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Process Operation and Microbiological Comparison of Industrial-Scale High-Solid Biogas Production from Food Waste

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Description

Around the world, anaerobic degradation is used to turn waste into energy. This method not only combats climate change but also several other important environmental objectives, such as improved waste management and recycling of nutrients to fertile land. In theory, any type of organic waste may be processed by microbial deterioration in anaerobic digesters, and the renewable biogas can be upgraded to vehicle fuel or injected into the gas grid. It can also be used to produce electricity, heat, and cool buildings. With appropriate rules that guarantee long-term profits and with process improvements that raise energy recovery to levels competitive with fossil fuels, the technology has significant economic potential [1].

Food waste is a plentiful organic resource that is largely underutilised. Almost 1.3 billion tonnes of harvested food are gathered each year, yet they are never eaten or are fed to animals. However, businesses, restaurants, and households all produce a staggering quantity of food waste. The three most popular ways to dispose of food waste right now are landfilling, composting, and incineration. These procedures result in significant yearly emissions of greenhouse gases into the atmosphere. By collecting food waste for anaerobic treatment, emissions that would otherwise be produced during conventional disposal are prevented while also serving as a waste feedstock for the creation of renewable biogas and biofertilizer. In continuously stirred tank reactors (CSTRs), anaerobic digestion of source-separated food waste is frequently carried out. It can be utilised as a solitary substrate or as a co-substrate with, for example, sewage sludge or animal waste. The use of food waste as the primary substrate for the production of biogas in CSTR processes is currently a well-established technology in Sweden, and the majority of plants operate with good process stability in both mesophilic and thermophilic conditions (roughly 11% of the total TWh of biogas produced in Sweden in 2017 came from food waste) [2].

High-solid treatment (HST) using plug-flow technology is an intriguing alternative because it allows for the treatment of larger volumes of waste per unit digester volume (requiring less space), avoids dilution with water (requiring less energy for heating), and minimises the need for pre-treatment of substrate and digestate dewatering. Five industrial-scale HST facilities have been built in Sweden as a result of these benefits since 2014. These plants mostly grow on source-separated organic matter from homes, eateries, and businesses (hereafter referred to as food waste). In some European nations, where the trash is frequently combined with yard, agricultural, or biological waste, the high-solid treatment of food waste is already a well-established method. In order to achieve in situ hygienization and lower the expense of external pretreatment necessary for certification of the digestate as high-quality fertiliser for arable land, the first HST plant developed in Sweden initially functioned under thermophilic conditions. Although this thermophilic HST plant had a difficult time starting up and went through a protracted period of process instability, the plant operator nonetheless chose to lower the process temperature to mesophilic. The whole process state of the Swedish HST plants that were recently established uses both thermophilic and mesophilic operating temperatures [3].

Food waste has been extensively studied as a substrate for the production of biogas, especially in relation to the significance of operating temperature but also productivity, stability, and predominating microbial populations. However, plug-flow digesters have received significantly less attention than CSTR technology, which has received the majority of research focus. In order to identify obstacles and opportunities for HST, the current study set out to screen and analyse the process performance of industrial-scale HST plants employing food waste for biogas production. Four HST digesters, one of which was operated at mesophilic (39°C), one at high-mesophilic (42°C), one at thermophilic (54°C), and one of which was sampled while the operating temperature was reduced from thermophilic (52°C) to mesophilic (38°C), were used to collect performance data and samples for analyses. To look into possible connections between microbiology, operational conditions, and performance in these industrial-scale facilities, Illumina sequencing and quantitative PCR investigations were carried out [4].

