

Biogenic CO₂ and Digestate as Resources for Sustainable Microalgal Cultivation

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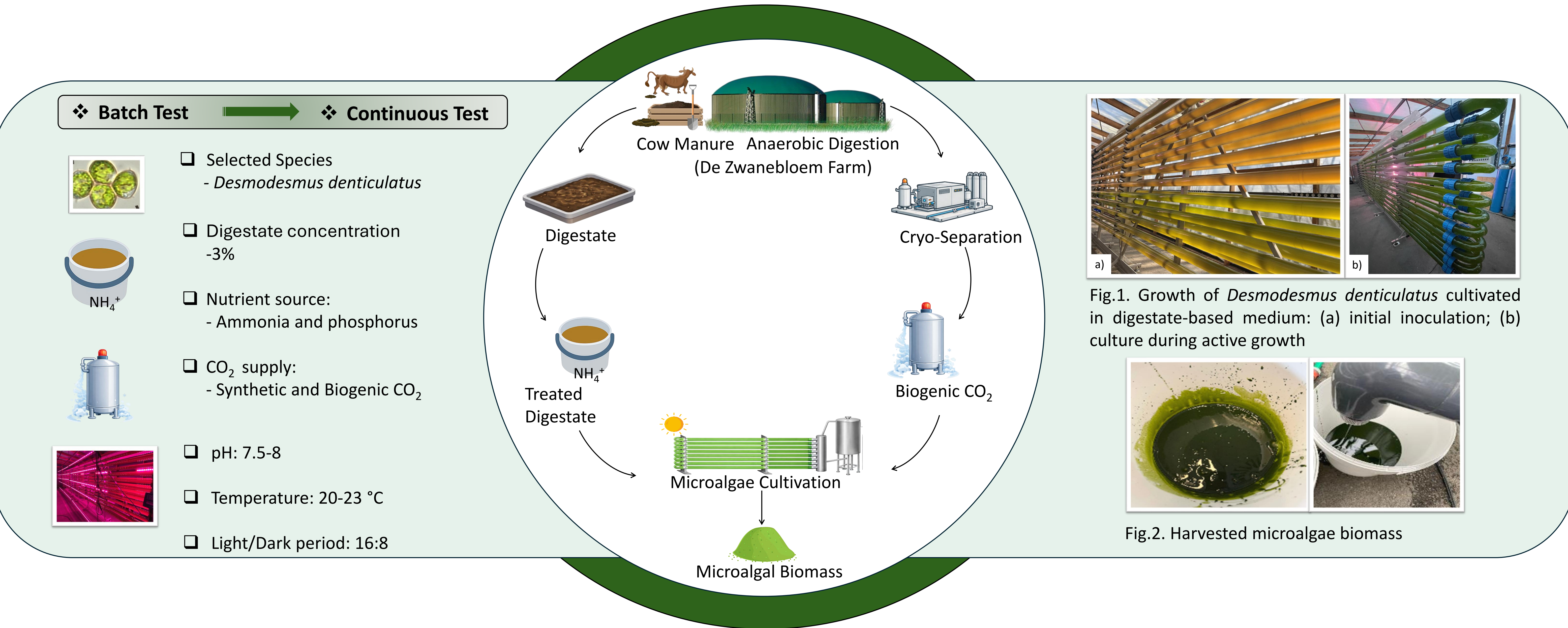
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BACKGROUND

The integration of microalgae cultivation with biogas production represents a sustainable biorefinery strategy that supports a circular economy. Anaerobic digestion generates nutrient-rich digestate and biogas streams, both of which can be effectively valorized within this integrated system.

The liquid fraction of digestate provides essential nutrients, nitrogen (N) and phosphorus (P), for microalgal growth. At the same time, biogenic CO₂ released during biogas production can be captured and reused as a carbon source. The combined utilization of these side streams enables microalgae-driven carbon capture and nutrient recovery, promoting the conversion of residual resources into value-added biomass.

