International Journal of Scientific Research and Engineering Development-– Volume 5 Issue 4, July-August 2022

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

BIOMETHANATION OF DIFFERENT LIVESTOCK EXCRETAS

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Abstract:
Several studies were carried out to assess the biomethanation capacity of cattle excreta. The research gives ways for evaluating biogas potential. The current experimental investigation demonstrates that the biogas generation potential of 18.76, 19.23, 15.31, 6.63, 13.54, and 19.03 liters specific biogas production the substrates of cow, buffalo, sheep and goat, pig, poultry, and horse excreta respectively for the above treatments under a mesophilic temperature condition of 35 ± 1°C as psychrophilic conditions are not acceptable for biogas formation. According to the findings of the study, the biomethanation capability of horse dung may also be used for cow and buffalo manure. There is a huge animal population roaming around the cities capable of generating a large amount of renewable energy in form of biogas

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1.Introduction:

Biogas technology has long been popular in India, as it provides a significant answer to the present energy issue in rural regions, such as the provision of home energy, and biofertilizers, and also helps to keep the environment clean. Biogas technology may be classified as one option for this renewable energy promotion plan as well as an alternative for reducing GHG emissions. India has the world's biggest cattle population, estimated to be 529.7 million people (NDDB). There are now roughly 42.6 lakh biogas plants in India, which is still quite low when compared to the installed capacity of 120 lakh. There are several renewable energy sources, such as sunshine, wind, and biomass, and agricultural wastes are a major source of bioenergy. The anaerobic digestion process is one of the methods utilized to generate energy while also reducing waste's organic load in terms of COD and BOD. Even with low energy prices in non-oil-producing countries, energy generation remains an essential industry. Biogas as a fuel is one such option, which may be created by anaerobic digestion of animal waste, and residential and farm waste, all of which are abundant in the countryside. Because India has the world's largest population, livestock manure may play an expanding part in the Indian energy production situation.

2. Material and Methods

Biomethanation of various animal excreta was carried out using an experimental setup consisting of a batch-type fermenter, gas transfer tube, and gas collecting bottle, as illustrated in (Fig.1). As batch fermenters, 4-liter polymer jars were employed. The fermenters (Fig.1) were designed with a slurry feed and an exit to transfer the gas generated. Each fermenter's output was attached to a gas collecting bottle, and all connections were sealed with Araldite and M-seal. In total, 18 of these fermenters were used. The fermenter's sample port was outfitted with a PVC pipe with an internal diameter of 30 mm, which was sealed with a tight conical rubber cork. After filling the substrate, the aperture of each digester was immediately sealed with a conical rubber cork stopper.

