Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 138 (2017) 386–392

Energy Procedia

www.elsevier.com/locate/procedia

2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies
2017 AEDCEE, 25-26 May 2017, Bangkok, Thailand

Kinetic Model of Biogas Production from Co-digestion of Thai Rice Noodle Wastewater (Khanomjeen) with Chicken Manure

Sunwanee Jijai[a]* and Chairat Siripatana[b]

[a]*Faculty of Science, Technology and Agriculture, Yala Rajabhat University, Yala 95000, Thailand*
[b]*School of Engineering and Resources, Walailak University, Nakhon Si Thammarat 80160, Thailand*

Abstract

This study aimed to evaluate the bio-methane potential (BMP) of Thai rice noodle wastewater co-digested with chicken manure. Batch anaerobic digestion systems were operated at room temperature (28-30 ºC) for 45 days. Five different amounts of chicken manure were added to Thai rice noodle wastewater operating in 5 digesters (10g, 20g, 30g, 40g and 50g of chicken manure added respectively). Time-rate derivative models including Gompertz model and its related extensions were used to represent the experimental data. In the biogas production, the Gompertz model becomes popular to describe growth and product formation data because it is simplicity and well-fitting to batch data. Chemical analysis showed that all digesters had the higher nitrogen content (or low COD: N ratio) which was in the range of 16.15-17.62. It was also found that, the digester supplemented with 30g of chicken manure gave highest BMP. This was due to more suitable pH and the ratio of volatile fatty acid to alkalinity (VFA/ALK). The initial pH and alkalinity had a strong effect on the BMP. In general, well nutrient balance, suitable initial pH, and VFA-to-ALK ratio promoted the growth of microorganisms and hence increased the biogas production rate. These were indicated by the kinetic parameters such as the maximum methane production rate (R_m, ml/d) and the methane production potential (P, ml) but not for the shorter lag-phase period (λ, day).

Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.

Keywords: Biogas production, Co-digestion, Anaerobic digestion, Kinetic model, Chicken manure ;

* Corresponding author. Tel.: +6-689-736-2513; fax: +6-673-299-629.
E-mail address: sunwanee.j@yru.ac.th

1876-6102
Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.
10.1016/j.egypro.2017.10.177

1. Introduction

Biogas is a clean renewable energy produced by an anaerobic process which can substitute conventional sources of energy such as fossil, fuels, oil, and etc [1]. The anaerobic digestion is one of the most widely used to produce biogas whereby the organic material will be converted by bacteria into the biogas [2]. In Thailand, the sources of biogas production cover a wide range of feedstock such as municipal solid waste, animal waste, agricultural waste, agro-industry waste and wastewater, industrial wastewater, sewage sludge and landfill waste [3]. Many researchers studied biogas production from alternative feedstock such as waste from agro-industry, solid waste, animal waste, industrial wastewater etc [4-6]. The traditional Thai rice noodle wastewater causes considerable environmental problems and largely ignored because many of them are small in size. When this wastewater enters into the river without pre-treatment, it may create the severe problem due to its high chemical oxygen demand (COD) [7]. In the wastewater treatment of Thai rice noodle wastewater, aerobic process are mainly used for the organic removal. However, the aerobic process is not regarded as a suitable treatment option because of high energy requirement for aerobic treatment [8]. The anaerobic co-digestion of wastewater with animal waste has recently been considered as a promising alternative. So, it not only has a potential to produce biogas for local energy need but also decreases the environmental pollution. The scope of this research is to study the bio-methane potential from different amount chicken manure added into Thai rice noodle wastewater (TRW) in anaerobic digestion (AD), whereas important factors for the anaerobic process is C/N ratio and buffer capacity [9]. The Thai rice noodle wastewater (TRW) has lowest of nitrogen content and pH and should preferably be co-digested with chicken manure which has high nitrogen content and pH. The co-digestion would balance nutrients and increase the buffer capacity and improve biogas production. Then we compared the different addition using the modified Gompertz model and other more, including Shnute, Gompertz power law, Grau n-order and Monod model [10]. The preliminary results in this work could be valuable for planning in start-up biogas plant in the large scales.

2. Materials and methods

2.1 Wastewater and Seed

The wastewater sample was collected from the community in Yala province and chicken manure was collected from the layer chicken farm. Characteristics of wastewater and chicken manure are shown in Table 1. The wastewater and chicken manure were kept at 0-4 ºC until used in the experiments.

2.2 Experimental set-up

The experiments were conducted at room temperature (28-30 ºC) until batch completion. The 300-ml-volume serum bottles were used as reactors and a working volume of 200 ml was used in all experiments. The serum bottles were covered with the rubber stoppers and sealed with aluminum caps. The volume of biogas was measured daily by using water displacement method [11-13]. The methane content was measured using Gas Chromatography (GC-8A Shimadzu). The experiments were duplicated in all experiments. The experiment setup is shown in Fig. 1.

Table 1. Characteristic of wastewater and chicken manure

Parameter	Waste	
	Thai rice noodle wastewater	Chicken manure
pH	4.3	6.7
COD (mg/l)	4,200	10,740
TKN (mg/l)	198	690
TP (mg/l)	18	-
TS (mg/l)	1,610	8,430
VS (mg/l)	1,106	6,759
SS (mg/l)	1,500	9,240
VSS (mg/l)	583.5	7,250
Alkalinity (mg/ las$CaCO_3$)	519	920
VFA (mg/ lasCH_3COOH)	294	1,240
C/N	-	12.40
VS (%w/w)	-	50.20