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Effect of sawdust and temperature on quantity and quality of biogas produced from poultry wastes and its utilization

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ABSTRACT

In the last decades, many countries are facing a shortage of traditional fuels, for instance in Egypt; fossil fuels represent 97% of total energy consumption also renewable energy represents only 3%. especially, poultry farms consume a huge amount of Liquefied Petroleum Gas (LPG) cylinders for heating purposes which affects the needs of the domestic sectors because Egypt imports 55% of the LPG consumption from aboard. Furthermore, poultry wastes are difficult to dispose of and their accumulation causes many environmental problems. On the other hand, poultry wastes can be anaerobically fermented to produce biogas to make self-sufficiency of methane in the poultry farm but there is a difficulty in this process, Poultry manure (PM) contains a high percentage of nitrogen which works as an inhibitor for anaerobic digestion process (AD). Laboratory biogas units were designed for performing AD process of poultry manure and poultry litter (PM+ Sawdust). The temperature of PM and poultry litter (PL) laboratory digesters were maintained at 37^{0}C and then maintained at 27^{0}C by keeping the digesters in the incubator, many parameters were measured as pH, carbon/nitrogen ratio, amount of produced biogas, and methane percentage. In comparing these parameters in PM and PL, it was found that the best biogas production and the highest methane content was found in Poultry Litter at 37^{0}C. By digesting poultry litter in a fixed dome biogas unit it was found that there is a saving in the consumption of LPG cylinders. The research concluded that sawdust in the poultry farms of warm countries improves the production, quality of biogas, and methane content, so the saving reaches 5.4 LPG cylinders monthly if the digestion of poultry litter for 5000 head poultry farm was applied.

Keywords:

Biogas, Environmental applications, Green chemistry, sawdust.

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INTRODUCTION

Egypt imports approximately 40% of the LPG consumption. in addition, the bill of subsidizing LPG borne by the government during the year 2019/2020 was approximately 16.5 billion pounds and that subsidization represents 88% of the total actual fuel subsidizing bill[1]. Subsequently, that cost makes a large load on Egypt's economy. Concurrently, Poultry farms consume a huge amount of these subsidized LPG cylinders while poultry wastes in these farms can be anaerobically fermented to produce biogas to be used as an alternative to LPG. poultry wastes contain a large amount of ammonia which consider an inhibitor to the AD process[2], so the C/N ratio must be adjusted to produce large amounts of biogas with high quality and high methane content.

METHODS AND MATERIALS

The parameters of the anaerobic digestion process were tested in small-scale biogas units and then applied in Large-scale biogas unit to calculate the feasibility of using biogas as an alternative source of energy in poultry farms.

Small-scale Biogas Unit (batch reactor):Four digesters were set up as in (Fig 1.) for preparing four experiments. All digesters were filled with 100 gm of organic wastes (2 digesters filled with PM and the other 2 digesters filled with PL). All digesters were diluted by distilled water 1:1[3]. The temperatures of PM and PL digesters were adjusted at 37^{0}C for 27 days and in the other two digesters the temperatures were adjusted at 27^{0}C for another 27 days. measured parameters are pH, carbon/nitrogen ratio, amount of produced biogas, and methane percentage.

Applied biogas unit: After making many experiments in laboratory biogas units, the Fixed dome digester was built as an applied biogas unit to test the amount of saving in LPG Cylinders in a real poultry farm. The filling capacity of the digester is 5.85m^3. Digester was fed with poultry litter at atmospheric temperature 36±2^{0}C. Water is added with the same weight and mixed with litter in the mixing tank[3]. a cocker burner was operated using the produced biogas. one medium flame torch is fired and the operating time is calculated and the flow rate of biogas was measured then the saving of LPG consumption was calculated.

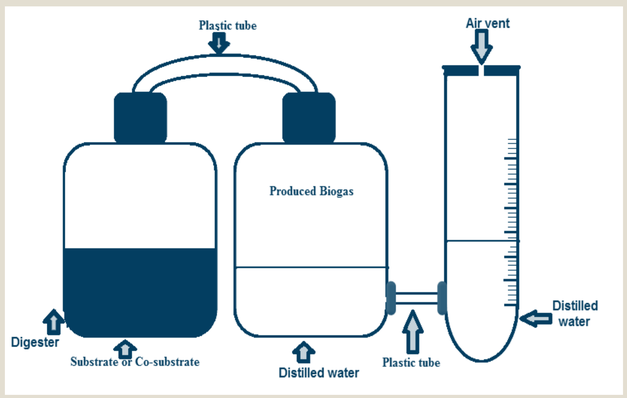

Figure 1. Laboratory Digester configuration

RESULTS

The largest amount of produced biogas came from the digester which contains Poultry Litter at temperature 37^{0}C. After determining the laboratory results, it can be concluded that PL can be used in a fixed dome digester and the biogas measured daily and after many calculations, the study found that 1 Kg of PL produces 0.027 m^{3}of biogas and in Poultry farm with 5000 chickens can generate 288.3 kg biogas /day.