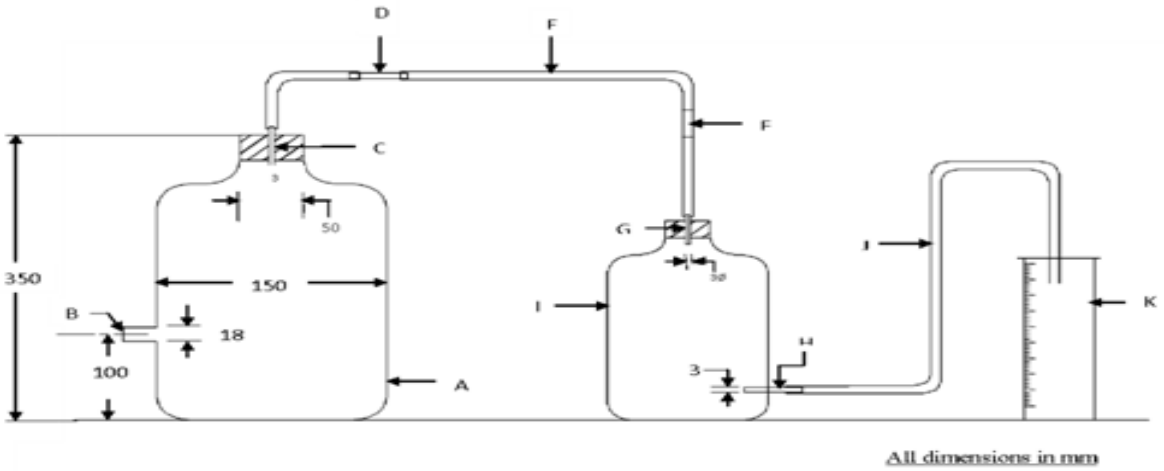

Fig.1Setup for batch digesters

As an exit for the biogas produced, a 100mm long copper tube with an internal diameter of 3 mm was installed in the center of the rubber cork. Synthetic glue and M-seal, as well as rubber cork, were utilized to seal the copper tubing. Each digester's output was connected to a gas collection device through a 3 mm internal diameter rubber tube. A copper tube jointer was installed between the digester's gas output and the gas transfer tube to ease the removal of the digester from the set-up during substrate sampling throughout the experiment.

2.1 Gas collection unit

Polymer jars with a capacity of two liters were used with each fermentation to collect biogas. Each fermenter's outflow was linked to a polymer bottle (Fig.1). Gas was collected using the water displacement technique.

To plug the opening of each gas collection bottle, a number 8 conical rubber cork was used. To connect the fermenter via a 3 mm dia PVC pipe, copper tubing 50 mm long with a 3 mm internal diameter was put in the rubber cork used for sealing the aperture of the gas collecting bottle. As an exit for water displacement, another copper tube of the same size was installed on the lower side of the gas collection polymer bottle. A rubber tube with an internal diameter of 3 mm was attached to the outlet of the biogas collecting bottle to transport the displaced water from the gas collection bottle to a measuring cylinder with a capacity of 1 liter. The gas transfer tube from each fermenter was connected to a gas collection bottle with a copper tubing jointer to allow for bottle pullout for refilling and transporting the biogas collection to the gas chromatograph for gas composition analysis.

2.2 Analytical Techniques

2.2.1 Determination of total solids

The total solids and volatile solids available were measured as per Standard Methods for the Examination of Water and Waste Water (APHA). The samples were weekly drawn from each fermenter for the determination of total and volatile solids. The samples were weighed on a Metter make AE 166 series electronic balance having the least count of 0.0001g. The pre-weighed wet samples kept in a pre-weighed silica crucible were dried to constant weight in a hot air oven at 103 to 105ºC. The total solids in the sample were calculated using the formula given below.

$$TS = (W_d/W_w) \times 100$$

Where,

W_d = weight of oven dried sample, g

W_w = weight of wet sample, g

TS = total solids, %

2.2.2 Determination of volatile solids

The volatile solids of the substrates were also determined as per Standard Methods for the Examination of Water and Waste Waters (APHA). The silica crucible having pre-weighed oven-dried samples was placed in a Wiswo make muffle furnace at 550±50ºC for 30 minutes. Thereafter dried samples (ash) were cooled in desiccators. The weight of crucibles having burnt samples (ash) and cooled samples were taken immediately using a precision balance. The volatile solids content of the samples was calculated using the following formula:

$$VS = [(W_d - W_a)/W_w] \times 100$$

Where,

VS= volatile solids present in the wet sample, %

W_a = weight of dry ash remaining after igniting the sample in a muffle furnace, g

W_d = weight of the dry sample, g

W_w = weight of the wet sample, g

2.2.3 Determination of pH

The pH of the influent substrate as well as the samples drawn from each treatment on every seventh-day interval was recorded using a Systronics make 324 pH meter. The least count on the pH meter was 0.05 pH. The pH meter was calibrated to the pH of seven using a buffer solution of pH 7 & pH 4. The buffer solution of pH 7.0 was prepared by dissolving a tablet of pH 7 and pH 4 in 100 ml distilled water separately. The pH of the sample was measured by diluting 2g of sample with 8ml of distilled water.

