DIGESTATE VALORISATION VIA MICROALGAL GROWTH: FOCUS ON CONVERTING WASTE NUTRIENTS AND CO_2 INTO GREEN BIOMASS

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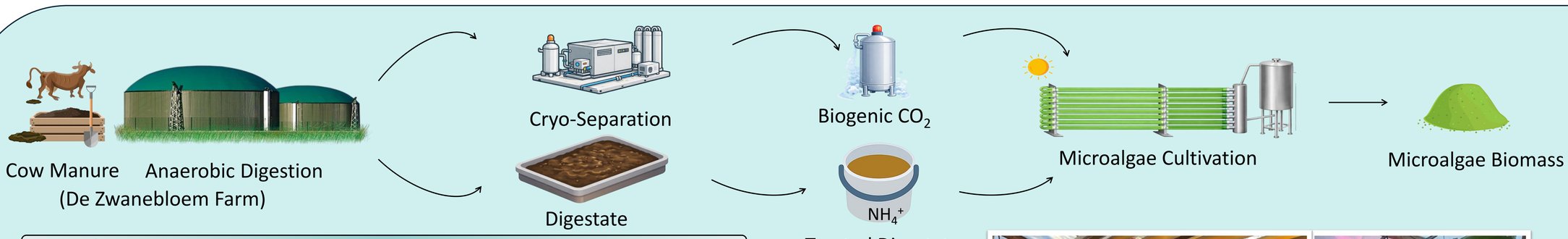
BACKGROUND

Anaerobic digestion generates nutrient-rich digestate and CO_2-rich biogas streams, however, the valorization of these residual flows remains a key sustainability challenge. Microalgae cultivation has emerged as a promising approach to simultaneously assimilate inorganic carbon and remove excess nutrients, enabling integrated resource recovery.

Microalgae utilize biogenic CO_2 as a carbon source while efficiently assimilating ammonium and phosphorus from digestate. This dual functionality supports the integration of carbon capture and nutrient recovery, promoting the conversion of residual streams into value-added biomass within a circular production framework.

METHODOLOGY



❖ **Batch Test** → ❖ **Continuous Test**

❑ Selected Species
- *Desmodesmus denticulatus*

❑ 6 cultivation sets:
- 2%, 3%, 4% with/without P addition and different feeding frequencies

❑ Nutrient source:
- Ammonia and phosphorus

❑ CO_2 supply:
- Commercial & Biogenic CO_2

❑ Selected Species:
- *Desmodesmus denticulatus*

❑ Growth Media:
- 3% Digestate with P addition

❑ CO_2 supply:
- Commercial CO_2

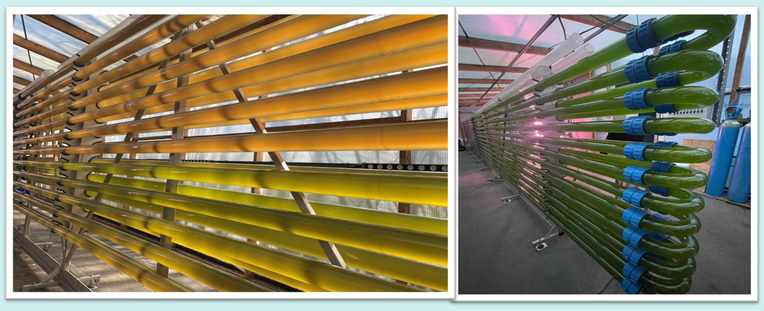


Fig.1. Growth of *Desmodesmus denticulatus* cultivated in digestate-based medium: (a) initial inoculation; (b) culture during active growth

