Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2017, 9(11):1-10

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Synthesis and Comparative Analysis of Natural Gas from the Sheep Droppings as Main Admixture and Food Waste as a Partial Admixture in a Confined Built Digester

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ABSTRACT

Solid waste is a one of the major issues created by the society due to the improper disposal of solid waste environmental issues are created. That is air pollution, ground water contamination, soil pollution, water quality depletion & human health related problems etc. The biogas production is one of the solutions to reduce solid waste related environmental problems. In this project study was conducted to analyze the biogas production with co-digestion of sheep droppings and food wastes. The biogas production was carried out under a mesophilic temperature of 27°C to 33°C for duration of 55 days. The objectives of this project are to analyze the different ratio co-digestion of sheep droppings and food waste and also optimize the high biogas producing ratio. There are five laboratory scale samples composed of a different ratio of a sheep droppings to food wastes to make a sample D1 (100:0, D2 (80:20), D3 (70:30), D4 (60:40) and D3 (50:50). The co-digestion occurred in a 20 litre capacity of cylindrical container. The sample will be a semi solid liquid which is poured 16 litre in the container. The pH is noted over the fermentation period of 55 days. All the parameter influencing the anaerobic digestion like pH, temperature, alkalinity, total solids, volatile solids and volatile fatty acid are tested every day to find the digestion process takes place inside the digester. Sample D1 (100% sheep droppings) showed the maximum gas production 85.45 l/kg at the end of the digestion. Sample D-2 (80: 20 for 80% sheep droppings and 20% food waste) of the gas production is 62.71 l/kg. Sample D-3 (60: 40 for 60% sheep droppings and 40% food waste) of the gas production is 36.46 l/kg. Sample D-5 (50: 50 for 50% sheep droppings and 50% food waste) of the gas production is 4.25 l/kg.

Keywords: Anaerobic digestion; High density poly ethylene; Liquefied petroleum gas; Microorganism; Volatile fatty acid; Waste to energy; Total solids; Volatile solids; Water hyacinth

INTRODUCTION

Mostly the waste is collected in sheep cattle or nearer to degradation in the open which cause a significant environmental hazard. The air pollutants spread from waste include methane, carbon dioxide, nitrous oxide, ammonia, hydrogen sulfide, volatile organic compounds and particulate matter, which can cause severe environmental issues and health problems. Previously, cattle waste was reused and simply spread onto agricultural land. The establishment of solid environmental management leads to unpleasant smell and water pollution. This creates that some form of waste management is necessary, which provides more reason for biomass-to-energy conversion [1]. To study about Production of biogas in batch digesters at WC from sheep droppings produced 93 1 gas/kg dry matters whereas cattle dung yielded 234 l/kg dry matter [2]. Reported the biogas production and some biochemical parameters of anaerobic fermentation at 30°C for 40 days were studied for eight experimental groups of fermentation [3] reported the study about the anaerobic digestion offers an advantageous alternative to land filling, incineration and composting since it is considered as the most appropriate treatment solution.

Food waste is an organic material having large calorific value and nutritive value to microbes and hence ability of methane production is higher. Food waste is disposed in landfill or discarded which causes the public health hazards. It can affect by polluting environment and ground water contamination. It emits unpleasant smell and methane, while carbon dioxide is a major greenhouse gas to emitting global warming. The biogas production is influenced by many factors, of which the temperature of the anaerobic digester process and of the sub layer is the most important.
Co-digestion is the simultaneous digestion process of more than one types of waste in same unit. Benefits include better digestibility, highly biogas production and methane yield come into existence from possibility of additional nutrients. Sheep dropping is high in anaerobic bacteria and is easily accessible nearby and also there is very limited literature available on using sheep dropping in co-digestion with food waste. Hence this research was undertaken to explore the possibility of co-digestion with sheep droppings and food waste. Sheep droppings and food waste were taken in different ratios observations were carried out for the mixture [4]. This study was carried out to assess and determine the biogas yield from cow and goat dung. Biogas yield assessment was carried out at room temperatures (26.0-30.0°C) for a period of 20 days from a solid dung mixture of 1000 g in each sample (fermentation slurry) left to ferment over 35 days.