Table 1. Effect of temperature and SD on amount of produced biogas and methane content.

Organic Substrate	Temperature (^{0}C)	Content		C:N	Amount Of Produced Biogas (mL)
		C%	N%		
PM	27	33.4	3.3	10.1	674
	37				992
PL (PM+SD)	27	39.8	2.4	16.6	896
	37				1168

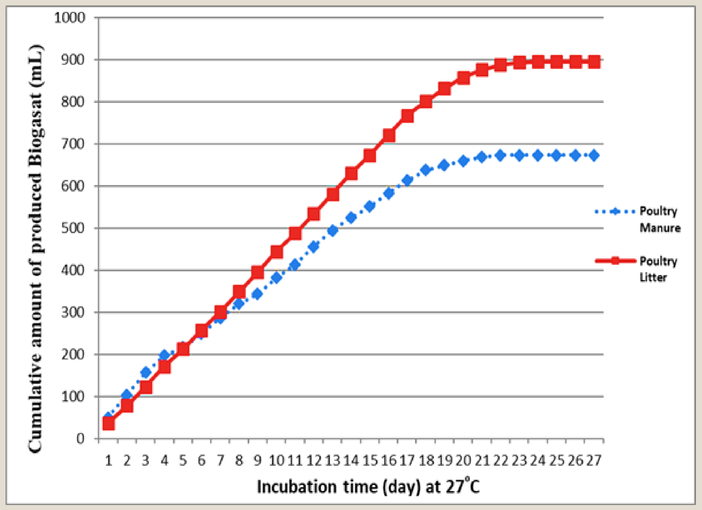

Chart 1. Cumulative amounts of produced from PM and PL (at 27ºC).

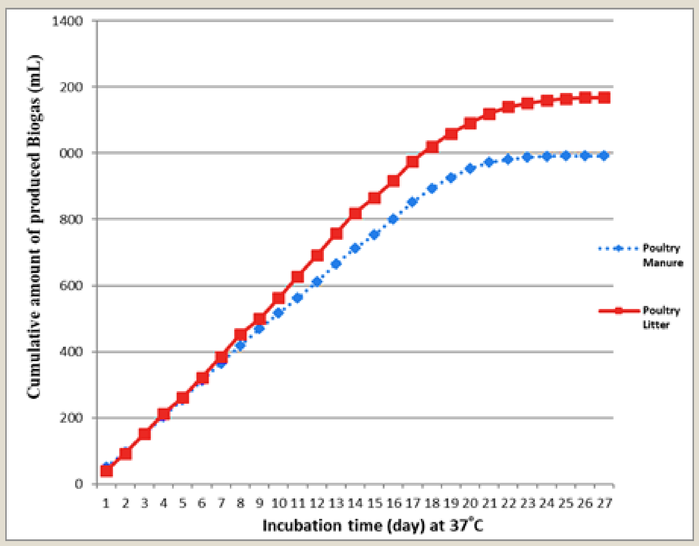

Chart 2. Cumulative amounts of produced from PM and PL (at 37ºC).

DISCUSSION

C/ N ratio of PL is more than PM due to the presence of sawdust which contains a high amount of carbon as in (Table 1). These results were partially approaching with akwaka et al ,2014 study [4] which mix cattle dung with sawdust. PL at 37^{0}C produced more amounts of biogas and more methane content than PM, that is due to the presence of SD in PL which increase the carbon content and neutralize the high nitrogen content in poultry wastes to improve the biogas production this result agreed with zhengyun, 2013 and bai, 2009 studies [5,6]and the temperature 37^{0}C enhanced more biogas production and more methane percentage because this temperature provides a suitable environment for methanogenic bacteria to produce biogas with high methane percentage, these results demonstrated in (Chart 1. , Chart 2.) and (Table 1).

CONCLUSIONS

For improving the amount of produced biogas and methane content the PL must be used as an organic material for digestion due to its suitable carbon percentage which neutralize nitrogen in poultry wastes. There is a higher production of biogas amount and methane percentage at 370C than at 270C, because this temperature is suitable for activating anaerobic bacteria. In fixed dome biogas unit, the PL is fermented at an atmospheric temperature (36±20C) and this temperature is very suitable for ideal biogas production as it tested before, many measurements and calculation were made and concluded that if biogas unit built for 5000 head poultry farm in warm country like Egypt there is a saving of LPG which reaches 164.16 L/ Month as The LPG cylinder contains 30 L of LPG. So, that means 5.4 cylinder/ month or 64.85.4 cylinder/ year.

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