Proceedings

Improvement of methane yield using bioaugmentation technique in a thermophilic anaerobic digestion process

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Abstract: A methanogenic consortium was used to improve the methane yield of a thermophilic anaerobic digestion process of organic fraction of municipal solid waste. The consortium was added to the system in different volume/volume proportions. The results showed that two treatments increased the methane yields by 5% in comparison to the control. About the bacterial communities, it was identified that the consortium was mainly constituted by members of the phylum Synergistetes. In all the treatments the phyla Firmicutes, Thermotogae, and Synergistetes were dominant and as the proportion of the consortium in the treatments increased, the presence of the family Thermotogaceae also did.

Keywords: bioaugmentation; hydrogenotrophic methanogens; organic fraction of municipal solid waste; thermophilic anaerobic digestion

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1. Introduction

Anaerobic digestion (AD) is a sustainable process for organic waste treatment, as it converts organic matter into energy (in the form of biogas) and digestate. AD is used to degrade various types of organic waste, including lignocellulosic biomass, food waste, agro-industrial waste, animal manure and sludge from wastewater treatment plants [1, 2]. However, AD frequently suffers from process instability due to high levels of toxic inorganic substances, variations in operating parameters, as well as imbalance between microbial groups [3]. Bioaugmentation can serve as a mechanism to regain the efficiency of systems due to greater microbial diversity and abundance. This technique is defined as the addition of specific microbial cultures to perform a definite task in a given environment [4, 5]. In this work, hydrogenotrophic methanogens were used to improve the methane yield of a thermophilic AD process of the organic fraction of municipal solid wastes (OFMSW) in Mexico City.

2. Materials and Methods

The OFMSW (substrate) and leachate (inoculum) were collected from a composting plant in Mexico City. The consortium containing the methanogens was isolated from the leachate using basal media. Biochemical methane potential (BMP) test was performed to determine if the consortium influenced the methane yield. A 1:1 volatile solids (VS) ratio substrate/inoculum was operated in 125 mL serum bottles with a working volume of 60 ml. The consortium was added at different volume ratios (0%, 10%, 25% 50% and 75%). The process lasted 32 days at 55° C and 60 rpm. Every 3 days, biogas composition and generation were determined, through gas chromatography with thermal conductivity detector (TCD) and water displacement, respectively. The identification of the microbial communities of all treatment groups and consortium were done by high throughput DNA sequencing of bacterial and archaeal 16S rDNA libraries, samples were taken at day 0, 17 and 32.

3. Results and discussion

The cumulative methane yields obtained are shown in Figure 1. The 25% and 50% treatments got the maximum methane yields in comparison with the control (on average 5% increase). However, it was also noticeable that only the 50% treatment had its methane generation peak at a higher rate than the rest of the groups, therefore, it is suspected that the addition of the consortium at that proportion contributed to shorten the adaptation phase of the microorganisms during anaerobic degradation [6]. Regarding the bacterial communities, the phyla Firmicutes, Synergistetes and Thermotogae predominated throughout the process in all treatments (Figure 2). However, in the 50% and 75% treatments, the abundance of Synergistetes and Thermotogae dominating as the days went by. Members of the phylum Firmicutes are known to have capacities for the decomposition of organic substrate and fermentation, while the members of Synergistetes can produce a range of organic acids or produce metabolites that are used directly by the methanogens [2, 7].

Figure 1. Cumulative methane yields for all treatments.

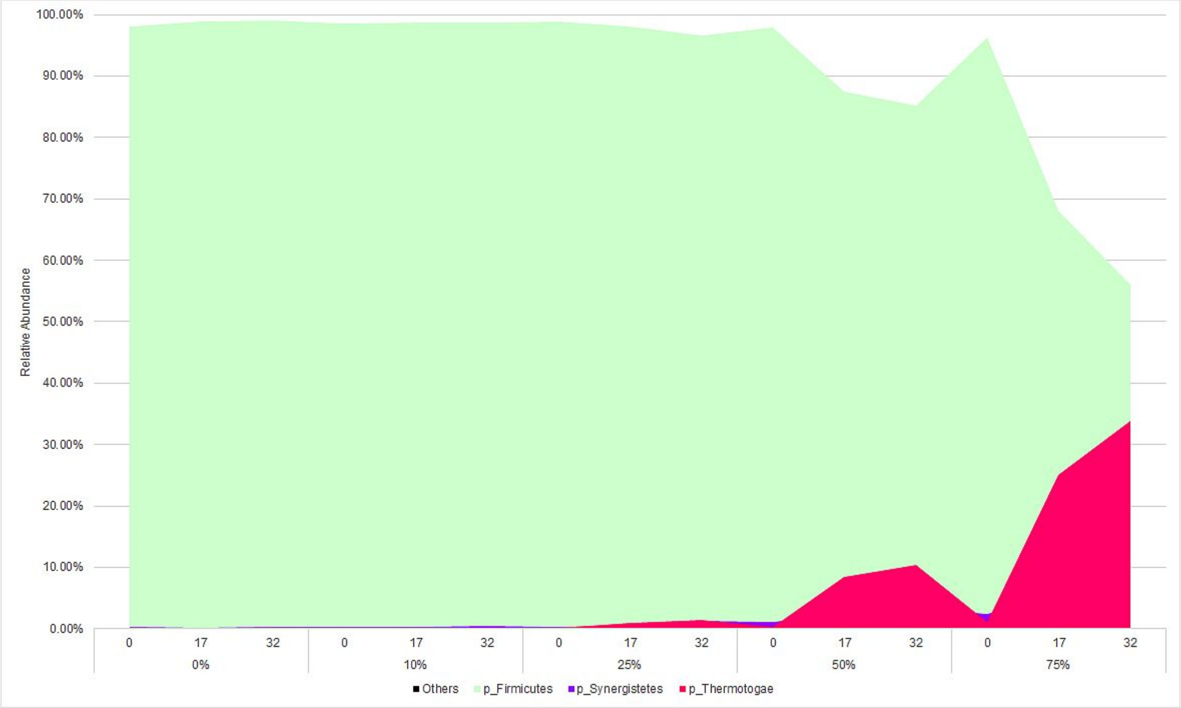

Figure 2. Bacterial relative abundance of all treatments.

4. Conclusion

The addition of the methanogenic consortium up to 50% increased the methane yield of the AD process by around 5% in comparison to the control. The bacteria found in the system are characterized by being substrate degraders, however the role of the methanogens remains to be determined.

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