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Solid state anaerobic co-digestion of yard waste and food waste for biogas production

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HIGHLIGHTS

- Solid state anaerobic digestion (SS-AD) of food waste and yard waste.
- The highest methane yields were obtained at feedstock/effluent (*F*/*E*) ratio 1.
- Increasing *F*/*E* ratio from 1 to 2 and 3 caused decreases in methane yield.
- The AD was upset at *F*/*E* ratio 3 except yard waste only.

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ABSTRACT

Food and yard wastes are available year round at low cost and have the potential to complement each other for SS-AD. The goal of this study was to determine optimal feedstock/effluent (*F*/*E*) and food waste/yard waste mixing ratios for optimal biogas production. Co-digestion of yard and food waste was carried out at *F*/*E* ratios of 1, 2, and 3. For each *F*/*E* ratio, food waste percentages of 0%, 10%, and 20%, based on dry volatile solids, were evaluated. Results showed increased methane yields and volumetric productivities as the percentage of food waste was increased to 10% and 20% of the substrate at *F*/*E* ratios of 2 and 1, respectively. This study showed that co-digestion of food waste with yard waste at specific ratios can improve digester operating characteristics and end performance metrics over SS-AD of yard waste alone.

1. Introduction

Solid-state anaerobic digestion (SS-AD) has been successfully used to convert various lignocellulosic biomass feedstocks to biogas (Li et al., 2011a). SS-AD has been the dominant AD system installed in Europe since the early 1990s for the treatment of municipal solid waste (MSW), and typically operates at 15–50% total solids (TS) content (Li et al., 2011b; Baere and Mattheeuws, 2008; Guendouz et al., 2010). SS-AD provides many benefits over liquid AD in digesting lignocellulosic biomass such as treating more organic solids in the same size digester and producing a compost-like finished organic material that is easier to handle and can be applied to agricultural land for fertilizer (Martin et al., 2003a; Li et al., 2011b). The SS-AD system also features fewer moving parts and lower energy inputs needed for heating and mixing (Li et al., 2011a), and it has a greater acceptance of inputs containing glass, plastics, and grit. Furthermore, SS-AD can overcome other common problems existing in the liquid AD process such as floating and stratification of fats, fibers, and plastics (Chanakya et al., 1999).

The start-up period of an SS-AD system is considered the most critical phase in batch digestion. The feedstock/effluent (*F*/*E*) ratio, an operating parameter that measures the amount of substrate to the amount of inoculum on a dry volatile solids (VS) basis, has been shown to be a critical factor affecting the performance of SS-AD (Li et al., 2011b). SS-AD may require up to 50% of digested residue for a rapid startup, which decreases reactor utilization efficiency (Martin et al., 2003b; Rapport et al., 2008; Li et al., 2011b). A highly concentrated and active inoculum source is important to reduce digestion time, improve digester efficacy, and increase TS in the finished product (Forster-Carneiro et al., 2008).

Co-digestion of mixed substrates offers many advantages, including ecological, technological, and economic benefits, compared to digesting a single substrate (Rughoonundun et al., 2012). However, combining two or more different types of feedstocks requires careful selection to improve the efficiency of

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