.11	65±11	6.2±4	55.6±4.6	40±2.2
N/P	13±4	17±7	23±14	32±24	26±23	11±5
COD/N	5±2	5±2	2±0.05	10±12	14±16	2±0.3

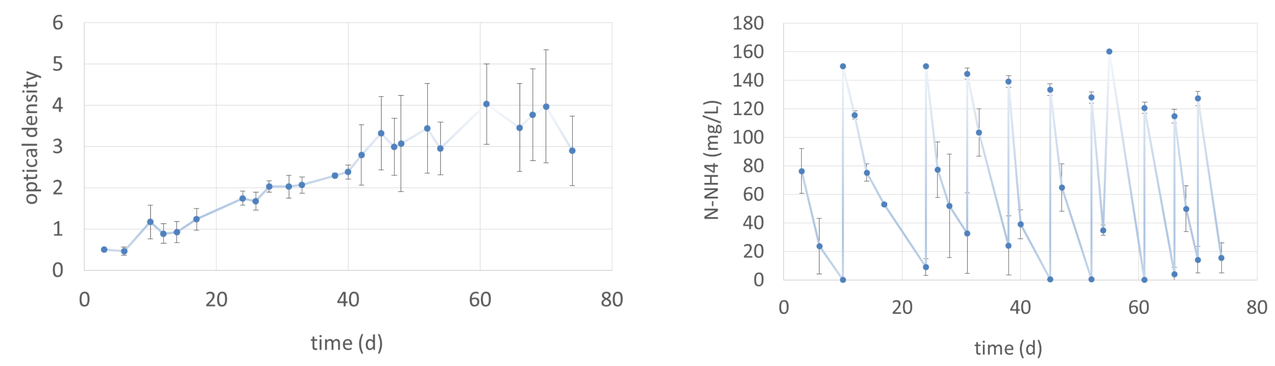


Figure 1. Results of the semi-continuous grow test on W2: ammonium concentration (left) and optical density (right).

Lab-scale algal growth tests

The liquid fraction of W2 was used.

Semi-continuous culturing tests in triplicate in 150 mL glass vials.

A mixed microalgal community dominated by *Chlorella spp*. and *Scenedesmus spp*. as inoculum.

Light: 6 fluorescent lamps (FLORA model from OSRAM, 18 W) 12 h dark/light periods.

Air was flushed at the bottom of each vial through a fine bubble diffuser.

Operation: every 1-2 weeks, 10 out of 150 mL of the algal suspension was substituted W2.

Ideal characteristics
- Low turbidity
- Acceptable N
- Ammonium content
- N/P=10-100, low COD/N

Best candidates: W2 L e W1 L

Results of the first semi-continuous tests on W2 L with a concentration of 1730 mgNH4-N/L are reported in Figure 1.

- Ammonium was efficiently (>97%) removed
- the microalgal concentration increased over time up to 3-4 times the initial value, above which light penetration was probably limiting.
- Long HRT (above 80 d) were requested due to the high ammonium concentration in the wastewater.

On going tests

A pilot-scale continuous test with outdoor plants:
- a continuously fed 70 L bubble column
- a 800L race-way pond

treating W2 L has been just started up in a farm and will last for around 6 months (May 2016-October 2016).

Successful start up of the bubble column completed

On-going: start-up of the raceway

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