METHODOLOGY



RESULTS

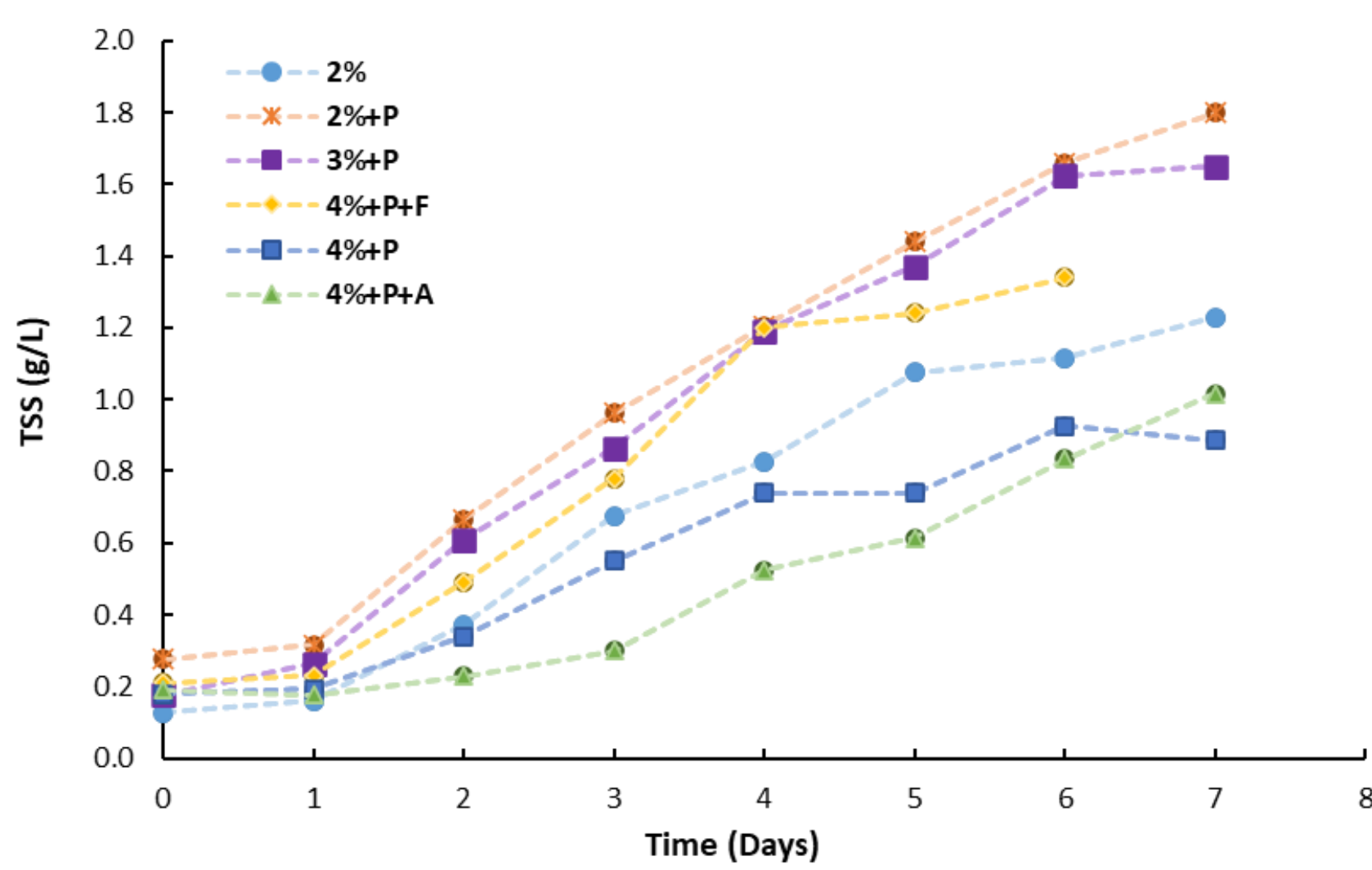


Fig.2. Biomass growth (TSS) of *Desmodesmus denticulatus* cultivated under different digestate concentrations and nutrient supplementation conditions

Parameter	Unit	2%	2%+P	3%+P	4%+P+F	4%+P	4%+P+P+A
Biomass Concentration	g L ⁻¹	1.7	1.4	1.9	1.8	1.7	1.6
Protein	% DM	14.3	16.0	23.3	20.7	34.2	30.7
Lipid	% DM	5.2	4.9	1.5	2.4	1.1	0.8
Carbon (C)	% DM	51.3	49.0	46.6	45.2	45.9	46.6