Every other week, samples of substrate and digester content were drawn, promptly frozen, sent on ice, and then kept at 20 °C until analysis. According to worldwide standard procedures, the concentrations of total solids (TS), volatile solids (VS), and ammonium-nitrogen were measured. The concentration of ammonia-nitrogen was estimated as previously mentioned. The following volatile fatty acids (VFAs) were measured by high-performance liquid chromatography (HPLC) as indicated: acetate, propionate, butyrate, isobutyrate, valeriate, isovaleriate, capronate, and isocapronate. The relevant plant operator provided information on methane yield, gas composition, digester configuration, and operating circumstances. Moreover, two samples were obtained from the digestate's liquid phase, which is recirculated in M39 on occasion. With respect to C5238, sample 1 was collected during thermophilic operation, samples 2-3 with a drop in temperature, and samples 4–11 during mesophilic operation.

The hydrogenotrophic methanogen Methanothermobacter (Methanobacteriales) regularly dominated methanogenic communities as determined by Illumina and qPCR investigations of methanogenic communities, demonstrating a prominent function for this methanogen as a methane producer and hydrogen consumer. In contrast to a thermophilic industrial-scale HST plug-flow digester fed food waste, where Methanoculleus was the predominate methanogen, the methanogenic structure in the thermophilic HSTs was different. The ammonia levels in the current HSTs (0.4-1.9 g NH3-N/L) and in the HST under investigation (0.5 g NH3-N/L) were higher than the threshold that prevents aceticlastic methanogenesis and instead encourages syntrophic acetate oxidation, which is a process that produces methane. Thus, it is likely that these methanogens participate in syntrophic acetate oxidation as a hydrogenotrophic partner. *Methanothermobacter* is known to be a thermophilic ammonia-tolerant methanogen and could thus be partner to a thermophilic species of the relatively highly abundant genus *Syntrophaceticus* or the Clostridia group MBA03, which, as described above, has been suggested to be syntrophic. *Syntrophaceticus* has been shown to include the mesophilic ammonia-tolerant syntrophic acetate-oxidizing species *S. schinkii* and there are strong indications that this genus also contains thermophilic species able to perform syntrophic acetate oxidation under high-ammonia conditions [5].

Conclusion

Ammonia-tolerant syntrophic acetate-oxidizing bacteria grow relatively

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slowly and the relatively long retention time in the HST could have supported its high presence compared with that generally found at the shorter retention times more commonly used in anaerobic digesters treating materials with lower solids content. The present analysis clearly demonstrated that propionate degradation is a major limiting step in thermophilic HST of food waste. Propionate is a common intermediate in anaerobic digestion and is degraded via syntrophic interactions between syntrophic propionate-degrading bacteria and hydrogen- and acetate-utilizing microorganisms. Knowledge of propionate degradation at high ammonia levels is currently lacking and it is thus difficult to link this function to any particular microbial group.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Baglinière, François, Aurélie Matéos, Gaëlle Tanguy and Julien Jardin, et al. "Proteolysis of ultra high temperature-treated casein micelles by AprX enzyme from Pseudomonas fluorescens F induces their destabilisation." *Int Dairy J* 31 (2013): 55-61.

2. Andrus, Alexis D, Brynne Campbell, Kathryn J. Boor and Martin Wiedmann, et al. "Postpasteurization hold temperatures of 4 or 6 C, but not raw milk holding of 24 or 72 hours, affect bacterial outgrowth in pasteurized fluid milk." *J Dairy Sci* 98 (2015): 7640-7643.

3. Ding, Ruixue, Yiming Liu, Shanshan Yang and Yumeng Liu, et al. "High-throughput sequencing provides new insights into the roles and implications of core microbiota present in pasteurized milk." *Food Res Inter* 137 (2020): 109586.

4. Roth, S, J. Feichtinger and C. Hertel. "Characterization of Bacillus subtilis spore inactivation in low-pressure, low-temperature gas plasma sterilization processes." *J Appl Microbiol* 108 (2010): 521-531.

5. Refaya, Ahmed Kabir, Gunapati Bhargavi, Noelin Chinnu Mathew and Ananthi Rajendran, et al. "A review on bovine tuberculosis in India." TB 122 (2020): 101923.

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