Improving volatile fatty acid productivity of anaerobic digestion

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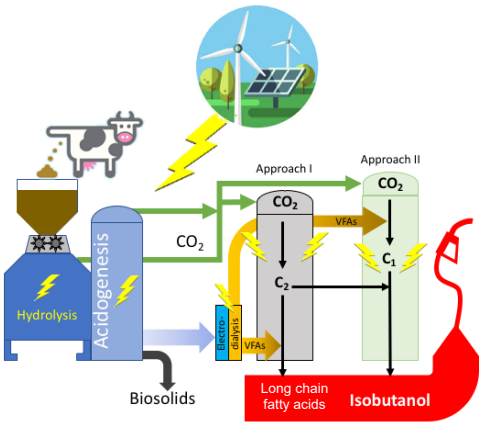
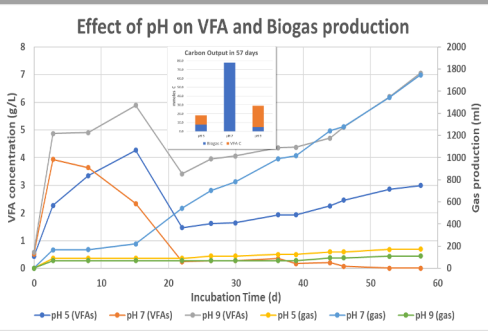
Project Goal

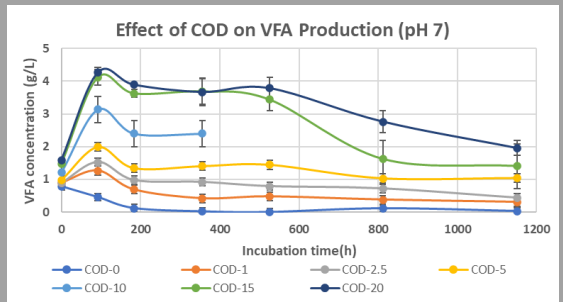
Typical anaerobic digestion (AD) focusses on complete conversion of waste to biogas (primarily carbon dioxide and methane). However, the intermediate metabolites of the AD process, which includes short- and long-chain volatile fatty acids (VFAs), that could serve as the precursors for useful industrial applications are typically ignored. The goal of this project is to enhance production of VFAs, develop extraction protocols, electro-enhance chain elongation and develop microbial electrosynthesis for alternate fuel production. Optimization of the various AD conditions, including chemical oxygen demand (COD), pH, and VFA removal techniques for improving VFA titers have been presented.

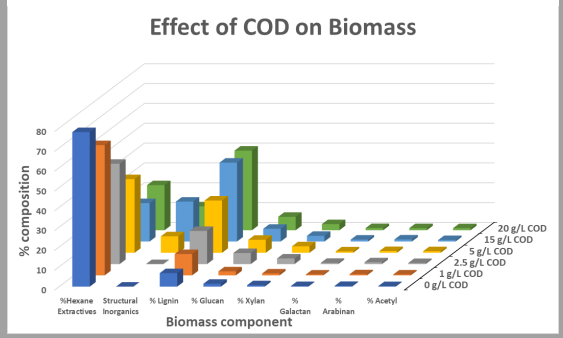


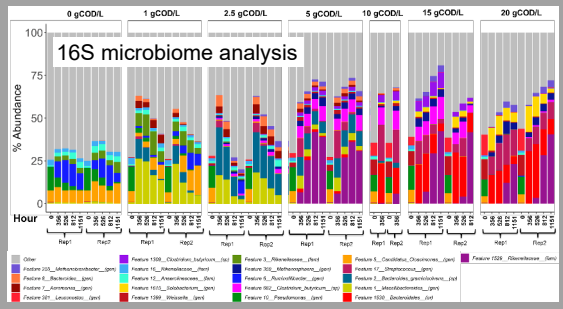
Methods:

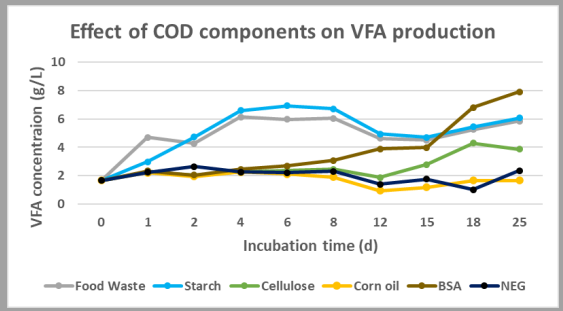
AD volumes: 100-200 ml
Temp: 35°C in shaker conditions
Inoculum source: Mixed (waste-water sludge and rumen mixture)
Substrate: Food waste from CSU cafeteria

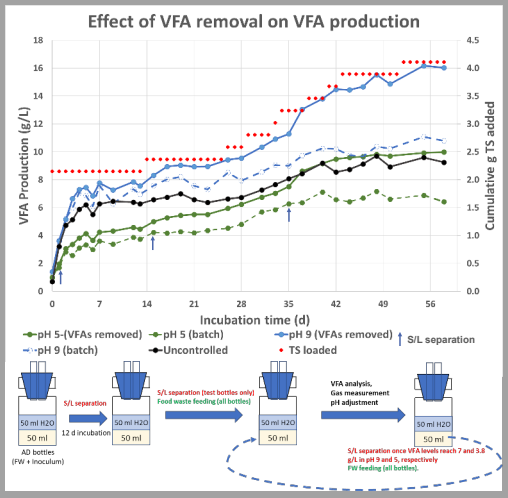












Conclusions

- 15-20 g/L COD is the optimal substrate loading required to produce maximum VFAs in batch feeding experiments.
- Higher COD levels results in a shift in the microbial consortia. The genera *Clostridium*, *Bacteriodales*, *Solobacterium* appear to be enhanced at higher COD levels.
- Increased COD does not affect the overall hydrolytic efficiencies based on biomass composition analysis.
- pH 7 yielded higher biogas production; pH 9 and pH 5 yielded 79% and 23% higher VFA concentrations, respectively. Overall, pH 9 had highest carbon conversion efficiency in the form of VFA.
- VFA removal (by solid/liquid separation) combined with intermittent substrate loading resulted in higher overall VFA accumulation.
- Starch appeared to be primary contributor to VFA production among the different food waste components, followed by proteins and cellulose.

Future Directions

- Optimization of alternate VFA removal techniques, such as electrodialysis (ED) and ion exchange resins, to alleviate inhibitory effects of VFA.
- Improve hydrolysis efficiency by microaeration.
- Exploring different inoculum sources to improve hydrolysis efficiency and production of longer chain fatty acids.
- Develop combined AD/ED methodologies to enable continuous VFA production and extraction.

Acknowledgement

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