Growth Conditions

pH: 7.5-8

Temperature: 20-23 °C

Light/Dark period: 16:8

RESULTS

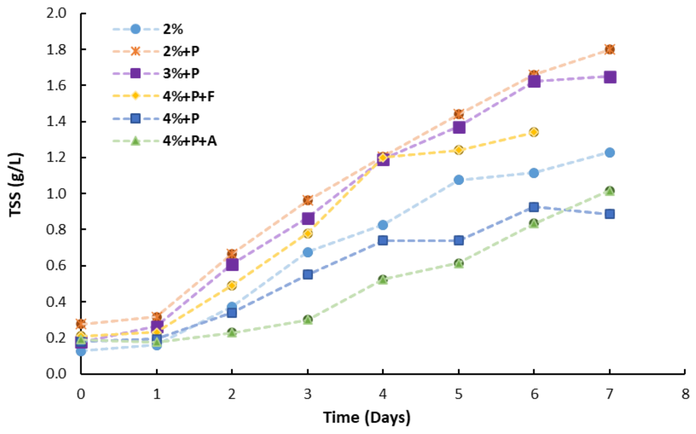


Fig.2. Biomass growth (TSS) of Desmodesmus denticulatus cultivated under different digestate concentrations and nutrient supplementation conditions

Parameter	Unit	2%	2%+P	3%+P	4%+P+F	4%+P	4%+P+ $(NH_4)_2SO_4$	
Biomass Concentration	g L^{-1}	1.7	1.4	1.9	1.8	1.7	1.6	1.3	0.5	1.2	1.0[2]	1.1
Protein	% DM	14.3	16.0	23.3	20.7	34.2	30.7	29.8	34.5	33.4	42.2	38.2
Lipid	% DM	5.2	4.9	1.5	2.4	1.1	0.8	0.5	1.1	0.8	1.9	1.8
Carbon (C)	% DM	51.3	49.0	46.6	45.2	45.9	46.6	45.8	47.9	48.2	51.2	48.7

Fig.3. Growth performance and biochemical composition of *Desmodesmus denticulatus* cultivated with different digestate concentrations and nutrient supplements

P addition and higher N availability under stable pH (7.5–8) enhanced protein production

3% digestate outperformed 2% and 4% in achieving an optimal balance between biomass production and protein content

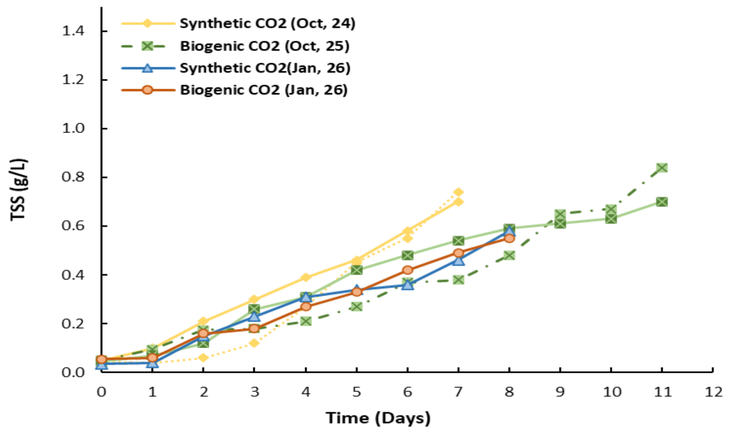


Fig.3. Biomass growth (TSS) *of Desmodesmus denticulatus* in under biogenic and synthetic CO_2 supply in BBM medium

The similar biomass production observed under synthetic and biogenic CO_2 (Jan 26) indicates functional equivalence between the two carbon sources

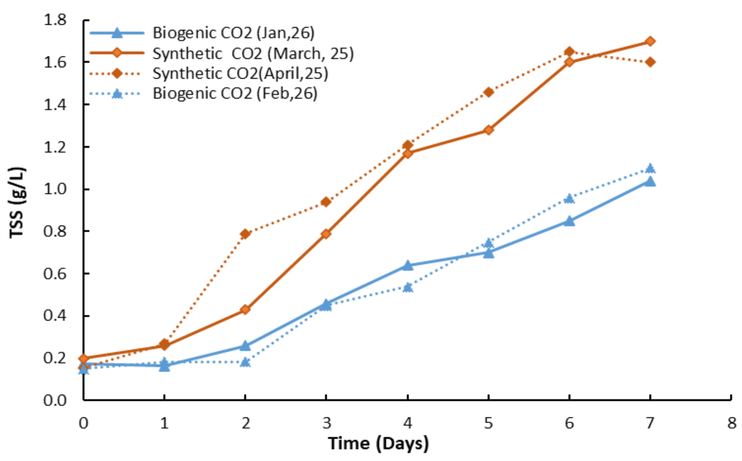


Fig.4. Biomass growth (TSS) *of Desmodesmus denticulatus* in 3% digestate (+P) under biogenic and synthetic CO_2 supply

