Macroalgae biogas production: using wastewater sludge to optimise the process

Ometto, F.[1,*], Berg, A.[1], Björn, A.[2], Šafarić, L.[2], Svensson, B.[2], Handå, A.[3], Steinhovden, K.[3], Wollan, H.[4] Ejlertsson, J. [1,2]
[1]Scandinavian Biogas Fuels AB (SE); [2]Linköping University, (SE); [3]SINTEF (NO); [4]Biokraft AS (NO).
[*]francesco.ometto@scandinavianbiogas.com

Funded by the European Union

Scope

The feasibility of a full scale system for anaerobic co-digestion of the kelp *Saccharina latissima* and municipal wastewater sludge is explored at mesophilic and thermophilic condition, respectively. In particular, the impact of the algae biomass on the digestion performances was investigated at increasing algae:sludge ratio.

Achievements

- ✓ Optimal digestion performances were obtained when digesting a 50:50 algae:sludge mixture.
- ✓ Algae biomass impacts the most the conductivity of the digestate.
- ✓ Wastewater sludge appeared an optimal co-substrate to maintain high digestion performances.
- ✓ Thermophilic condition allows higher yields and algae loading.

Considering a yearly production of 10 000 ton wet kelp biomass[1] (12%TS with 20% ash content), between 100 000 to 130 000 m^3 CH_4 can be generated under optimal digestion condition, enough to fulfil the biomethane demand of 2-3 local city buses[2].

Results

Control

320 ml CH_4/gVS at 37°C, 340 ml/gVS at 52°C.

The pH value was stable at 7.5 and 8, respectively, with a VFAs concentration <0.6 mM. Ammonium was stable at 1100 and 1500 mgNH^{4+}-N/l, and conductivity equal to 7.6 and 8 ms/mc, depending on the reactors.

20% Algae

290 ml CH_4/gVS at 37°C, 280 ml/gVS at 52°C.

Conductivity was the only parameter significantly effected (+90%) by the algae addition.

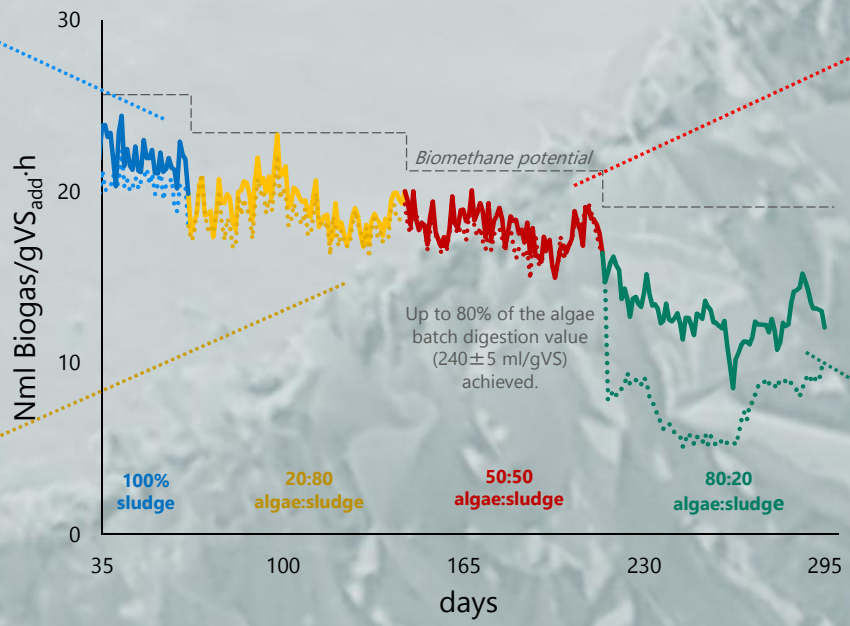


Fig. 1 – Biogas production (average of duplicate) at mesophilic (continuous line) and thermophilic (discontinuous line) condition, respectively. Horizontal grey lines represent estimated biomethane potential (BMP) value measured at 37°C after 60 days digestion.

50% Algae

260 ml CH_4/gVS in both reactors.

Initial VFAs accumulation (up to 4 mM Acetic acid) was observed in the 52°C reactors. Conductivity values showed +200% compared to controls. H_2S increased to 1100 ppm in both reactors due to lack of iron in the system.

80% Algae

230 ml CH_4/gVS in both reactors during final stage.

Sever VFA accumulation occurred until day 250, to degrease afterword. Conductivity showed +350% and H_2S exceed 9000 ppm.

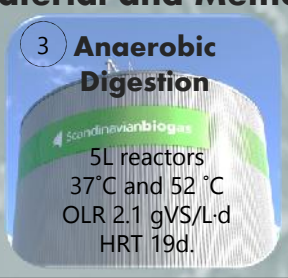
Material and Methods

1 ***Saccharina latissima***

cultivated in Norway. WWS was collected in Linköping (Sweden).

2 **Pre-processing**

Algae (12% TS at 50% ash), blended to size ≤ 1cm².

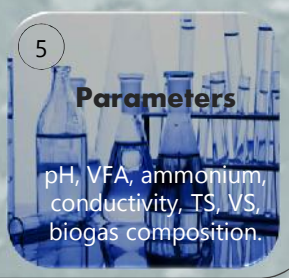


3 **Anaerobic Digestion**

5L reactors
37°C and 52 °C
OLR 2.1 gVS/L·d
HRT 19d.

4 **Operational condition**

OLR composition changed every 3 HRTs: 100:0, 20:80, 50:50, 80:20 algae:sludge VS ratio.



5 **Parameters**

pH, VFA, ammonium, conductivity, TS, VS, biogas composition.

[1] Broch, O.J et al., 2013 Modelling the cultivation and bioremediation potential of the kelp *Saccharina latissima* in close proximity to an exposed salmon farm in Norway. *Aquacult Environ Interact* Vol. 4, 187-206; [2] Scandinavian Biogas Fuels AB internal data based on Stockholm (SE) city busses' biomethane demand.

The authors would like to thank the EU Framework 7 project ATBEST Advanced Technologies for Biogas Efficiency Sustainability and Transport (n. 316838), as well as the TEMA–Environmental Change department at Linköping University, Biokraft AS and SINTEF for their financial and intellectual support.