POTENTIAL OF BIOGAS PRODUCTION FROM CO-DIGESTION OF DOMESTIC WASTEWATER AND FOOD WASTE AT MESOPHILIC CONDITION

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Abstract- This research investigation examined the potential of biogas production from the co-digestion of domestic wastewater and food waste through mesophilic condition.The samples were fermented in the ratio of 10:90, 25:75, 50:50 and 70:30 of food waste : wastewater at 35°c.The results revealed that the highest biochemical methane production (BMP) and chemical oxygen demand (COD) removal efficiency were 61.72 ml CH4 g-1 COD and 75.77 %, respectively, at the ratio of 10:90 for domestic wastewater and food waste. These primary results indicated the significance of co-digestion of domestic wastewater with food waste for biodegradation and biogas production.

Keywords- Anaerobic Treatment, Co-Digestion, Biogas, Domestic Wastewater, Food Waste.

I. INTRODUCTION

The great amount of wastewater in such area with dense population could reflect a critical environment issue. Generally, the domestic wastewater is purified by the aerobic technique which requires a large amount of electricity and land. According to the study of, the anaerobic process could be practically applied to purify domestic wastewater. The product from anaerobic process including methane gas can be used as a renewable energy supported the energy used in the community. However the low carbon content in this wastewater impact on unsatisfied treatment efficiencies when comparing with others wastewater types. Therefore the addition of supplemental substrates or co-digestion at least of two different substrates in order to improve the anaerobic digestion efficiency should be applied. Similar to domestic wastewater, the increasing of domestic solid waste have always been a problem in term of disposal management and may affect the environment. Many reports claimed that of only 25% of total domestic solid waste in Thailand were recycled. In addition, the solid waste composition analysis pointed that it contains food scraps mixed with organic compounds made up of 63.57%. Moreover, it was found that there was more than 50% of carbon in the mentioned solid waste. Thus the food scraps, in other words, organic compound, may be fermented with domestic wastewater. Therefore this research concentrated on the investigation of optimal domestic food waste and wastewater ratio and study the bio-methane formation potential of these substrates co-digestion.

II. MATERIALS AND METHOD

A. Wastewater

Domestic wastewater used in this study was obtained from storage ponds of Hatyai municipal treatment system in Songkhla province, Thailand. Food wastes were collected from a cafeteria center in Hatyai campus of Prince of Songkla University, Songkhla, Thailand. The anaerobic sludge used as inoculums were taken from Upflow Anaerobic Sludge Blankget (UASB)reactorof wastewater treatment plantof frozen seafood manufacturing in Hatyai, Songkhla. The substrates and inoculums were individually homogenized and subsequently stored at 4 °C until use.

B. Batch experiment procedure

The biogas production potentials of co-digestion between the domestic wastewater and food wastes used in this study were determined in anaerobic batch digesters (FIGURE 1).The biogas potential measurement of co-digestion of the domestic wastewater and food waste, 35 % (v/v) of were added to reactor.

The of co-substrates between the food waste and domestic wastewater were at 10:90, 25:75, 50:50 and 70:30 (%w/v) respectively, control set of experiment were at ratios 0:100, 100:0 and inoculums respectively to determine the optimum ratio of biogas production.

After that the pH was adjusted to be in the range of 7.0-7.2After filling, all digesters were closed with a rubber cap and the atmospheric oxygen in the gas phase was purged with N_2. During the experiments, all digesters were operated at 35°C and were shaken once a day. Biogas production was monitored periodically until gas production became negligible. An outlet in the stopper was used for collecting biogas in gas tight glass jars and the daily biogas production was recorded through the measurement of water displacement.

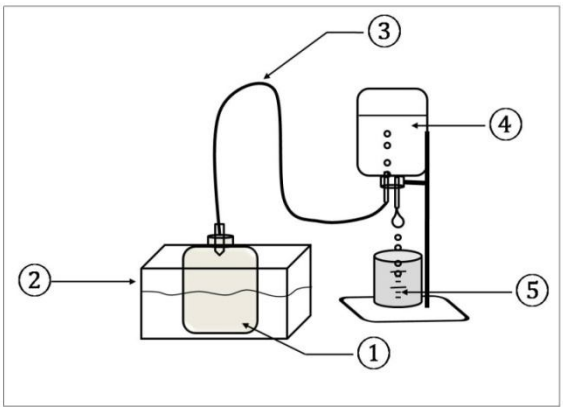


FIGURE 1: Schematic diagram of the digester (1, Fermentation bottle; 2, Water Bath; 3, Silicon Tube; 4,Water; 5, Beaker).

C. Analytical analysis

The samples were taken from each digester before and after the experiments. Analysis of the chemical oxygen demand (COD), total nitrogen (TN), total phosphorus (TP) and pH, were performed according to the Standard Methods for the Examination of Water and Wastewater.

III. RESULTS AND DISCUSSION

A. Substrates composition

Table 1 presented the characteristics of substrates used in this study. The domestic wastewater contains high nitrogen content that results low C:N ratio (14:1) while the food waste had high carbon content. Therefore the co-digestion of these substrates was reasonable to be conducted.