EXPERIMENTAL SECTION

Characterstics of Biogas

Composition of biogas depends upon feed material also. Biogas is about 20% lighter than air has an ignition temperature in range of 20°C to 35°C. It is an odorless and colorless gas that burns with blue flame similar to Liquefied Petroleum Gas (LPG). Its caloric value is 20 Mega Joules (MJ)/m^3 and it usually burns with 60% efficiency in a conventional biogas stove. This gas is useful as fuel to substitute firewood, cow-dung, petrol, LPG, diesel and electricity depending on the nature of the task and local supply conditions and constraints [5]. Reported the present work explores the production of biogas from fruit and vegetable wastes mixed with cow manure in an anaerobic digester. The total solid, volatile solids, moisture content and ash content of the wastes were examined. Anaerobic biogas digesters also function as waste disposal systems particularly for human wastes and can therefore prevent potential sources of environmental contamination and the spread of pathogens and disease causing bacteria. Biogas finds its natural calorific value from various composites [6]. Completed a study about Poultry litter (a mixture of rice hulls, sawdust and chicken excreta of broilers) mixed with the co-substrate cow dung and poultry droppings was evaluated under anaerobic conditions for the production of biogas (methane).

Batch Feeding

A full charge of raw material is placed into the digester which is then sealed off and left to ferment as long as gas is produced. When gas production has ceased, the digester is emptied and refilled with a new batch of raw materials. Batch digesters have advantages where the availability of raw materials is limited to coarse plant wastes which contain undigestable materials that can be conveniently removed when batch digesters are reloaded. Also, batch digesters require little daily attention [7-11].

Continuous Load Digester

A small quantity of raw material is added to the digester every day Continuous-load digesters are especially efficient when raw materials consist of a regular supply of easily digestible wastes from nearby sources such as livestock manures.

Digested Slurry

Discussions in previous sessions might have created an impression that the inflammable gas (methane) is the main product of a biogas system and the digested slurry is the by-product of it. Such technology can effectively yield a large amount of natural gas synthesis. The slurry is equally important, if not more, for its high nutrient content and multiple uses as manure [12,13]. The nutritive value of anaerobically digested slurry for maintenance of soil fertility and increased crop production, the different methods of utilization of slurry for crop production.

Objective of the Study

- To produce biogas from sheep dropping and food waste.
- To replaces fossil fuels and other sources of non-renewable energy.
- To provide a fertilizer from the digested waste.
- To decrease greenhouse gas emission.

Survey

In this study, survey taken about the material to available nears the surroundings of National Engineering College, Kovilpatti. The waste is dumped more created environmental hazards. Environmental issues are created due to non-renewable energy consumption. Biogas production reduced the consumption of non-renewable energy. Sheep droppings are mostly used as a fertilizer and food waste is disposed in land fill or discarded which causes public health hazards. Biogas production from organic wastes it's one of the solution for solid waste management.

Collection of Waste

Sheep droppings are collected from Nalatinputhur 3 km from the Kovilpatti a industrialized city in south India. Food wastes are collected from own premises. A food wastes contains banana peels, stale cooked food, rotten eggs and vegetables refuse like rotten tomatoes, brinjal etc. These will be crushed separately by mixer grinders. Heavy food loadings with ample organic content value produces a desirable content of biogas yields. Mixer can be used to convert solid into semisolid [14-16].

Digester Setup

Fresh sheep droppings and crushed food waste mixed with water thoroughly by hand and poured into a 20 litre cylindrical container .The waste can be filled 16 litre in each digester. 20% empty space inside the digester to collecting the gas. They planned to co digestion with sheep droppings and food waste can pour into a digester with a different mix ratio. The digester can be filled with 16 litre of waste. The waste can be poured into the digester will can be sealed tightly with the cape. 5000 gms of waste taken to make a digester. There are 5 different sets of ratio with different composition are installed as below.100:0, only sheep droppings with water to make 10 litre which is poured in 20 litre cylindrical container D1.

Lab Scale Experiment

In lab scale this experiment was done in 20 litre cylindrical container. Here bio wastes are mixed with different proportions. Different parameters of input and effluent like total solid, volatile solid, volatile fatty acid, pH, temperature and alkalinity will be measured. Here also different parameter will be checked below (Figures 1-7).

- Total solid
- Volatile solid
- Volatile fatty acid
- pH
- Temperature
- Alkalinity

RESULTS AND DISCUSSION

General

This chapter consists of the graphical view of the taken experimental results like Ph, temperature, volatile fatty acid, total solids, volatile solids and alkalinity. The interpretation as well as comparison chart was provided. The work also correlates the relationship between the rate of amount of production of biogas yield corresponding to its pH range, VFA, TFA and organic loading of the digester (Table 1).

