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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BACKGROUND AND SIGNIFICANCE

- Low-cost & carbon rich fuels emit large amounts of greenhouse gases.
- Hydrogen gas is known as one of the most clean and sustainable type of energy that yields 3 times higher than fossil fuels (Momirlan et al., 2005).
- Currently, most energy utilization from anaerobic digestion is methane oxidization, which increases global warming potential because its combustion significantly emits CO_2 (greenhouse gas) (The Geography of Transportation Systems, 2017).
- H_2 has the highest energy content compared to other gases in biogas. Also, the hydrogen ignition generates water, not CO_2, as the end-product (Balat M., 2008).

Biological H_2 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.

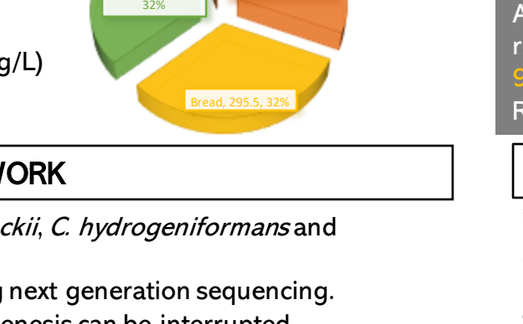
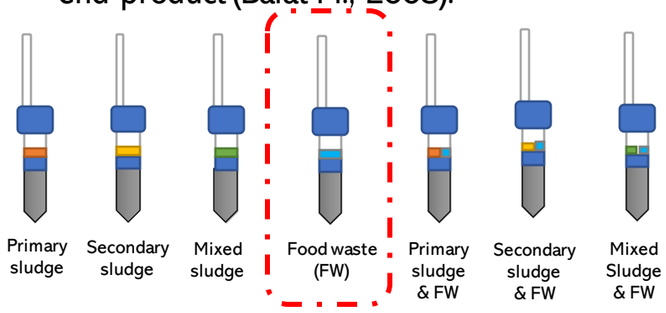


Figure 1 Anaerobic digestion pathways (Uckun Kiran et al., 2016)

METHODOLOGY



- 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.

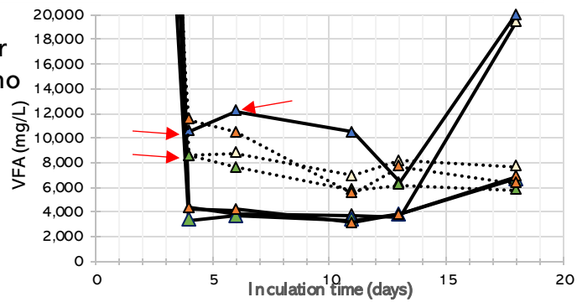
Hach DR 3900 Spectrometer (left) for measuring chemical oxygen demand (COD), volatile fatty acid (VFA), ammonium ion (NH_4^+-N) and alkalinity

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

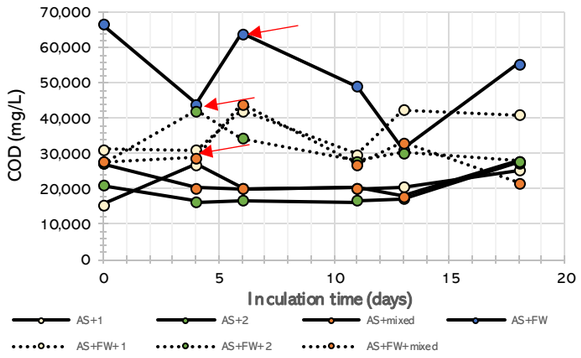
FOOD WASTE COMPOSITION

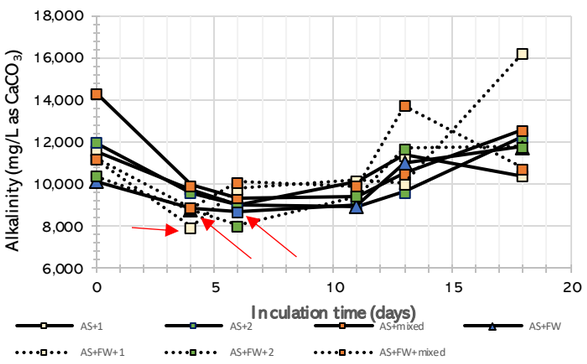
RESULTS AND DISCUSSION

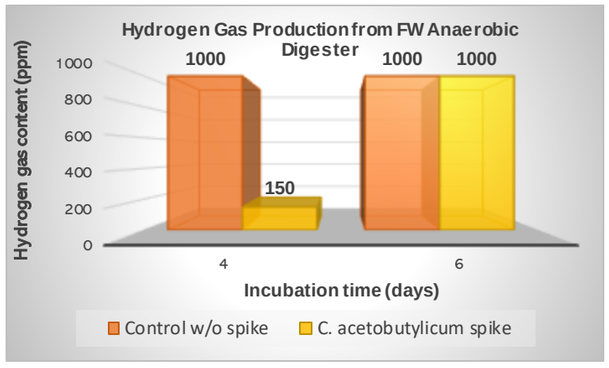
- COD, VFA, alkalinity and NH_4^+-N were observed over 18 days (data shown only no spike rectors)

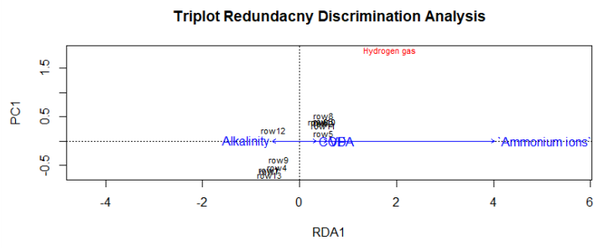


- Multi-variable analysis via RDA shows COD, VFA and ammonium ions concentrations combined directly influenced high H_2 content in RDA1 component.









Among all samples, with or without pure culture spike, H_2 gas was measured at Day 4 and 6 of FW reactor. In addition, Day 4 of FW + Primary sludge reactor without the spike had a H_2 concentration of 900 ppm. 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.

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.

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