TABLE 1: The characteristics of the Domestic wastewaterand food waste.

Parameter	Domestic wastewater	Food waste
COD	613 mg/L	-
Total N	44mg/L	2.72 % of TS
Total P	7.5mg/L	0.78 % of TS
pH	6.98mg/L	5.50 % of TS
Carbon	-	54.95 % of TS

The mixing ratio of the substrates were varied at 10:90, 25:75, 50:50 and 70:30 for food waste:wastewater (v/v). The control experiments were also performed (0:100 and 100:0) in order to investigate the contribution of each substrate on methane production yield of co-digestion.

B. Results of biogas and methane production

Figure II presents the profiles of accumulative biogas volume produced by various mixing ratios. The food waste: wastewater mixing ratio at 10:90 (v/v) gave the highest biogas production. The higher food waste proportion yielded lower biogas production because of high carbon contents. The fermentation of single substrate, food waste or wastewater, could produce biogas only at the initial phase and then the reaction decreased sharply that resulted low biogas obtained.

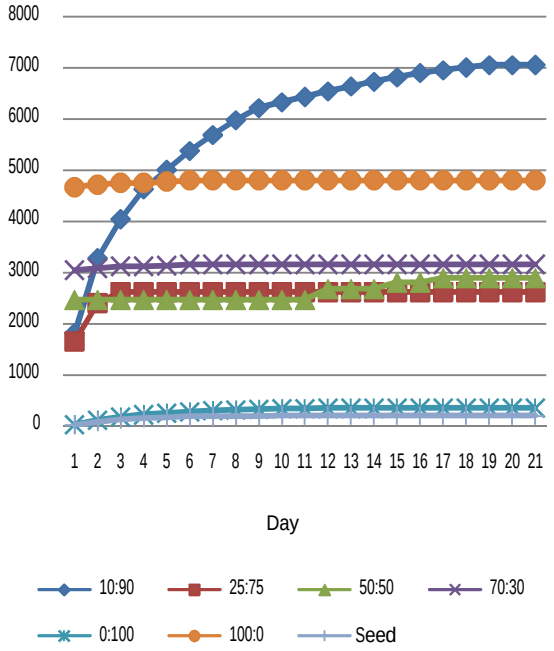


FIGURE 2: Accumulative biogas produced from various substrates mixing ratios.

The methane content of biogas produced was also analyzed in order to evaluate the bio-methane formation potential. It was found that when the volume of methane was calculated, the mixing ratio at 10:90 still gave highest methane production (Table 2 and Figure 3).

The contribution of substrates in biogas and methane production can be observed from results presented in Table 2. It was found that the domestic wastewater was the main substrate that was digested to produce biogas and yielded high methane contents but it required the carbon supplemental source. The methane yield of experiments used mixing ratio at 10:90 and 0:100 (food waste:wastewater, v/v) were similar while the use of higher ratio and food waste fermentation yielded low biogas and methane production. The addition of food waste into domestic wastewater by 10%v/v could enhance the methane yield by 13 % but increased the biogas and methane productions by 6696 and 4875 ml respectively.

The treated wastewater from these biogas experiments was determined their characteristics. It was found that it was still contaminated by high concentration of organic contents and some macro-nutrients. Therefore this wastewater can be studied in the future to be used as substrate for some interested system such as fertilizer production.

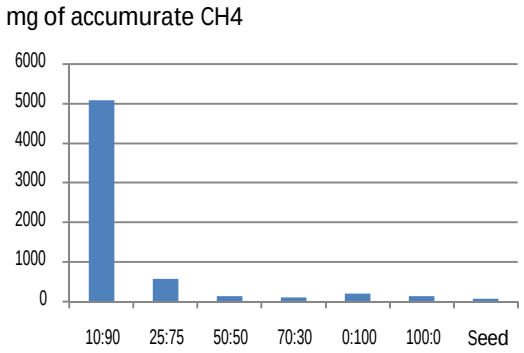


FIGURE 3: Accumulative methane produced from various substrates mixing ratios.

TABLE 2: Methane yield and production of co-digestion.

Ratios	% CH_4	Ac Biogas (mL)	Ac CH4 (mL)	CH4 yield ($mlCH_4$/mgCOD removed)
10:90	72	7053	5078	141.65
25:75	22	2619	576	12.19
50:50	5	2893	145	0.83
70:30	4	3161	111	0.38
0:100	57	357	203	124.88
100:0	3	4801	144	0.36
Seed	35	208	73	1.86

CONCLUSIONS

The co-digestion of domestic wastewater with food waste can enhance the biogas, methane productions and methane yield obviously. But due to the high carbon content contained in food waste, the mixing ratio has to be limited. The result showed the food waste:domestic wastewater ratio at 10:90 v/v yielded highest production efficiencies. The biogas and methane produced were contributed by domestic wastewater than food waste. The result of this study could be the preliminary data for further study with up-scale experiment and would be an alternative for domestic wastes management. This co-digestion could valorize the domestic waste by use as source of renewable energy.

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