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

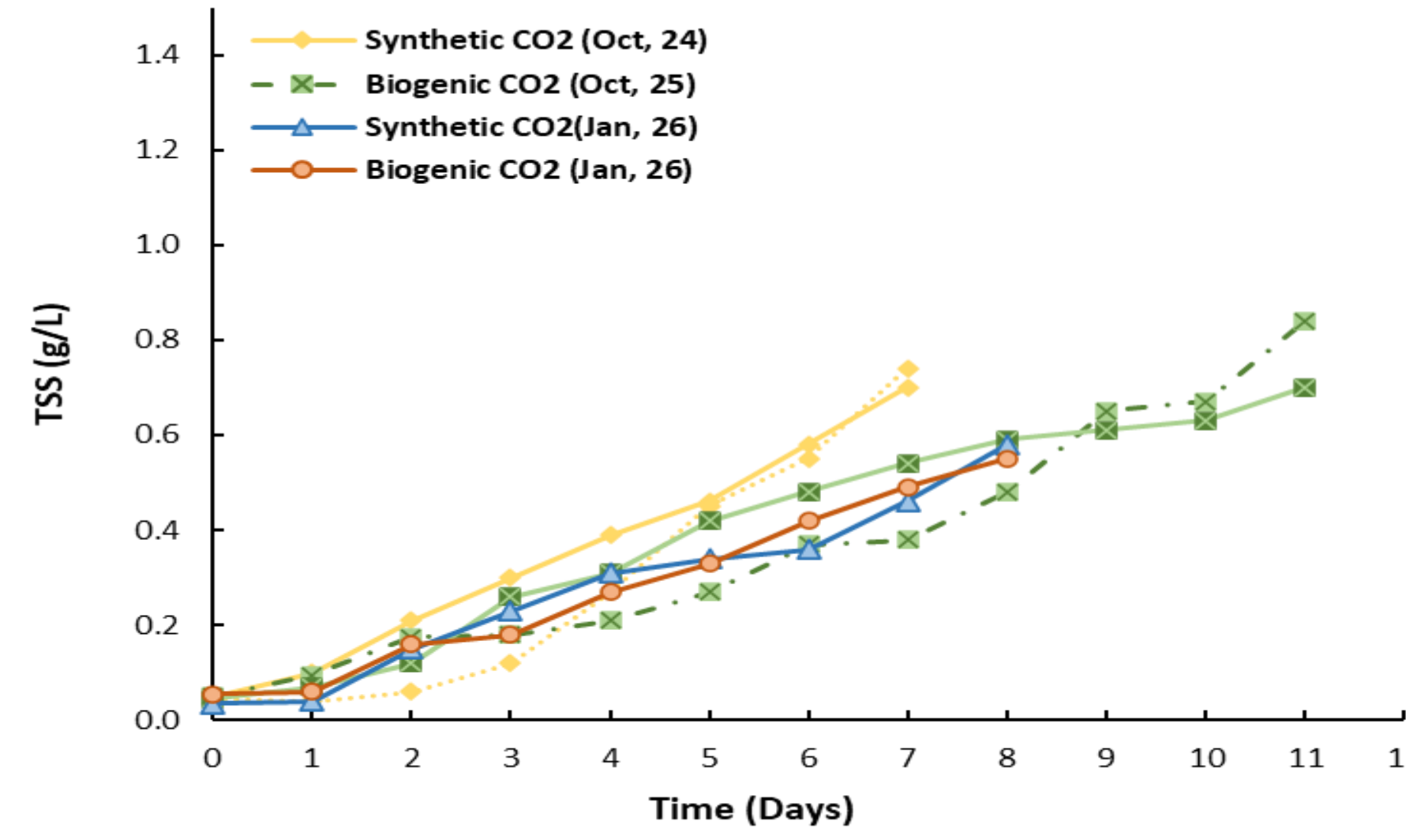


Fig.3. Biomass growth (TSS) of *Desmodesmus denticulatus* in under biogenic and synthetic CO₂ supply in BBM medium

✓ The similar biomass production observed under synthetic and biogenic CO₂ (Jan 26) indicates functional equivalence between the two carbon sources