At initially the gas production is nill for one or two days later on the production commences Since initial day of production on the 4th day of setting up of the digester the production begins with rate of 440 l/kg of biogas synthesis production. For the calculated period of 53 days of biogas synthesis it reached the maximum amount of 3900 l/kg production of biogas synthesis rate. The progress of methanogenesis is followed by acidogenesis, hydrolysis. The outlet gas has been periodically monitored as a biogas or not by a simple gas valve outlet which is flammable in nature.

Table 1: Digester-1 gas production

SL. NO	TEM P°C	pH	VOLATILE FATTY ACID mg/L	ALKALINITY mg/L	TOTAL SOLIDS mg/L	VOLATILE SOLIDS mg/L	DAILY GAS PRODUCTION l/kg	CUMULATIVE GAS PRODUCTION l/kg
1	28	6.94	5790	11350	65600	20600	0	0
2	30	6.85	5955	11600	60300	22300	0	0
3	28	6.81	5030	11850	59400	23450	0	0
4	29	6.77	5350	12100	56700	23900	440	440
5	33	6.71	5640	12300	52500	25300	690	1130
6	28	6.55	5760	12650	47000	25800	700	1830
7	32	6.53	6120	12800	41000	25900	1420	3250
8	33	6.31	9000	12950	40100	26000	1320	4570
9	29	6.42	9480	13000	40000	26700	1100	5670
10	28	6.37	7440	13100	36500	27000	960	6630
11	32	6.3	9960	13300	35800	30800	780	7410
12	33	6.18	10320	13400	35300	35300	450	7860
13	33	6.04	11460	13650	34800	39000	620	8480
14	30	6.57	12080	13850	34000	44750	440	8920
15	32	6.19	12720	14400	33950	50000	420	9340
16	33	6	13200	14600	33000	52500	410	9750
17	33	6.13	13200	15000	35800	66000	390	10140
18	31	6.24	13440	15200	37600	39600	480	10620
19	30	6.46	13560	15350	38800	36600	630	11250
20	32	6.37	13695	22500	45800	23500	740	11990
21	32	6.28	13960	23500	46200	23000	850	12840
22	33	6.22	14190	23500	42800	22500	980	13820
23	31	6.16	15180	24200	39400	22400	1140	14960
24	33	6.26	15360	25500	38100	20250	1260	16220
25	30	6.3	15675	30500	37750	19800	1340	17560
26	32	6.32	15720	33000	37000	19700	1430	18990
27	32	6.37	16170	33625	36900	19500	1500	20490
28	33	6.19	16200	33950	36000	19200	1280	21770
29	31	6.52	17160	34660	34800	17900	1360	23130
30	28	6.59	19320	34750	33700	17500	1790	24920
31	30	6.63	22200	35500	32600	17400	2030	26950
32	32	6.67	21800	37000	31600	17000	2230	29180
33	33	6.72	21730	38600	29700	16400	2350	31530
34	28	6.76	20450	21000	49600	15900	2640	34170
35	31	6.78	19450	18300	67000	15650	2800	36970
36	32	6.82	18900	17860	60600	15200	3200	40170
37	33	6.85	16350	17600	35800	14600	3330	43500
38	33	6.89	15960	17500	42800	14400	3450	46950
39	32	6.9	14920	17150	34800	12800	3550	50500
40	31	6.96	14720	16750	35800	10200	3680	54180
41	28	6.98	14650	16700	37200	26200	3740	57920
42	30	7.02	14500	16500	38400	20200	3830	61750
43	33	7.46	14200	16500	40000	18200	3900	65650
44	32	7.35	13950	16200	40400	12200	3920	69570
45	31	7.45	13500	16000	29400	16800	3780	73350
46	30	7.66	13350	15900	34400	18300	3600	76950
47	28	7.71	12750	15850	36800	17860	2960	79910
48	28	7.6	11250	15750	38200	17600	2150	82060
49	30	7.66	10850	15600	39400	17150	1860	83920
50	33	7.56	10550	15600	40100	16750	930	84850
51	32	7.58	10350	15500	41400	16700	500	85350
52	31	7.67	10200	15480	42400	16200	100	85450

