Microbial Populations Shift During Mesophilic and Thermophilic Anaerobic Digestion-Phase 1: Biological Hydrogen Gas Production from Lab-Scale Batch Anaerobic Digester using Various Substrates



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Low-cost & carbon rich fuels emit large

Hydrogen gas is known as one of the most

anaerobic digestion is methane oxidization,

which increases global warming potential

because its combustion significantly emits

 CO_2 (greenhouse gas) (The Geography of

ignition generates water, not CO_2 , as the

Food waste

(FW

 H_2 has the highest energy content compared

to other gases in biogas. Also, the hydrogen

Transportation Systems, 2017).

end-product (Balat M., 2008).

Mixed

sludge

clean and sustainable type of energy that

yields 3 times higher than fossil fuels

Currently, most energy utilization from

amounts of greenhouse gases.

(Momirlan et al., 2005).

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VFA

Biological H₂ production generated during anaerobic digestion is a fraction accounted within the 1%. The microbial substrate competitions during anaerobic digestion inhibits high biohydrogen gas content formation.



Multi-variable analysis via RDA shows COD, VFA and ammonium ions concentrations combined directly influenced high H₂ content in RDA1 component.





Among all samples, with or without pure culture spike, H₂ gas was measured at Day 4 and 6 of FW reactor. This shows food waste enhance H_2 gas production at a short residence time of 4-6 days. Remark: 1000 ppm (mg/L) = 0.1%. Impacts of C. acetobutylicum spike was not observed.

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BACKGROUND AND SIGNIFICANCE

METHODOLOGY

Primarv Secondarv sludge sludae





Primary

sludge

& FW

Hach DR 3900 Spectrometer (left) for

measuring chemical oxygen demand

(COD), volatile fatty acid (VFA),

Secondary

sludge

& FW

Mixed

Sludge

& FW

Hydrogen analyzer 0-1,000 ppm (mg/L) Forensics: Detectors (left)

ON-GOING AND FUTURE WORK

- Batch experiments continued using C. butyricum, C. beijerinckii, C. hydrogeniformans and Lactobacillus spp.
- Molecular biology to determine population in samples using next generation sequencing.
- Repeat experiment to determine if the process of methanogenesis can be interrupted.

Reference: Balat M (2008) Potential importance of hydrogen as a future solution to environmental and transportation problems. Int. J. Hydrogen Energy 33: 4013-4029.; Momirlan M, Veziroglu T (2005) The properties of hydrogen as fuel tomorrow in sustainable energy system for a cleaner plant. Int J Hydrogen Energy 30: 795-802.; The Geography of Transport Systems. 4th Ed. Jean-Paul Rodrigue (2017), New York: Routledge 440 pages. Energy Content of some Combustibles (in MJ/kg).; Uckun Kiran, E., Stamatelatou, K., Antonopoulou, G., Lyberatos, G. (2016) 10-Production of biogas via anaerobic digestion, Handbook of Biofuels Production (Second Edition), Processes and Technologies, 259-301.



Figure 1 Anaerobic digestion pathways (Uckun Kiran et al., 2016)

- 50-mL batch reactors were incubated at 35°C for 18 days. (right)
- 25 mL of anaerobic digested sludge (grey) and 5 mL of $NaHCO_3$ (blue) in each.
- 5 mL of substrate was provided as indicated (right).
- Dual substrate provided at 50% each.

FOOD WASTE COMPOSITION



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RESULTS AND DISCUSSION