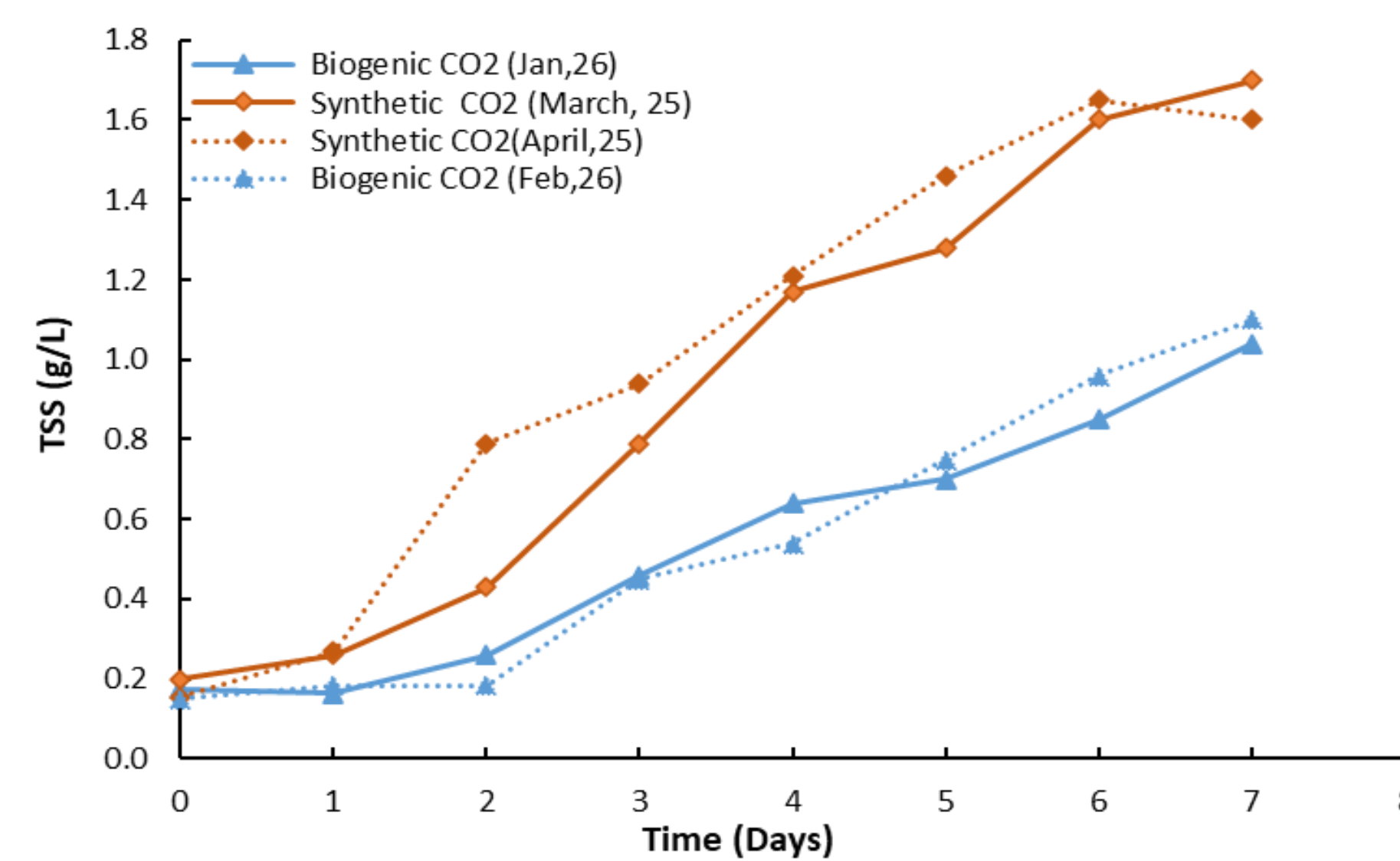


Fig.4. Biomass growth (TSS) of *Desmodesmus denticulatus* in 3% digestate (+P) under biogenic and synthetic CO₂ supply

