

Enhancing CO₂ valorization from biomethane and digestate streams to produce alternative proteins from green microalgae cultivation.

G. del Puerto-Tañà^{a,b}, L. Paredes^a, J. González-Camejo^a, M. Fernandes de Souza^b, Erik Meers^b, S. Ponsá^a

^a BETA Tech. Center (TECNIO Network), University of Vic-Central University of Catalonia (UVic-UCC), Carretera de Roda 70, Vic 08500, Spain.

^b Laboratory for Bioresource Recovery (RE-Source), Department of Green Chemistry and Technology, Ghent University, 9000 Ghent, Belgium.



georgina.delpuerto@uvic.cat

Introduction

In biogas plants, CO₂ generated during biogas upgrading is released into the atmosphere, while digestates - the semi-solid by-product of anaerobic digestion - require further treatment. Novel technologies for CO₂ capture and digestate treatment are necessary.

In the **SEMPRE-BIO project** (www.sempre-bio.com), microalgae cultivation is proposed to recover CO₂ from biogas and nutrients from digestate.

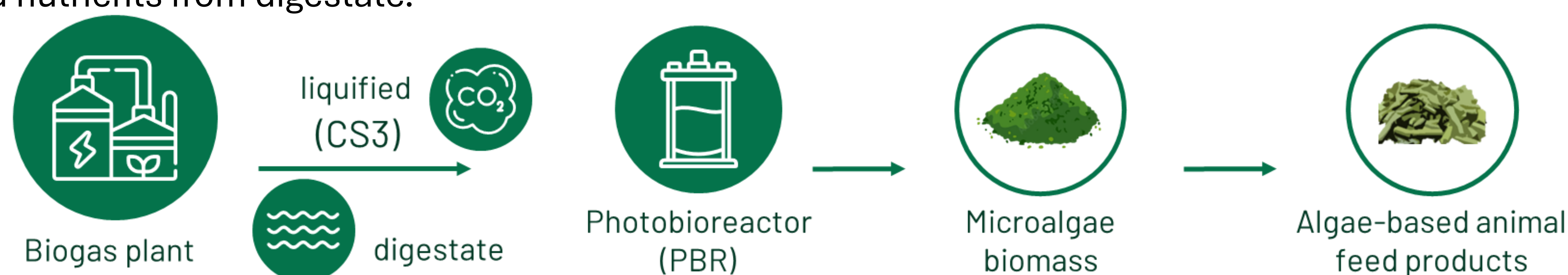


Figure 2. SEMPRE-BIO process scheme.



Figure 1. Pilot scale photobioreactor (PBR).

Methods

An outdoor pilot-scale photobioreactor (PBR) is operated using *Parachlorella kessleri* as microalgae strain, recovered CO₂ as carbon source and digestate (4%, 124 mg N-NH₄⁺/L) as nutrient source (Table 1). Following each cultivation periods, including batch and sequential-batch (SB) phases, microalgae biomass is harvested and characterised.

Table 1. PBR cultivation periods.

