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Using fluorescence excitation–emission matrix spectroscopy to monitor the conversion of organic matter during anaerobic co-digestion of cattle dung and duck manure

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HIGHLIGHTS

- Spectroscopic characteristics of dissolved organic matter in anaerobic digestion.
- Co-digestion obtains remarkable organic matters removal rate.
- Tyrosine-like/fulvic-like fluorescence intensity indicates nitrogen form conversion.
- Tryptophan fluorescence intensity variations reflect microbial activity.
- Co-digestion corrects the limitation of single manure digestion.

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ABSTRACT

In this study, the removal of volatile solids (VSs) and soluble chemical oxygen demand (SCOD) by co-digesting cattle dung (CD) and duck manure (DM) was determined and compared with the reduction achieved with CD or DM digestion alone. Moreover, fluorescence excitation–emission matrix spectroscopy was utilised to characterise the conversion mechanisms of organic nitrogen. It was found that the co-digestion provided 71% VS reduction compared with 58% for CD and 61% for DM. The amounts of COD removed were 28%, 23% and 31% for CD, DM and the mixture, respectively. Tyrosine-like/fulvic-like fluorescence intensity (FI) ratios increased during the initial 15 days of co-digestion and were associated with an increase in total nitrogen in the supernatant. After 15 days, CD and DM exhibited a lower tryptophan-like/fulvic-like FI ratio (0.8–1.6), whereas the co-digestion remained stable at a high level (3.0–3.6), rendering an improved microbial population and biochemical activity.

1. Introduction

Anaerobic digestion (AD) is a biochemical technology used to treat organic waste and produce biogas. As one of the most important substrates in the AD process, cattle dung (CD) has been extensively used (Ahn et al., 2006; Angelidaki et al., 2006). However, its digestion efficiency is not favourable due to the relatively low biodegradability and biogas yield. One approach for improving its efficiency is to increase its biogas production rate using co-digestion, where CD is mixed with highly degradable wastes as long as they are available in the vicinity of farms (El-Mashad et al., 2010).

The mixture of different materials can stimulate digestion due to a better carbon and nutrient balance (Mshandete et al., 2004; Parawira et al., 2004). According to Angelidaki et al. (2005), there are two advantages to using cattle manure for co-digestion. First, cattle manure supplies a wide variety of sources of nutrients, trace metals, vitamins and other compounds necessary for microbial growth. Second, it can neutralise pH levels and improve buffering capacity. Braun et al. (2003) and Weiland (2000) reported that the co-digestion of animal manure with biodegradable waste appears to be a robust technology that can increase biogas production by 80–400% in biogas plants. Moreover, many studies have shown that the sensitivity of the AD process to environmental changes can be improved by combining different sources of organic wastes (Creamer et al., 2010; Zhang et al., 2011). Duck manure (DM) is a desirable material to co-digest with CD because of its high biodegradability and nutrient content. Thus, the

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