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Semi-continuous anaerobic co-digestion of chicken litter with agricultural and food wastes: A case study on the effect of carbon/nitrogen ratio, substrates mixing ratio and organic loading

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Abstract

In this study, four agro-industrial substrates, chicken litter (CL), food waste (FW), wheat straw (WS) and hay grass (HG) were assessed as feedstock for anaerobic digestion (AD) under semi-continuous conditions at organic loading rates (OLRs) of 2.0-3.0 g TS/L.d and hydraulic retention time (HRT) of 20 days. Six different substrate mixtures were prepared such that the C/N ratio of each was 20 or more. Using principal component analysis 68.1% of data variability was explained. Biogas production from CL, as single substrate, was 181.3±9.8 mL_N biogas/g VS_{added} at OLR of 2.0 gTS/L.d. The optimum substrates -mixture was CL:FW:WS 60:20:20, where 73.0%, 167.2% and 116.9% increase in total biogas production at OLR of 2.0, 2.5, 3.0 gTS/L.d, respectively, compared to that from CL, was obtained. Digestate sequential fractionation revealed carbohydrate degradation is an important factor that can explain the variation in performance and production of biogas for feedstocks of balanced C/N ratio.

Keywords

Continuous anaerobic co-digestion, C/N ratio, organic loading rate, chicken litter, food wastes, hay grass, wheat straw, lignocellulose fractionation, anaerobic digestion reactor performance, PCA analysis.

1. Introduction

The sustainable management of the increased amounts of solid organic wastes such as manure, lignocellulosic, industrial and organic wastes have emerged as an area of major concern worldwide (Bong et al., 2018; Zahan et al., 2018). Among the different waste management technologies, anaerobic digestion (AD) has received attention for offering biogas of high calorific value, less sludge production, small footprint, lower overall operating and maintenance costs and promoting renewable alternatives (Demirel and Yenigün, 2002; Mao et al., 2015).

In Victoria, Australia, around 0.45 million tonne of chicken litter (CL) and considerably large amounts of other agro-industrial wastes are produced every year. Although these wastes have high bio-energy potential, varying characteristics and complex structure have limited their