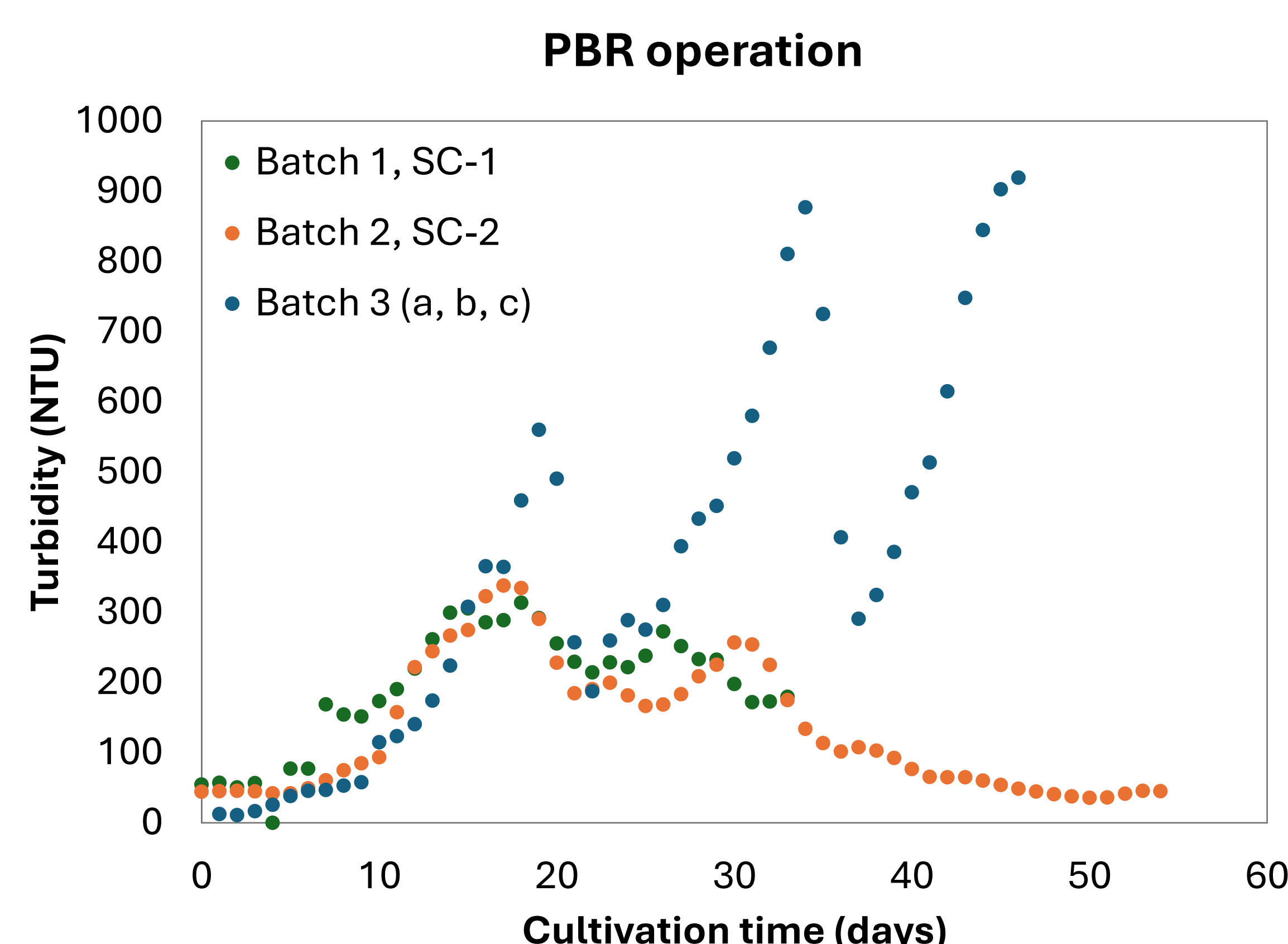
Period	Date	Summary
Batch 1	Autum 2024	pH 8.5; mineral medium, 9 days
SB-1	Autum 2024	pH 8.5; mineral medium; HRT=7, 17 days
Batch 2	Autum 2024	pH 8.5; digestate medium (3.5%), 16 days
SB-2	Autum 2024	pH 8.5; digestate medium (3.5%), 17 days
Batch 3a	Spring 2025	pH 7.5, mineral medium, 20 days
Batch 3b	Spring 2025	pH 7.5, mineral medium, 15 days
Batch 3c	Spring 2025	pH 8.0, mineral medium, 10 days

Results and Discussion

Table 2. Summary of results obtained for each period.

Period	Average PAR (μmol · m ⁻² · s ⁻¹)	Growth rate (d ⁻¹)	Initial concentration (mg DW/L)	Max. concentration (mg DW/L)	Biomass productivity (mg DW/L/d)	N-removal (mg N/L/d)	Protein content (% DW)
Batch 1	357	0.217	43	362	35	3.2	-
SB-1	283	-	208	797	57	16.8	-
Batch 2	200	0.199	109	642	30	2.6	-
SB-2	198	-	625	662	24	14.6	-
Batch 3a	200	0.202	21	693	43	2.22	25 ± 6
Batch 3b	399	0.096	322	1090	59	4.2	29 ± 3
Batch 3c	833	0.095	510	1313	98	7.8	39 ± 7

• Protein content ranged from 25-39 %DW



Conclusions

- Growth rate values were in the range of previous lab-scale experiments (0.180 d⁻¹).
- High N-NH₄ concentration, unbalanced N/P ratios, and solid content are the main challenges to treat digestate.

Acknowledgements

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