Effects of dairy manure and corn stover co-digestion on anaerobic microbes and corresponding digestion performance

Zhengbo Yue\textsuperscript{a,c}, Rui Chen\textsuperscript{a}, Fan Yang\textsuperscript{b}, James MacLellan\textsuperscript{a}, Terence Marsh\textsuperscript{b}, Yan Liu\textsuperscript{a}, Wei Liao\textsuperscript{a,*}

\textsuperscript{a}Department of Biosystems and Agricultural Engineering, Michigan State University, East Lansing, MI 48824, USA
\textsuperscript{b}Department of Microbiology and Molecular Genetics, Michigan State University, East Lansing, MI 48824, USA
\textsuperscript{c}School of Resources and Environmental Engineering, Hefei University of Technology, Hefei, Anhui 230009, PR China

\textbf{HIGHLIGHTS}

\begin{itemize}
  \item Both HRT and corn stover had significant impacts on the anaerobic digestion.
  \item Bacteroidetes, Clostridia and methanogens fully influenced the biogas production.
  \item Adding corn stover did not change the chemical composition of solid digestate.
  \item Hydrolyzibility of solid digestate was associated to microbial composition.
\end{itemize}

\textbf{ABSTRACT}

This study investigated the effects of corn stover as a supplemental feed on anaerobic digestion of dairy manure under different hydraulic retention times (HRT). The results elucidated that both HRT and corn stover supplement significantly influenced microbial community and corresponding anaerobic digestion performance. The highest biogas production of 497 mL per gram total solid loading per day was observed at a HRT of 40 days from digestion of manure supplemented with corn stover. Biogas production was closely correlated with the populations of Bacteroidetes, Clostridia and methanogens. Composition of the solid digestate (AD fiber) from the co-digestion of corn stover and dairy manure was similar to the digestion of dairy manure. However, the hydrolysis of AD fiber was significantly ($P < 0.05$) different among the different digestions. Both HRT and feed composition influenced the hydrolyzability of AD fiber via shifting the composition of microbial community.

\textbf{ARTICLE INFO}

Article history:
Received 9 August 2012
Received in revised form 5 October 2012
Accepted 7 October 2012
Available online 1 November 2012

Keywords:
Dairy manure
Corn stover
Anaerobic co-digestion
Anaerobic microbial community
Solid digestate

1. Introduction

USDA has recently estimated that a total of about 120 billion dry kilograms of cattle manure are produced annually from 67,000 dairy farms and 956,500 beef cattle producers in the United States (USDA Economic Research Service, 1997; USDA National Agricultural Statistics Service, 2009). Compared to other practices of manure management, anaerobic digestion (AD) is the biological treatment process that is capable of simultaneously generating a renewable energy, biogas, from the wastes as well as alleviating the associated environmental concerns such as odor, greenhouse gas (GHG) emissions, and groundwater contamination (Speece, 1996).

To improve the system efficiency, co-digestion of manure and crop residues has been considered as one of the potential strategies to enhance biogas generation (Kavacik and Topaloglu, 2010; Molinuevo-salces et al., 2010; Nizami et al., 2009). It has been reported that the improvement in biogas production using co-digestion system is due to the better balanced nutritional composition which would support microbial growth for efficient digestion and increase buffering capacity that helps maintain the stability of the AD system (Kaparaju et al., 2008). Recent studies also demonstrated new applications of both liquid AD effluent and solid digestate (AD fiber) for biofuels production. For instance, various techniques have been developed using liquid AD effluent to culture algae as a non-edible feedstock for biorefineries (Chen et al., 2012; Wilkie and Mulbry, 2002), and the AD fiber has been demonstrated as a good feedstock for ethanol production (Teater et al., 2011; Yue et al., 2010).

Microbes as the processor in anaerobic digestion play a key role influencing the amount of gas production, and corresponding quality of effluent streams. The most common microbes in AD can be roughly assigned into three categories: the polymer degraders, the acetogens, and the methanogens (Bagi et al., 2007). The polymer degrading bacteria (such as Bacteroidetes and Clostridia) function in sensing, regulating, and degrading polymers (such as...