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Continuous hydrogen production from co-digestion of municipal food waste and kitchen wastewater in mesophilic anaerobic baffled reactor

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A B S T R A C T

This study was carried out to assess the impact of organic loading rate (OLR) on the performance of mesophilic anaerobic baffled reactor (ABR) for H_2 production from a co-digestion of municipal food waste and kitchen wastewater. The reactor was operated at different organic loading rates (OLRs) of 29, 36 and 47 g COD_{total}/Ld. The hydraulic retention time (HRT) was kept constant at 1.6 d. The results showed that increasing the OLR from 29 to 36 g COD_{total}/Ld, leads to a significant (p □ 0.01) drop in the H_2 production from 6.0 ± 0.5 to 5.4 ± 1.04 L H_2/d, respectively. However, the H_2 production remained at the same level of 5.3 ± 1.04 L H_2/d at increasing the OLR from 36 to 47 g COD_{total}/Ld. The H_2 generation was mainly due to conversion of COD (57%) and carbohydrate (81%). Protein and lipids conversion represents only 23.3% and 4.1% respectively for H_2 production.

1. Introduction

Municipal food waste (MFW) represents 60% of total municipal solid waste (MSW) in Egypt. It is estimated that the rate of MFW generation ranges from 0.03 in rural areas to 0.8 kg/capita/d in big cities, but it can be as high as 1.5 kg/capita/d for hotels and tourist resorts. Crude open dumping is the most common practice and dumpsites are commonly set alight to reduce the volume of accumulating MFW, hence adding to the air pollution caused by the uncovered dumped waste itself. Since the 1990s the Egyptian Government has clearly opted for a policy of waste recovery, focusing mainly on energy production from biodegradable waste materials. H_2 gas has great potential as a sustainable, environmentally friendly alternative fuel, because it combusts to form only water and energy (Chang and Lin, 2004). The hydrogen gas can be generated in a number of routes, i.e. through fossil fuels processing or by electrolysis using solar power or by thermal conversion of biomass (gasification) (Chonga et al., 2009). However, these processes are highly energy intensive and therefore expensive and not always environmentally benign, i.e. the fossil fuels processing (Wang et al., 2011).

The biological H_2 production is always more attractive since it is less energy-consumption than chemical or electrochemical processes (Hwang et al., 2011). Currently, anaerobic co-digestion has attracted more attention due to its potential in providing better pH conditions, more balanced carbon/nitrogen (C/N) ratio, and increased H_2 production (Wang et al., 2011). Radjaram and Saravanane (2011) investigated anaerobic co-digestion of press mud with water or sewage in a continuous up-flow anaerobic sludge blanket (UASB) reactor for H_2 production. They found that the UASB reactor achieved a H_2 production of 187 ml/g VS reduced at a HRT of 30 h. Co-digestion of cassava stillage and wasted sewage sludge for H_2 production were also investigated by Wang et al. (2011) who found that H_2 yield of 74 ml/g VS added was achieved under thermophilic conditions. Moreover, Kim et al. (2004) found that the addition of sewage sludge on MFW up to 13–19% could enhance H_2 production potential due to balanced carbohydrate/protein ratio. The maximum H_2 production potential of 122.9 ml/g carbohydrate-COD was found at the waste composition of 87:13 (food waste: sewage sludge). These results suggested the potential of co-digestion of different biodegradable wastes for H_2 production. Kitchen wastewater (KWW) is heavily polluted household waste with high carbohydrate content, alkalinity and abundant nitrogenous compounds, and it could be easily used for dilution of MFW instead of clean water prior dark fermentation process.

Most studies on biological H_2 production from MFW have been conducted in a mesophilic continuous stirred tank reactor (CSTR) (Fang and Liu, 2002) and anaerobic fixed-bed bioreactors (Lee

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