Table 1 Initial experimental conditions for batch fermentation

Types of substrates	Treatment No.	Weight of livestock excreta, kg	Weight of water added, kg	Amount of inoculum added, kg	Weight of inoculated substrate, kg	Initial TS of substrate %	Initial VS of substrate %	No. of replication
Cow Dung	**T1**	1.00	0.880	0.12	2	6.93	5.38	3
Buffalo Dung	**T2**	0.960	.800	0.24	2	7.02	5.93	3
Sheep and Goat Droppings	**T3**	0.500	1.260	0.24	2	12.51	9.42	3
Pig Slurry	**T4**	0.680	1.08	0.24	2	12.31	9.54	3
Poultry Droppings	**T5**	0.500	1.26	0.24	2	8.54	6.79	3
Horse Dung	**T6**	0.670	1.09	0.24	2	5.11	4.5	3

2.2.4 Determination of total alkalinity

Measurement of total alkalinity was based on potentiometric titration to endpoint pH method as described in Standard Methods for Examinations of Water and Waste Water (APHA). The analysis was performed on 5 g of samples. These samples were diluted ten times using distilled water and then filtered in a 150 ml beaker. The filtered samples were then titrated with 0.1 N sulphuric acids to bring the pH of the sample to 4.3 as the endpoint. The total alkalinity in the samples was then calculated using the following equation.

Total alkalinity = 50,000. A. N/V

(mg of $CaCO_3$/l)

Where,

A= Volume of Standard acid used, ml

N= normality of standard acid

V= Volume of sample, ml

The calculated value of total alkalinity was multiplied by the dilution factor of 10 to obtain the total alkalinity of the sample.

3.Result and Discussions

3.1 Reduction in Total Solids

Total solids in undiluted livestock excreta were 16.06, 15.20, 50.06, 35.71, 47.45, and 17.03 for cow, buffalo, sheep and goat, poultry, and horse, respectively. In a typical anaerobic fermentation process, the substrate is diluted with an equivalent amount of water. Dilution of substrates reduces total solids. This reduction in total solids content typically aids in the quicker breakdown of solids.

Table2.Characterization of various livestock excreta studied

	Cow	Buffalo	Sheep and Goat	Pig	Poultry	Horse
Treatments	T1	T2	T3	T4	T5	T6
Total Solids%	16.07	15.20	50.06	35.71	47.45	17.03
Volatile Solids%	13.33	13.17	38.55	28.31	36.16	14.91
Total Alkanity(g/l)	5.0	4.1	7.7	7.6	7.4	6.2
NH_3-N(mg/l)	260	240	190	1300	1300	280
pH	7.55	8.3	9.24	6.72	8.24	6.76

3.2 Reduction in Volatile Solids

The treatment T1, T2, T3, T4, T5 and T6 contained an initial volatile solid of 5.38, 5.93, 9.42, 9.54, 6.79 and 4.58 percent respectively.

3.3 Variation in pH

A suitable environmental condition for methanogenesis in an anaerobic digestion process is decided by the pH of the process. The influence of process parameters reveals that satisfactory process operation occurs in the pH range of 7.0 to 7.6 whereas pH below 6 is considered toxic to the methanogens.

3.4 Daily Biogas production

Gradual increase in biogas production was observed for all the treatments with some rise and fall due to effect of process parameters and microbial activities inside the digester. A gradual decrease in biogas production was observed after third week for all the treatments with some down fall due to effect of process parameters and microbial activities inside the digester. A total biogas production of 18.97,18.70,17.89,16.23 ,12.82,7.9liters was observed for treatment T2, T1, T6,T3, T5, and T4 respectively for 40 days of operation.

4. Summary and Conclusion

The analysis of foregoing results on parameters governing the anaerobic fermentation process , reduction in total solids and volatile solids, biogas yield indicates that the biomethanation potential of horse and buffalo dung is comparable to cow dung and process parameters also remains within the desirable limit under mesophilic temperature conditions. The present investigation has revealed the potential of anaerobic treatment as a viable technique for production of green energy beside the treatment of livestock excreta for pollution control. A maximum efficiency of above20 percent total solids removal was found with a sufficient biogas production of 0.72 l/g VS destroyed for cow and horse dung. On the basis of this, it can be concluded that the underutilized livestock excreta should also be used for the production of biogas a green energy through anaerobic fermentation process in biogas plants.

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