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Biogas Production From Oil Palm Empty Fruit Bunches through Dry Fermentation Process: Preliminary Results

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SUMMARY

The purpose of this paper was to present a preliminary result of biogas production from oil palm empty fruit bunches (EFB) through dry fermentation process. Research was conducted at Agroindustrial Waste Management Lab. of the Agroindustrial Technology Department, the University of Lampung. Two sources of bacteria were used for comparison, namely fresh cow dung collected from local cow farmer near the university and effluent from a digester working with palm oil mill waste water. The EFB, obtained from Bekri Palm Oil Mill of PTPN VII, was merely shredded prior to fermentation process to facilitate the mixing with bacteria sources. Biogas production was conducted using 220 liter capacity drum digester. Parameters to be observed including biogas production (daily and cumulative), biogas yield (per VS removed), and biogas composition. Results showed that total biogas yield of EFB with cow dung reached 1652 L within 41 days of solid retention time (SRT) and 1235 L from EFB plus effluent with 46 days of SRT. Methane content of the biogas was comparable, namely 36.1% for the case of EFB plus cow dung and 40.1% for EFB plus effluent.

Introduction

Two important waste from palm oil mill is POME (Palm Oil Mill Effluent) and EFB (Empty Fruit Bunches). Currently, POME was treated using sedimentation ponds and used for land application afterward. Modern application of POME is used for biogas generation through anaerobic process. The EFB can be used as fuel in the boiler furnace for electricity generation and process hot water. Common usage of EFB is for soil mulching after. Some industries are using the EFB and POME together to produce compost [1]. Composting of EFB together with POME minimizes nutrient losses and concentrates all nutrients from POME and EFB in one product [2]. The process is usually performed using open windrow system with the addition of POME.

The composting process can also be conducted using dry anaerobic digestion with the benefit of producing biogas during the digestion. Dry anaerobic digestion is able to overcome disadvantages of wet fermentation which adversely affect the economic feasibility of solid feed digestion [3]. The purpose of this paper was to present preliminary results of biogas production from EFB through dry fermentation process.

Material and Method

Research was conducted Waste Management Lab., Dept. of Agroindustrial Technology, University of Lampung. EFB, obtained from Bekri Palm Oil Mill of PTPN VII, Lampung, was shredded prior to incubation. Cow dung was collected from local cow farmer in Sidosari Village, Natar, South Lampung. Another bacteria source was effluent (digestate) collected from a POME-based small scale anaerobic digester located in the Department of Agroindustrial Technology.

A 220 liter capacity plastic drum was modified as digester equipped with water shower and gas piping (Figure 1). Inside of the drum was equipped with perforated floor to facilitate leaching. Shredded EFB (14 kg) was thoroughly mixed with fresh cow dung (4 kg). The mixture was loaded into the drum. Before digester was sealed, substrate mixture was sprayed with water (10 L). The leachate was collected and recirculated daily. For experiment using bacteria source from wet digester effluent, 14 kg of shredded EFB was loaded into the equivalent drum. The drum was then sealed and about 10 L effluent was daily sprayed into the drum. Organic matter content of fresh and spent EFB was analyzed by burning the material in a furnace (Barnstead Thermolyne 1300) at a temperature 500 oC for 2 hours. The volume

of biogas production was monitored daily using simple water displacement method. Biogas composition was measured using a GC (Shimadzu C114843).

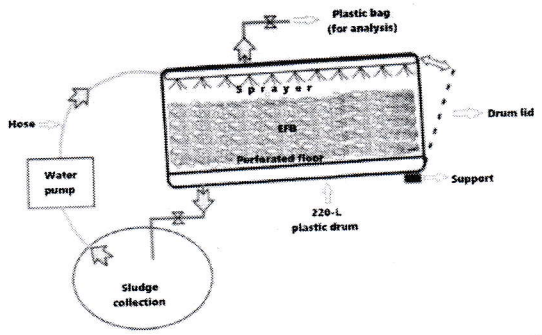

Fig. 1 Schematic for anaerobic dry digestion of EFB

Result and Discussions

Figure 2 and 3, respectively depicted daily and cumulative biogas production from EFB with cow dung and with wet digester effluent. It can be seen that digestion process requires 41 days and 46 days SRT (solid retention time), respectively for EFB with cow dung and EFB with effluent. Biogas production from EFB using cowdung was higher than that of EFB using effluent. During that time, biogas production reached 1652 L (average 40.3 L/day) for EFB with cow dung case, and 1235 L (average 26.8 L/day) for EFB with effluent. This difference may be due to the addition of biogas produced from cowdung alone.