Seasonal variability under biogenic CO_2 resulted in measurable performance differences, highlighting the importance of process optimization

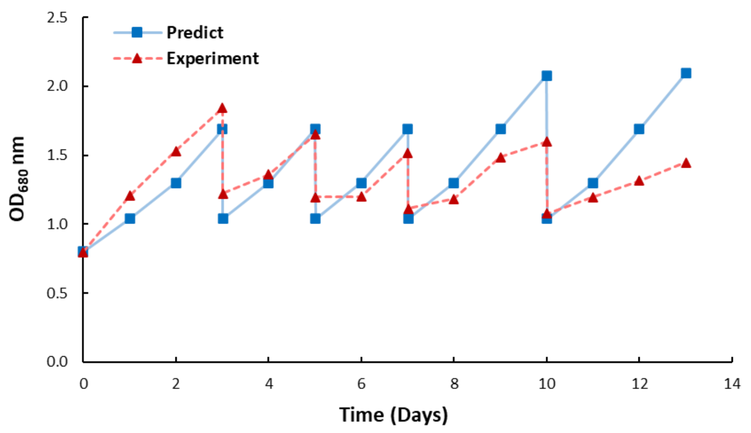


Fig.5. $OD_{(680)}$-based prediction vs. experimental growth of *D. denticulatus* in 3% digestate (+P) under semi-continuous cultivation

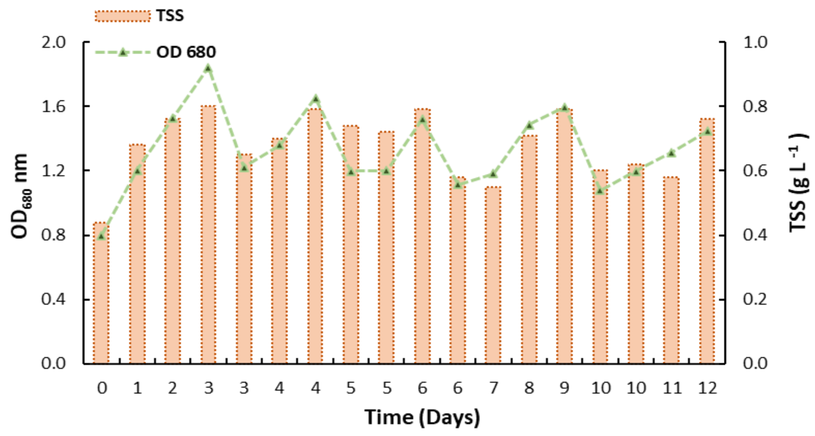


Fig.6. Biomass (TSS) and OD_{680} dynamics of *Desmodesmus denticulatus* under 3% digestate (+P) under semi-continuous cultivation

The OD_{680}-based 50% renewal strategy every 2 days supported culture maintenance over 14 days, indicating promising potential for semi-continuous production using digestate

Further investigation is necessary to assess the system's long-term operational stability

CONCLUSIONS

✓ 3% digestate provided the best trade-off between biomass production and protein content

✓ *Desmodesmus denticulatus* grew successfully with biogenic CO_2, confirming its suitability for integrated cultivation systems

✓ Both batch and semi-continuous systems performed well; further optimization is required to increase productivity

SCAN ME

ACKNOWLEDGMENTS

This project has received funding from the European Union's Horizon Europe programme under grant agreement Nº 101084297

Innolab Lab 4 Biomass

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