Influence Of Different Ratio Of Food Waste And Cow Dung For Biogas

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ABSTRACT: This study discusses about biogas production from various compositions of food waste and cow manure using response surface methodology (RSM) and focuses to determine the optimized ratio of food waste to cow manures in producing biogas. The anaerobic process will be carried at constant temperature of 35°C by using water bath method, in order to investigate the volume of the gas production. The characteristics of food waste and different inoculum of pH, total solids, total suspended solids, moisture content were tested. Batch fermentation was conducted in 150 mL serum bottle with 100 mL of working volume at different concentration of dry cow manure and food waste. Batch fermentation was held for 14 days to study the effect of different concentration at different ratio of food waste with dry cow manure. The evaluation from RSM analysis shows that pH 8.0 with ratio of 50:50 is best for biogas production yielding at 315mL. The best performance based suggested on RSM for biogas production is at pH 7.02 with the ratio of the cow manure and food waste at 54:46 at 399.7 mL biogas production.

Keywords: *biogas, fermentation, response surface methodology(RSM)*

1. INTRODUCTION

The role of renewable energy was becoming more important in the development as well as the development of countries to meet partially the need of global energy [1] . The growth of this global in energy demand had induced an active search for alternative energy source [2] . The more efficient of deployment of renewable energy sources will facilitate a reduction in greenhouse gas emissions and air pollution. increase of population, economic growth for sustainable development and inadequate waste legislation enforcement [3]. The number of solid waste generated was recorded of 2,000 tons per day. Accordingly, the solid waste generation average for any person is 1.2 kilograms a day [4]. Hence, anaerobic digestion should be used to degrade food waste and recover energy. The energy carrier in focus was biogas which was among alternatives to fossil fuels. The biomass used to produce biogas was food wastes. By anaerobic digestion, the wastes could be treated to minimize the environmental impact and at the same time converted into methane gas.

2. Experimental Method

2.1 Material preparations

Cow manure (CM) was collected from the Cow farm located at Universiti Malaysia Perlis (UniMAP). Food waste (FW) was collected from the Cafeteria at Perlis. FW was separated into three categories; carbohydrate (rice), fiber (vegetable) and protein (meat and fish) at a ratio of 3:2:2. 1000 g of FW was ground in 1000 mL water using a blender (Panasonic) and kept in cool room prior to use.

2.2 Operating Procedure

Batch fermentation was carried out in a serum bottle of 150 mL with a working volume of 100 mL at concentrations of dry cow manure to food waste. Serum bottle was purged in and tightly cap with rubber septa and aluminium cap using crimper. Batch fermentation was conducted for 14 days to study the effect of different concentration of dry cow manure at different ratio of manure to food waste at 0:100, 100:0 and 50:50. The fermentation was conducted at temperature 35°C using a water bath. Initial pH was adjusted using 2M HCI and 2M NaOH. Biogas produced during fermentation was directly collected using syringe (Terumo 50 ml) with needle.

2.3 Experimental Design and Optimization

The software Design-Expert 6.0 (Stat Ease Inc. Minneapolis, USA with Design Expert 6.0.6 of central composite design (CCD) was used in the optimization of methane gas production from the mixer at different compositions of FW and dry CM.

3. Result and discussion

The mathematical equation of regression model for analyzing was based on Table 4.2 of the analysis data of variance (ANOVA) model.The values obtained which are subjected to the response analysis to evaluate the relationship between ratio of solution (A) and pH of solution (B). The mathematical regression models for specific methane production fitted in term of coded factors were obtained from the analysis of variance (ANOVA) which is as follows:

$$Y_{SMP} = 16.69 + 2.64A - 2.72B + 3.20AB - 1.95A^2 - 7.94B^2 \quad (1)$$

Equation 4.2 of regression model represents specific methane production. Analysis of Variance (ANOVA) was used to determine the adequacy and significance of the quadratic model. Summary of ANOVA is shown in Table 1.

Table 1 :Analysis of variance (ANOVA) of the model

Sources	Sum of square	Df	Mean square	F value	p-value Prob>F
Model	77.48	5	15.50	13.83	0.0016
A	5.46	1	5.46	4.87	0.0631
B	2.17	1	2.17	1.94	0.2067
AB	1.92	1	1.92	1.71	0.2318
A^2	13.15	1	13.15	11.73	0.0111
B^2	29.83	1	29.83	26.62	0.0013
Residual	7.85	7	1.12		
Lack of fit	6.07	3	2.02	4.56	0.0884
C.V	7.65				
R^2	0.9080				
Adjusted R^2	0.8424				

The low value of coefficient of variation (CV, 2.58) indicated that a high degree of precision and a good deal of reliability of the experimental values. The regression analysis of the experimental design indicated that the linear model terms (A), quadratic model term (A2 , B2) and interactive model term (AB) are significant (P0.05).