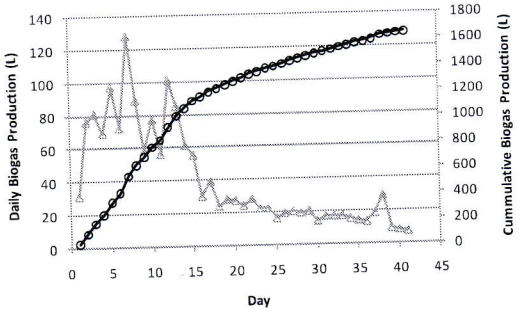

Fig. 2 Schematic for anaerobic dry digestion of EFB

As presented in Table 1, methane content for both cases was also comparable, respectively 36.1 % for cowdung case and 40.1 % for effluent case. The low methane content was also reported by others [4].

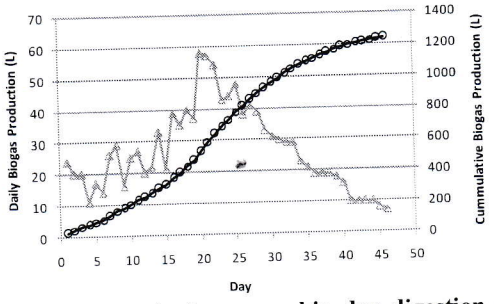

Fig. 3 Schematic for anaerobic dry digestion of EFB

Table 1 Biogas composition (% vol)

Gas Composition	EFB + CD	EFB + DE
N_2	21.5 %	13.1 %
CH_4	36.1 %	40.1 %
CO_2	42.2 %	46.7 %

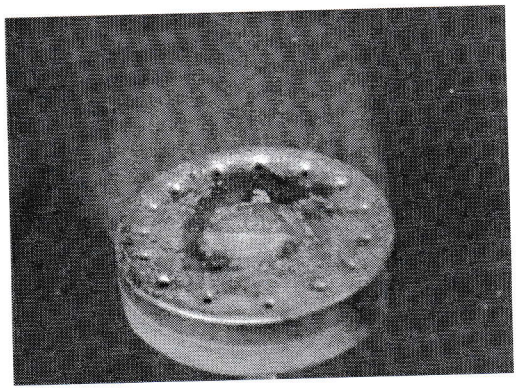

Fig. 4 Burning test for biogas produced from efb through dry anaerobic fermentation.

The biogas produced was also tested by burning it in a simple burner. As can be seen from Figure 4, the gas was successfully burnt and produced blue flame quite similar to the flame resulted from LPG.

Table 2. Proximate analysis of substrates.

Parameter	Initial	Final (EFB+CD)	Final (EFB+DE)
Water content (%, wb)	64.2	75.1	72.9
Total Solid, TS (%, wb)	35.8	24.9	27.1
Organic matter (% TS)	91.6	88.0	88.9
Ash (% TS)	8.4	12.0	11.1

Table 2 showed proximate analysis of the substrates before and after process. During anaerobic fermentation that going on six weeks, organic matter slightly decreased from 91.6% to 88% with cow dung and to 88.9% with wet digester effluent. The fibers of EFB were still physically strong. This implied that the biogas might be produced mainly from the degradation of such organic materials as oil and debris that are attached in the EFB. Compost resulted from this process, however, need to be analyzed deeply and compared to those one produced from conventional open windrow.

Conclusion

Preliminary results showed that dry anaerobic digestion is potential to be applied for biogas production using EFB as substrate. Biogas productivity from dry anaerobic digestion of EFB was comparable with both bacteria sources, namely 1,137.0 L/kg VSremoved with cowdung and 1,120.6 L/kg VSremoved with wet digester effluent.

Acknowledgement

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Reference

1) Schuchardt F, Darnoko D, and Guritno P. (2002). Composting of empty oil palm fruit bunch (EFB) with simultaneous evaporation of palm oil mill waste water (POME). International Oil Palm Conference, Nusa Dua, Bali, Indonesia, July 8-12, 2002. pp. 1-9.

2) Hasanudin U. and Setiadi T. (2013) Sustainable Wastewater Management in Palm Oil Mills. Draft of Book Chapter 34

3) Radwan AM, Sebak HA, Mitry NR, El-Zanati EA, and Hamad MA. (1993). Dry anaerobic fermentation of agricultural residues. Biomass and Bioenergy 5: 495-499.

4) D. Cahyani.(2012) Potensi Reduksi Emisi Gas Rumah Kaca Melalui Pemanfaatan Kotoran Sapi Menjadi Biogas Skala Rumah Tangga Di Provinsi Lampung. Skripsi. Universitas Lampung