Co-Anaerobic Digestion of Cow Dung and Food Waste with Additive for Biogas Production

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ABSTRACT

Animal waste from farms in developing countries is usually stored and then dumped. For farm waste disposal. However, these practices contribute to climate change, eutrophication, and unpleasant odours. Anaerobic digestion is a proven method for recovering waste energy, including animal waste. The present of study focused on anaerobic co-digestion of cow dung (CD) with food waste (FW) and the present of herds such as tea tree leaves (TTL) as additive for potential biogas production. The aim of the study was to evaluate the effect of addictive towards the biogas production for anaerobic co- digestion of cow dung and food waste. The operating temperature was 35°C in mesophilic condition. pH values and C/N ratio are noted until 36 days. The biogas production was analysed by using biogas analyzer. The highest methane gas (CH4) production is 58.6% which co-digest between food waste and cow dung without the present of tea tree leaves. With the present of tea tree leaves, the hydrogen sulfide gas (H2S) was decreased to 151 ppm. Tea tree leaves were effect the production of methane and hydrogen sulfide gas in anaerobic digestion process.

Keywords: Anaerobic digestion, cow dung, tea tree leaves, methane gas.

1. INTRODUCTION

The recent rise in dairy product demand in Malaysia is correlated with an increase in the volume of manure produced by livestock. Dairy cows are the main producers of livestock manure, with a vast amount of cow dung contributing to the majority of greenhouse gas emissions, in addition to producing milk and meat [1]. The management of animal waste produced in farms typically entails stockpiling the waste and then applying it straight to the ground. This is done in order to dispose of the waste produced by the farms. The inadequate methods used to manage cow dung have caused the release of hazardous pathogens, greenhouse gas emissions, and airborne ammonia, resulting in environmental problems which are contributions to climate change, eutrophication, and offensive odours [2].

Manure is a valuable source of methane-rich biogas due to its inclusion of the specific bacteria necessary for anaerobic digestion. It can serve as a substrate or inoculum for this process [3]. Anaerobic digestion is one of the well-established technologies that recovers the energy that is contained in waste, including animal waste. This energy can be used for a variety of purposes [1]. Biogas, comprising a substantial quantity of methane, is produced through anaerobic digestion utilizing various types of raw materials. The process has the capacity to generate methane gas with a yield of up to 75% [2]. Anaerobic digestion is a technique for producing clean biomass energy, to realise the resource utilization of waste from animal waste and agricultural. The process of anaerobic digestion that makes use of multiple feedstocks at the same time is referred to as co-digestion. The co-digestion of cow dung and food waste which improved the quantity and quality of anaerobic digestion products [4].

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Herbs plants such as tea tree leaves produced some fragrant and contains a variety of volatile molecules such as phenol-derived aromatic components, terpenoids and terpenes where they are also insecticide potential, larvicidal and reproduction inhibitors [5]. Past research also has shown that the tea leaves able to produce biogas [6].

The purpose of this research is as follows: (1) to characterize the physiochemical change during co-digestion process of cow dung and food waste with tea tree leaves as addictive. (2) To evaluate the effect of methane (CH_4) and hydrogen sulfide (H_2S) gas production during co-anaerobic digestion process.

2. EXPERIMENTAL PROCEDURE

2.1 Feed Stock and Inoculum

The inoculum consisted of a fresh cow dung that was obtained from a cow farm in Padang Besar, Perlis. This sample was used in this research. The food waste was used as feedstocks was obtained from the stall area on campus, which is located at the UniMAP Campus in Jejawi Perlis. Every week, one kilogramme of food waste was collected. Meanwhile, tea tree leaves were obtained from Institute of Sustainable Agrotechnology (INSAT), UniMAP, Perlis.

2.2. Lab Scale Digesters

The co-digestion of cow dung and food waste was carried out in two phase anaerobic digestion. The ratio of feedstock to inoculum was 2:1 and. The amount of tea tree leaves be added is 15g to the feedstock. The cow dung was acclimatized for 2 weeks The mixtures were placed in at temperature of 35°C for 36 days.

2.3. Analytical Methods

The Parameters such as pH was determination after sampling by using pH meter. Carbon and total nitrogen were measured by using HACH method. The composition of biogas was determined by using a biogas analyzer.

3. RESULTS AND DISCUSSION

To determine the methane gas production that can be achieved through co-digestion, two types of reactors can be used: single phase and two-phase reactors. In this research, two-phase reactor was used to determine the methane gas production. Anaerobic digestion can be divided into two reactors to increase process efficiency. This is because the first reactor will enhance hydrolysis and acidogenesis then, the second reactor will produce higher-quality biogas [7]. The additive was added to compared the biogas production and to observe the hydrogen sulfide gas production which is offensive odours during the anaerobic digestion process. The gas was measure in the second reactors. Before being fed into the first reactor, the pH of food waste was measured, and it range from 5.92 to 6.64.

