Anaerobic Co-Digestion of Food Waste, Fruit and Vegetable Waste, and Cow Dung for Improved Biogas Generation

M. J. Sukhesh,(m.sukhesh@gmail.com), P. Venkateswara Rao

National Institute of Technology, Warangal, India-506004

1. Introduction

Anaerobic digestion is a promising alternative for organic waste management compared to landfilling and composting and is being encouraged with current guidelines of the Government of India. However, the nutritional imbalance in anaerobic digestion of single organic waste is limiting the effective digestion resulting either low biogas production or process failure(Siddique and Wahid, 2018). Co-digestion of multiple organic wastes is a promising method to enhance the nutritional balance where the digestion of two or more substrates carried out in a single digester(Astals et al., 2014). The present study investigated the possibilities of improving the biogas production with co-digestion of food waste, fruit and vegetable waste, and cow dung.

2. Materials & Methods

The food waste was obtained from the hostel mess NIT Warangal campus. The impurities such as bones, napkins, plastic bags etc were hand sorted and removed. The vegetable and fruit wastes were obtained from local market Warangal. The fresh cow dung was obtained from a local dairy farm. The wastes were shredded and homogenised with a cutter. The wastes were ground in a blender and stored at refrigerated conditions (4 °C) until used. Augumented simplex centroid method was used for design of experiments using mixture proportions of food waste, fruit and vegetable waste, and cow dung (Table 1).

Reactor Name	Cow dung	Food waste	Fruit vegetable waste
R1	1	0	0
R2	0	1	0
R3	0	0	1
R4	0.5	0.5	0
R5	0	0.5	0.5
R6	0.5	0	0.5
R7	0.333	0.333	0.333
R8	0.167	0.167	0.667
R9	0.167	0.667	0.167
R10	0.6667	0.167	0.167

Table 1 Experimental design for anaerobic batch digestion

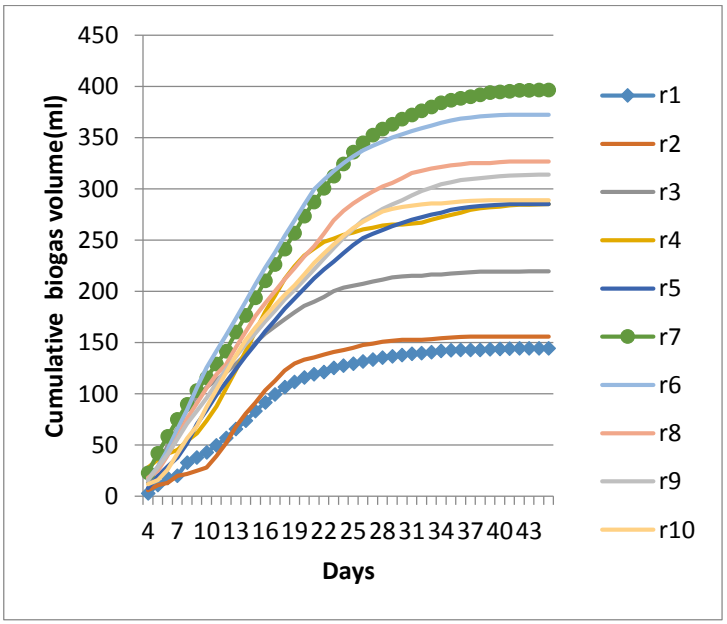

Figure 1 Cumulative biogas production

Ten batch scale reactors (120 mL) of various mixture proportions were set up and biogas yield was recorded for 45 days. The blended waste was mixed with water in the ratio 1:3 based on mass. From this an appropriate volume

of waste was taken according to the co-digestion combinations and was made up to 60 mL of volume. The reactor performances were evaluated using biogas production. The daily biogas volume was measured using the water displacement method and methane content in biogas was analysed with gas chromatography system.

3. Results & Discussion

Biogas production is a function of the feed stock's organic content and biodegradability. In the present study, significant variations in biogas production was observed among the reactor co-digestion mixes (Figure 1). The anaerobic digestion was found to need a longer time of 10-20 days to start methanogenic process so that acclimatization of bacteria occurs(Jugal Sukhesh and Venkateswara Rao, 2018). The methane content of the biogas was in the range of 40-60%. The maximum biogas yield of 406 mL was obtained for equal proportion of food waste, cow dung and fruit waste (r7) i.e., 0.333:0.333:0.333 while mono digestion of cow dung only produced 144 mL(r1).The high biogas production due to its high biodegradability and presence of active microbial action due to synergistic interaction. Co-digestion with sufficient amount of food and vegetable wastes gave the perfect nutrient balance it needed for the biogas production. Overall, it can be observed that the co-digestion of organic wastes improved the biogas yield 2-3 times compared to mono digestion.

4. Conclusions

The high biogas production can be achieved with co-digestion compared mono-digestion of organic wastes due to synergistic interaction. The study recommends the equal proportion (0.333:0.333:0.333) of food waste, cow dung and fruit and vegetable waste at for improved biogas production in anaerobic digestion .

References

Astals, S., Batstone, D.J., Mata-Alvarez, J., Jensen, P.D., 2014. Identification of synergistic impacts during anaerobic co-digestion of organic wastes. Bioresour. Technol. 169, 421–427. https://doi.org/10.1016/j.biortech.2014.07.024

Jugal Sukhesh, M., Venkateswara Rao, P., 2018. Synergistic effect in anaerobic co-digestion of rice straw and dairy manure - a batch kinetic study. Energy Sources, Part A Recover. Util. Environ. Eff. 1–12. https://doi.org/10.1080/15567036.2018.1550536

Siddique, M.N.I., Wahid, Z.A., 2018. Achievements and perspectives of anaerobic co-digestion: A review. J. Clean. Prod. 194, 359–371. https://doi.org/10.1016/J.JCLEPRO.2018.05.155