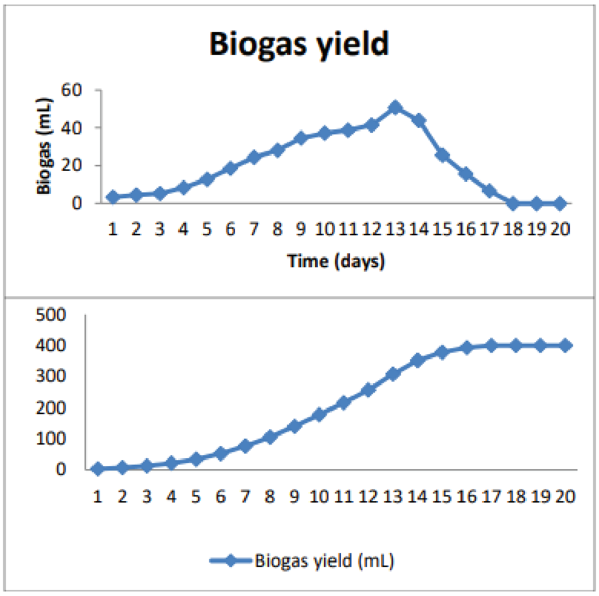

Figure 1: Cumulative biogas yield from co-digestion of fresh cow manure and food waste at 54:46 ratio.

Figure 4.5.1 and figure 4.5.2 shows time courses profile of biogas along the incubation period for fermentation conducted at pH 7.02, at 35 oC temperature and the ratio at54:46mix of fresh cow manure and food waste for 20 days. The ratio 54:46 mix of fresh cow manure and food waste had the highest methane yield compared with the ratio at 100:0, 0:100 and 50:50 respectively. After optimization of pH and ratios respectively, biogas yield was calculated to be 399.7mL. Based on the comparison for the optimized parameters, the results indicated that more than 27 %o biogas yield increased after controlling the pH and ratios during fermentation. In general, pH 7.0 alone improved biogas production from the recycled digested sludge the most because it optimizing the biogas-producing microbes, acid, alkali, thermal, and sonolytic treatments [5] .

CONCLUSIONS

This study indicates that the co-digestion of fresh cow manure and food waste are feasible for biogas production under suitable operational parameters. Co-digestion of fresh cow manure and food waste are suitable for the production of renewable energy in the form of biogas. Co-digestion also improves the production of high biogas yield. Response surface methodology (RSM) indicated optimum parameters for biogas production. The operational parameters for using RSM analysis showed that pH 8.0, at 35 oCtemperature and the50:50 ratio were suitable for biogas production with the yield of 315mL. Conditions for optimum response and model validation were confirmed by using Response Surface Methodology (RSM) atR20.9143. The suggested optimized parameter by RSM for biogas production is at pH 7.02 with the ratio of the fresh cow dung to food waste at 54:46. Optimization of parameters suggested by RSM consisting of pH, and ratio are to be controlled strictly during the digestion process. Maximum biogas yield was obtained at399.7 mL after 20 days of fermentation process at optimum parameters of and ratio respectively.

REFERENCES

[1] Islam, R., Banerjee, G., & Ali, F. (2014). Design and Benefit analysis of Biogas plant for rural development in Bangladesh. International Journal of Engineering and AdvancedTechnology (IJEAT), 342- 348.

[2] Al Imam, F. I., Khan, M. Z. H., Sarkar, M.A.R., & Ali, S. M. (2013). Development of Biogas Processing from Cow dung, Poultry waste, and Water Hyacinth. International Journalof Natural and Applied Science, 13-17.

[3] Nadi, B., Ahmad, R., Pirasteh, S., &Shamshiry, E. (2011). Challenges of Solid Waste Management in Malaysia. Research Journal of Chemistry and Environment, 1-4.

[4] Budhiarta, I., Siwar, C., &Basri, H. (2012). Current Status of Municipal Solid Waste Generation in Malaysia. International Journal on Advanced Science engineeringInformation Technology, 16-21.

[5] Goswami, R., Chattopadhyay, P., Shome, A., Banerjee, S. N., Chakraborty, A. K., Mathew, A. K., & Chaudhury, S. (2016). An overview of physico-chemical mechanisms of biogas production by microbial communities: a step towards sustainable waste management. 3 Biotech, 6(1), 78–79. https://doi.org/10.1007/s13205-016-0395-9