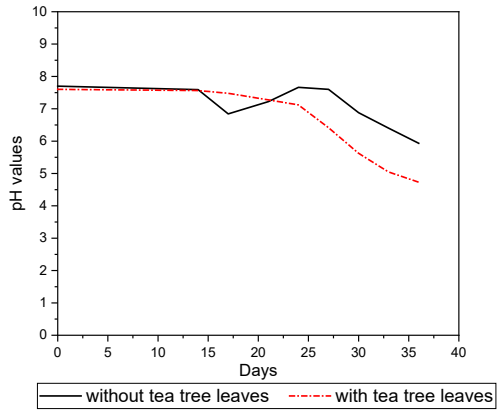

Figure 1. Result of pH of mixtures with and without tea tree leaves.

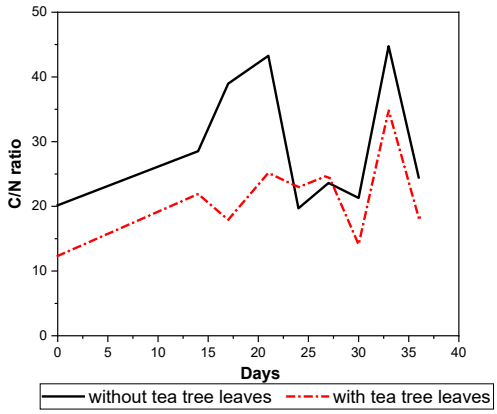

Figure 2. Result of C/N ratios of mixtures with and without tea tree leaves.

The figures above show the properties of the mixture during the anaerobic process. The initial of pH are 7.7 and 7.6 are shows in Figure 1. The pH of mixtures was maintained between 7.5 and 6.8 for both mixtures. The best range of pH thought work for methane gas production are from 6.5 to 7.5 because methanogenic bacteria prefer a neutral environment [8]. However, the pH start drops on day 30. This happened due to the different pH values of food waste added to the samples every 3 days.

Figure 2 shows the initial of C/N ratio, are 20.16 and 12.33 for both mixtures that indicated that cow dung contains high nitrogen with low carbon content. The C/N of cow dung was reported between 16 and 25. Cow dung's C/N ratio is suitable for anaerobic digestion, as the literature suggests a C/N ratio of 15–30 for anaerobic digestion [9]. However, the ratio was increase to 21.91 for the mixture with additive during day 14. This indicate that the nitrogen contains are increase. The carbon to nitrogen C/N ratio is an important consideration in the manufacturing of methane. With a low C/N ratio, nitrogen will be present in the form of ammonia, which inhibits the methanogens' metabolism due to its toxicity [10].

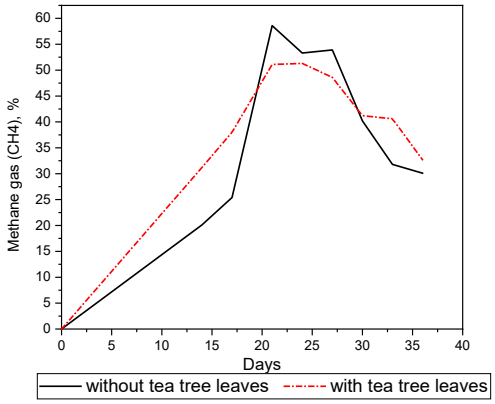

Figure 3. Result of methane gas of mixtures with and without tea tree leaves.

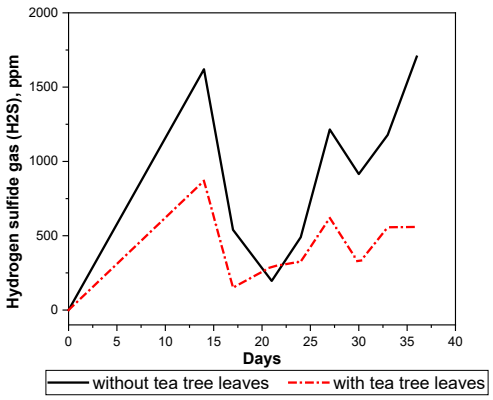

Figure 4. Result of hydrogen sulfide gas of mixtures with and without tea tree leaves.

The percentage of biogas produced from the co-digestion of cow dung and food waste as the control with and without additives for 3 every day at a temperature of 35°C are presented in Figure 3 and 4. The methane gas produces more without additive which is reached its peaks on day 21 which 58.6% compared added some addictive which is 51.1% only. For hydrogen sulfide gas, the concentration of gas was reduced with additive which compared without addictive. However, the production of hydrogen sulfide can reduce with additive but it also effects the percentage of methane gas production. Tea tree leaves produced some fragrant and phenol-derived aromatic components for odours which is related to the hydrogen sulfide, however, it is also herbs that reproduction inhibitors that can inhibits the methanogens for methane gas production [5].

4. CONCLUSION

Though the co-anaerobic digestion of cow dung and food waste produced high percentage of methane gas than adding additives, however hydrogen sulfide content was lower with the addition of additive as they possessed a toxic effect towards anaerobic digestion process. Future research work will involve optimization of the biogas production by combining with other additives that can produce high methane gas production but can reduce the hydrogen sulfide for odours problems.

ACKNOWLEDGEMENT

The authors would like to extend their gratitude to the owners of the cow farms in Padang Besar, Perlis, for their assistance and kindness during the sampling collection. Special thanks to the Civil Engineering Technology Faculty at UniMAP for providing the facilities for this study. This research stud was supported by a grant from the UniMAP- E-Idaman Research Grant; the reference number for this grant is 2019/12/001.

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