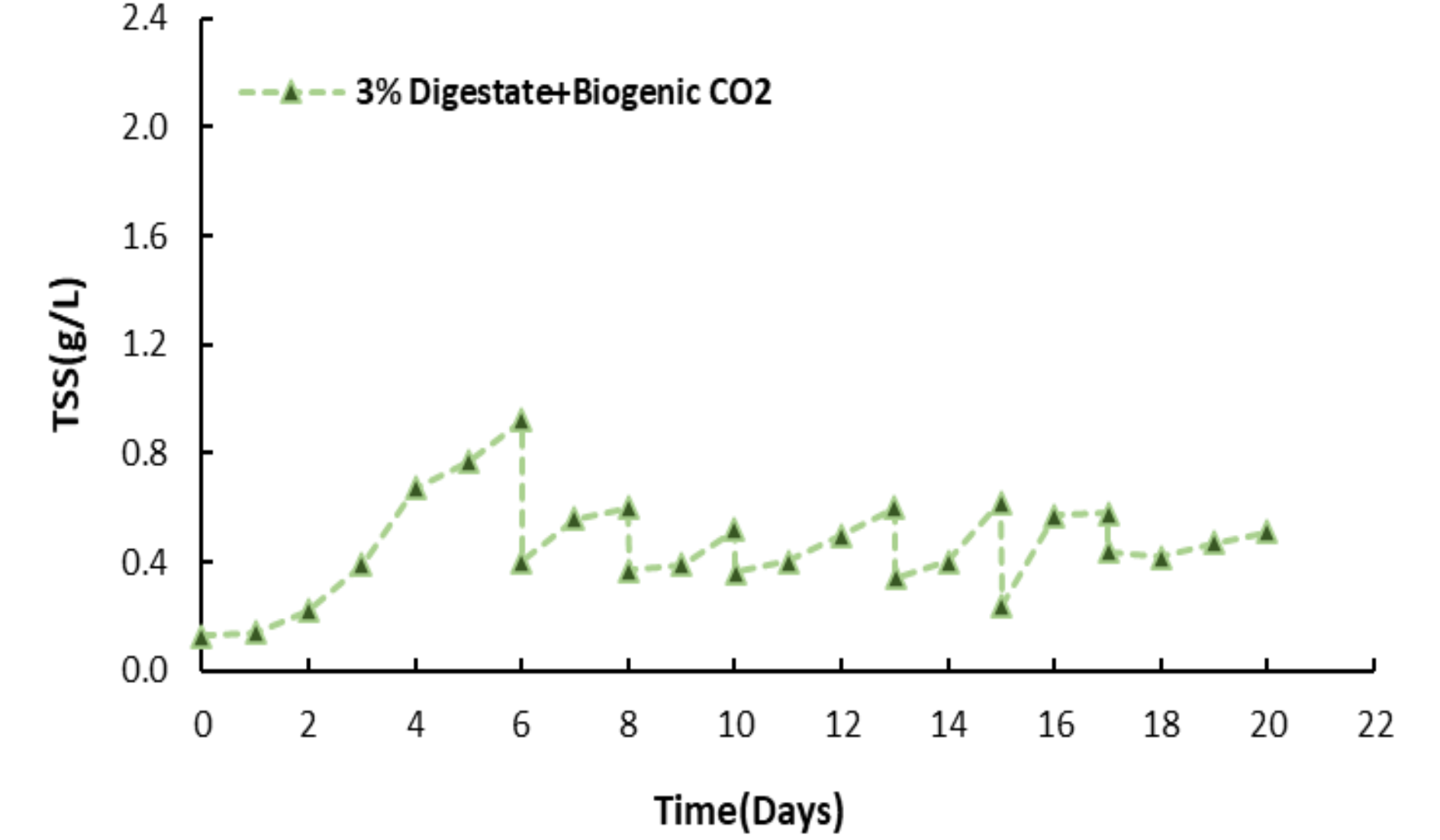


Fig.5. Biomass growth (TSS) of *Desmodesmus denticulatus* in 3% digestate (+P) under semi-continuous cultivation (20days) with biogenic CO₂ supply

✓ A 50% culture renewal based on OD₆₈₀ every 2 days ensured stable operation over 20 days, supporting the feasibility of semi-continuous cultivation with digestate.

✓ Seasonal variability under biogenic CO₂ resulted in measurable performance differences, highlighting the importance of process optimization

✓ 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
- ✓ Digestate and Biogenic CO₂ supported microalgae growth, showing it is suitable for sustainable cultivation
- ✓ Further optimization is needed to improve productivity in both batch and semi-continuous systems.



ACKNOWLEDGMENTS

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