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Does Food Waste Grinding Improve Biogas Production?

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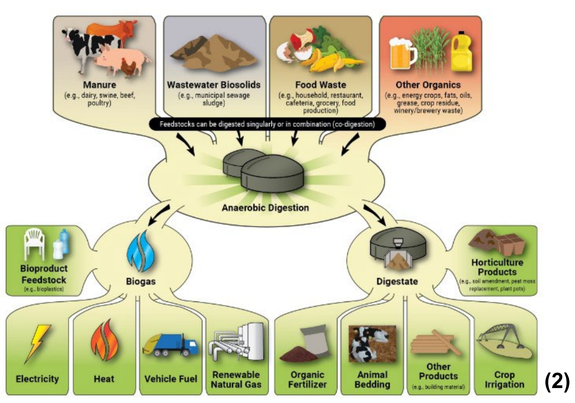
Objective

Producing clean energy is necessary to protect our air, water and soil. Using livestock and food waste to produce biogas replaces fossil fuel use, and can reduce the emission of methane, a potent greenhouse gas. This experiment examines the efficacy of grinding food waste on the production of biogas.

Rationale

Greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) trap the sun's heat next to the earth. Methane comprises a small amount of the greenhouse gases but is 25 times more potent than carbon dioxide and has a life span of 12 years. Reducing the concentration of this gas may have an impact within our lifetimes. Livestock and food waste can result in methane gas production, depending on how it is handled. Fortunately, that waste can be made into renewable natural gas providing farmers with economic benefits. The Consortium for Cultivating Human And Naturally reGenerative Enterprises (C-Change) (including Penn State) has been tasked with developing new ways for farmers to produce renewable natural gas. These studies seek to improve biogas production by experimenting with feedstock mixtures.



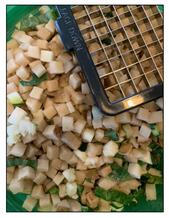
(2)

Method

In this experiment, two continuous anaerobic digesters were filled with manure. Digester 1 was fed a mixture of manure and diced food while Digester 2 was fed a mixture of manure and pureed food. The feedstock used consisted of 0.32 liters of manure and 0.08 liters of food waste. The food waste was made from a mixture of lettuce, zucchini, and potatoes. Five percent of the digester volume was replaced with fresh feedstock daily, corresponding to a mean hydraulic residence time of 20 days.

Hydraulic retention time (HRT)

$$HRT = \frac{8\ L}{0.4\ L/day} = 20\ days$$



Diced Food Stock Digester 1

Pureed Food Stock Digester 2

Experimental Digesters

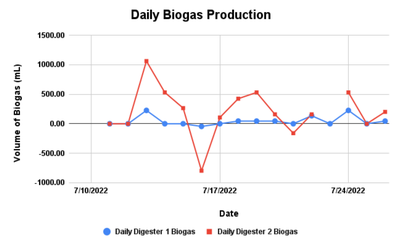
On-Farm Anaerobic Digesters (1)

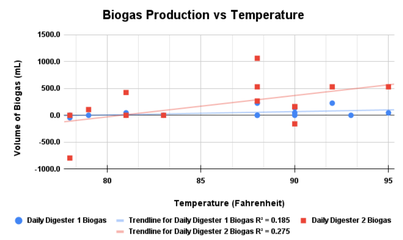
Results

- Biogas production was higher in Digester 2 for 9 out of the 16 days of the experiment.
- There were only two days when Digester 1 outperformed Digester 2.
- There appears to be some production dependency based on outside temperature. However, Digester 1 biogas production seemed to be less affected by the temperature.

Results continued...

- The average daily volume of gas produced for digester 1 was 45 mL with a standard deviation of 83.
- The average daily volume of gas produced by digester 2 was 201 mL with a standard deviation of 427.
- The mean Digester 2 output is 3.6 times higher than Digester 1 output.





Conclusions

Pureeing the food waste did result in higher biogas production. There was a great deal of variability in the biogas production which needs further study. Temperature appears to have some effect on the production of gas and would need to be controlled in order to isolate the viability of the grinding on biogas production. With a longer experiment time, the gas production may stabilize giving us a more accurate picture of the average daily production.

Acknowledgements

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References

1. Bristola. (16 Feb. 2022). *Types of Anaerobic Digesters.* https://bristola2.com/blog/types-of-anaerobic-digesters/.

2. United States Environmental Protection Agency. (2 Mar. 2022). *AgSTAR: Biogas Recovery in the Agriculture Sector*. https://www.epa.gov/agstar.

See also, Pramanik, Sagor Kumar. (2019). The Anaerobic Digestion Process of Biogas Production from Food Waste: Prospects and Constraints. *Bioresource Technology Reports*, 8, 100310. https://doi.org/10.1016/j.biteb.2019.100310.

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