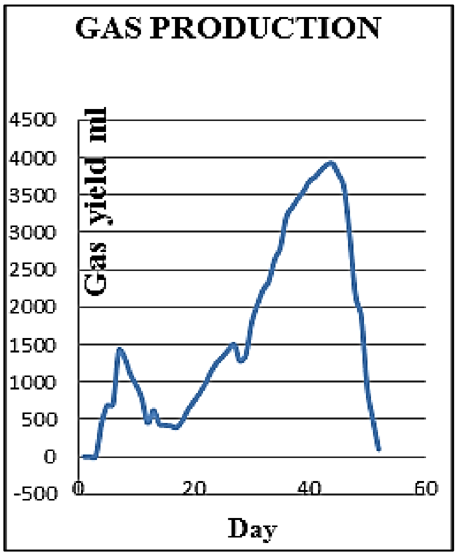

Figure 1: Gas production for digester1

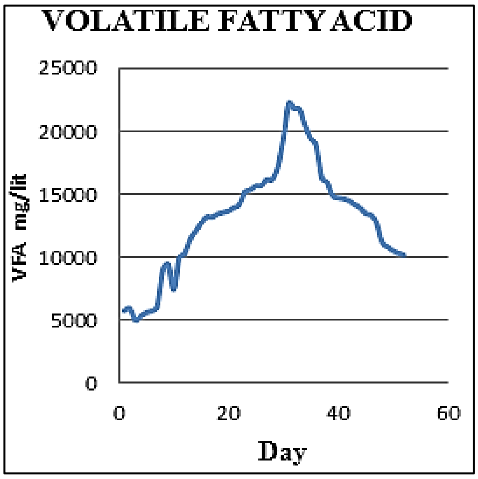

Figure 2: VFA for digester-1

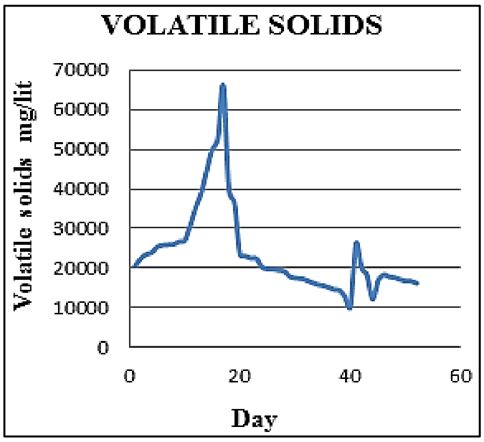

Figure 3: Volatile solids for digester-1

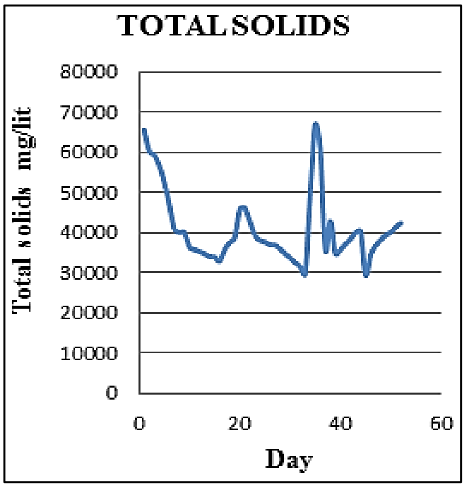

Figure 4: Total solids for digester-1

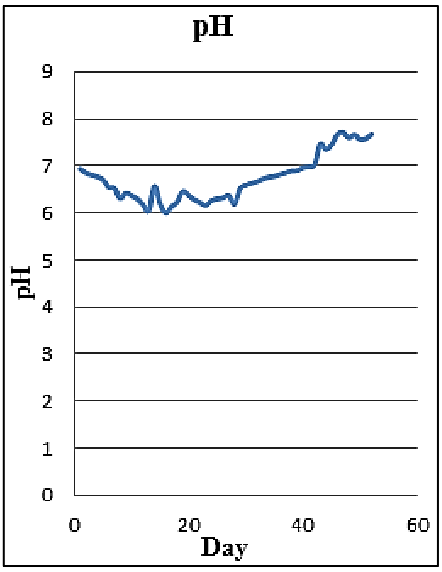

Figure 5: pH for digester-1

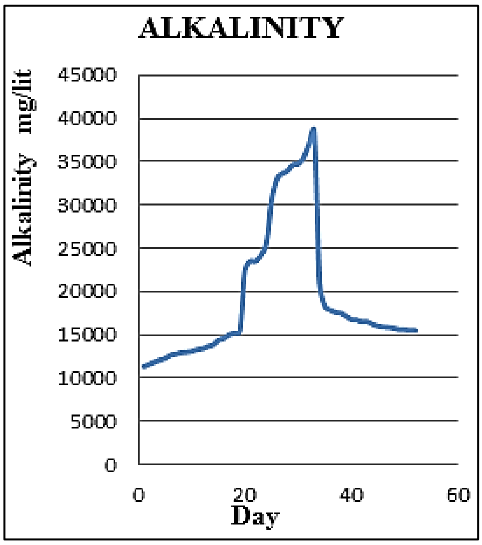

Figure 6: Alkalinity for digester-1

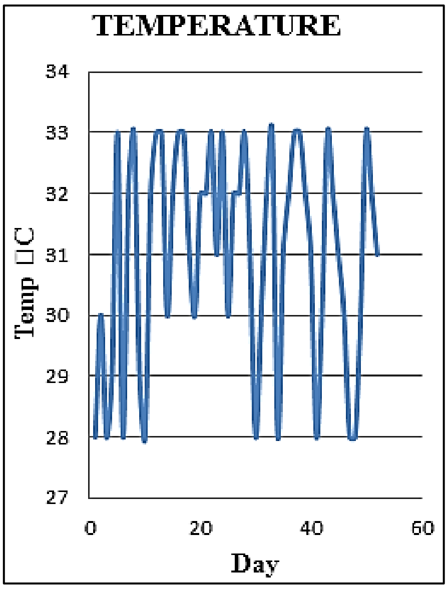

Figure 7: Temperature for digester-1

This graphs represents in the digester – 1, the temperature is maintain at under a mesophilic condition at 28°C to 33°C. The temperature should be maintained 53 days for the complete production of methane. The growth of methanogenic bacteria under the pH ranges above 5.5 to 8. The pH maintain in the digester, so the methane production is high. The volatile fatty acid is an important factor consider to biogas production. The volatile fatty acid increase the biogas production is stop. If the VFA is decrease the methanogenic reaction is process in the digester. Alkalinity is maintained a buffering capacity to maintain the pH ranges maintained in the digester. The bicarbonate ion (HCO_3-) is the main source of buffering capacity to maintain the system's pH in the range of 5.5-7.6. The concentration of HCO_3^- in solution is related to the percent of carbon dioxide in the gas phase. Alkalinity usually provides enough buffering capacity to withstand moderate shock loads of volatile fatty acids. Total solids 1st total solids are high in the ranges 30%. And then again the maintain medium solids in the medium range of 18%. Volatile solids, the waste characterized by a high solids and low non bio degradable material is suited for the anaerobic digestion factors. In this graph both are maintained frequently same. Gas production has a constant and produce 85.450 l/kg at a long term duration for 53 days (Figures 8-11).

