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Effects of ultrasonic and thermo-chemical pre-treatments on methane production from fat, oil and grease (FOG) and synthetic kitchen waste (KW) in anaerobic co-digestion

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HIGHLIGHTS

- Ultrasonic pre-treatment cannot effectively enhance biogas production.
- Ultrasonic pre-treatment introduced inhibitory effects on FOG co-digestion.
- Thermo-chemical pre-treatment enhanced biogas production from co-digestions.
- Non-linear regressions can accurately simulate and support discussion.
- COD solubilization (SCOD/COD%) can effectively reflect pre-treatment performance.

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ABSTRACT

The effects of ultrasonic and thermo-chemical pre-treatments on the methane production potential of anaerobic co-digestion with synthetic kitchen waste (KW) or fat, oil and grease (FOG) were investigated. Non-linear regressions were fitted to accurately assess and compare the methane production from co-digestion under the various pre-treatment conditions and to achieve representative simulations and predictions. Ultrasonic pre-treatment was not found to improve methane production effectively from either FOG co-digestion or KW co-digestions. Thermo-chemical pre-treatment could increase methane production yields from both FOG and KW co-digestions. COD solubilization was found to effectively represent the effects of pre-treatment. A comprehensive evaluation indicated that the thermo-chemical pre-treatments of pH = 10, 55 °C and pH = 8, 55 °C provided the best conditions to increase methane production from FOG and KW co-digestions, respectively. The most effective enhancement of biogas production (288 ± 0.85 mL CH_4/g TVS) was achieved from thermo-chemically pre-treated FOG co-digestion, which was 9.9 ± 1.5% higher than FOG co-digestion without thermo-chemical pre-treatment.

1. Introduction

To enhance biogas production and assist in wastewater treatment and municipal organic waste management, anaerobic digestion with the addition of co-substrates, i.e. co-digestion, has been recognized as an effective, low-cost, and commercially viable approach to improve methane yields (Alatriste-Mondragón et al., 2006; Natural Resources Canada, 2002). A number of studies have shown that co-digestion with municipally available organic wastes including fats, oils and grease (FOG) and kitchen waste (KW) or food waste, which can be collected in close proximity to the treatment facility, could be employed as potential co-substrates (Carucci et al., 2005; Davidsson et al., 2008; Gunaseelan, 2004; Kabouris et al., 2008; Li et al., 2011; Martín-González et al., 2010).

Pre-treating substrates using various pre-treatment methods has also been reported as a potential approach to improve methane production efficiency (Dohányos et al., 2004). Among the different pre-treatment approaches available, thermo-chemical and ultrasonic pre-treatments have been reported as effective and economically viable methods (Apul and Sanin, 2010; Kim et al., 2003; Pilli et al., 2011; Rafique et al., 2010; Valo et al., 2004). Kim et al. (2003) obtained a >34.3% methane increase from waste activated sludge (WAS) using thermo-chemical pre-treatment. Pilli et al. (2011) reviewed ultrasonic pre-treatment and concluded that this pre-treatment was effective for sludge, but that the efficiency varied with the sludge characteristics.

Although ultrasonic and thermo-chemical pre-treatments have been recognized as effective processes to enhance methane

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