Mathematical Modelling for Natural Gas Production

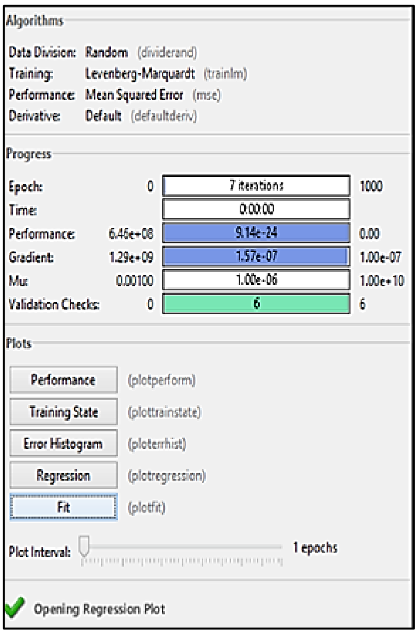

Figure 8: Plot networking using ANN modelling

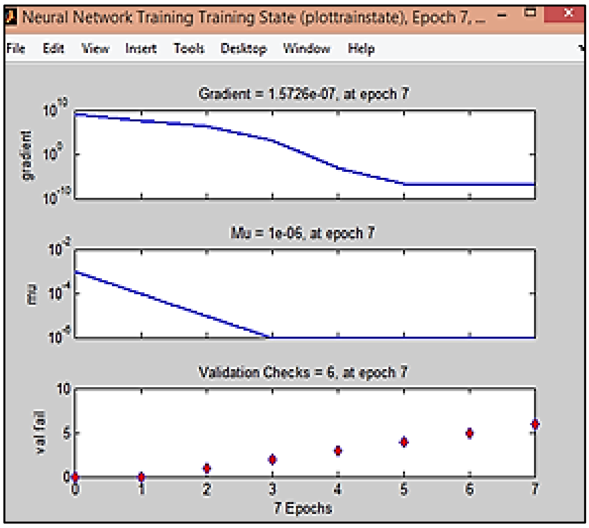

Figure 9: Plot network training state using ANN

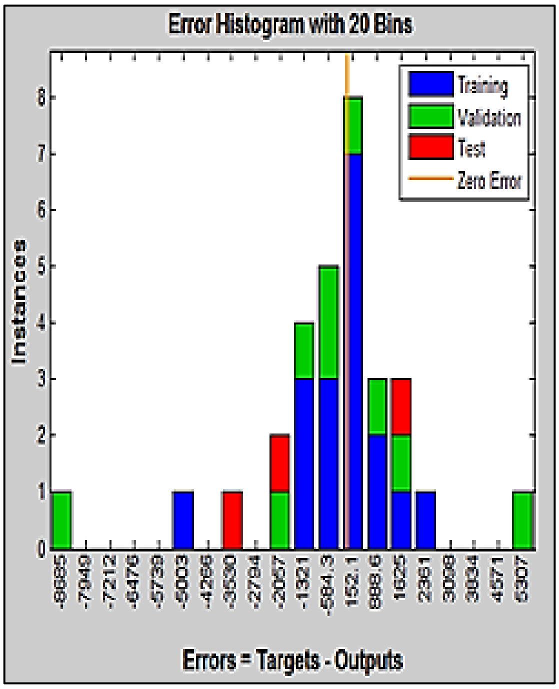

Figure 10: Plot error histogram networking using ANN

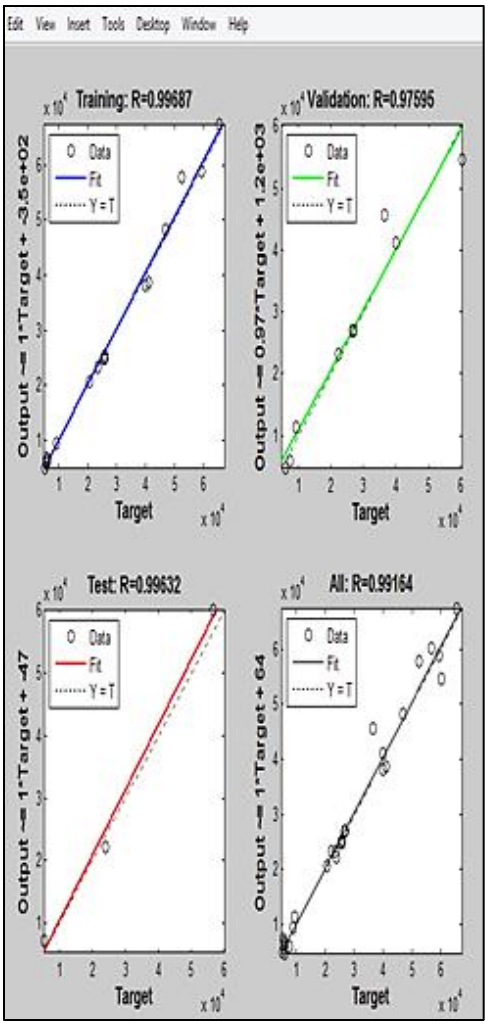

Figure 11: Regression modelling for the digester readings

CONCLUSION

The Results of this study has been shown clearly that sheep droppings and food wastes, when used in combination are good substrates for biogas generation. The D-1 (100:0) sheep droppings produces around 85.450 l/kg in a 16 lit of slurry under a mesophilic temperature 27°C to 33°C. The methanogenic bacteria growth under PH ranges 5.5 to 8, so the production is long term of 53 days and gives a higher yield results compare to the other digester. The C/N ratio is high due to the consumption of nitrogen by the methanogenic bacteria.

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