SISLA MEDICAL JOURNAL OF MICROBIOLOGY
Volume 1 Issue 2 Research Article

Biogas Production: Use of Different Approach Towards Optimization of It's Yield

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Received Date: May 26, 2024**; Published Date:** June 26, 2024

Abstract:
This research done to reveal the effect of using different approach in biogas optimization process. Ten-liter container was used to fabricate digester. Different approach like use of cellulase producing bacteria, use of bovine blood, magnesium sulphate, pH of 8, sodium carbonate and zinc nitrate were used as additive. After 21 days of retention time, it was recorded that addition of bovine blood yield-ed 231.1g, Magnesium Sulphate recorded 136.3g. But the addition of Zinc nitrate gave rise to for-mation of ammonia which inhibited the growth of bacteria. That gave the biogas of 3.4g. This re-search is recommending that bovine blood and magnesium sulphate should be used in optimization process. Also anything that will produce ammonia should be avoided.

Keywords: *Substrate; Co-Digestion; Anaerobic; Biogas; Methanogen; Fermentation*

Introduction

Intestinal Because of crisis in energy sector and its short fall in the wild world; there is great need for a replacement of the already used fos-sil generated energy. Biogas is a renewable and an ecofriendly form of energy which can sub-stitute wood and other fuels in several applications and bring down the rising costs of petroleum products and falling of trees for energy production. Urbanisation has led to rapid production of "wastes" leading to poor management practices in developing nations. Because man must generate waste at all times and his inability to manage it well. Biogas generation has become way of waste reduction.

The high standards of living have increased the release of pollutants and Greenhouse Gases (GHGs) into the environment. According to current research and future predictions, the crude oil will run out within 40 to 70 years, and natural gas will be finished within 50 years (Courtney and Dor-man, 2003). Biogas production is a sustainable solution to treat waste and the cost of the waste treatment is low. There is limited competition with food by using industrial wastewater and residues to produce biogas. The effluent from the biogas process supplies essential nutrients which can also be utilized as fertilizer. The major raw materials or substrate in biogas production is the lignocellulose waste. This lignocellulose is rich in food nutrients. It has three major components. Biogas is one of the most efficient and effective options among the various other alternative sources of renewable energy currently available. It is produced through anaerobic digestion processes where the microorganisms convert complex organic matter into a mixture of methane and carbon dioxide. The anaerobic digestion of biomass requires less capital investment per unit production cost compared to other renewable energy sources, such as hydro, solar and wind energy [1]. It has been early demonstrated that bio-gas production from crop residues is economically feasible on a farm-scale level (50-500 kW).

Aim of The Research

To use different approach in the optimization biogas production varying certain parameters.

Materials and Methods

Sample Collection and Analysis

The pig dung samples were collected from an individual piggery with empty buckets of 20 li-tre capacity. Batch culture anaerobic fermentation method was used. Bioreactors were fabricated with container of 20 liter capacity. Vehicle tubes were used for collection of gases. According to Maravi & Kumar (2020), two cellulose degrading bacteria were isolate from cow dungs. They were identified to molecular level. They were improved and used as inoculum in the fermentation process to ascertain their effect in biogas production.

Parameters of Optimization Used In The Batch Culture Fermentation

1. Substrate mixed with raw na_2co_3.
2. Substrate mixed with shigella flexneri.
3. Substrate mixed with bacillus paramycoides.
4. Substrate mixed with bovine blood.
5. Substrate mixed with protein or meat extract.
6. Substrate mixed with solution of charcoal water.
7. Substrate mixed with zinc nitrate.
8. Substrate mixed with water only (control).
9. Substrate mixed with mgso4 (hard water).
10. Substrate mixed with water of ph 8.

The different substrates as stated above were allowed to stay for 21 days in the fabricated bioreactors. The gases produced were measured daily using electronic digital weighing balance.

Results

After the hydraulic retention time of 21 days, the raw masses of the tubes were recorded. The masses of the gas produced were calculated from the raw data.

On the first day of te batch culture fermentation, all the reading gave 0g as there was no gas production. On the second day, the digester with $MgSO_4$ produced the gas of 24.3g followed by the one with bovine blood which recorded 19.9g. The substrate with $Zn(NO_3)_2$ recorded the lowest yield of 1.3g. This continued in this trend until at the retention time of 21 days. Biogas Yield at The 21st Day and Possible Reason

- Digester with Na_2CO_3 and the pH-8 produced the gas of 80g and 90g respectively this is due to the fact that alkaline pH favours biogas production. The pH inside a biodigester has been found to enhance upon ammonium chloride (NH_4Cl) addition. The inclusion of this buffering capacity to a particular feedstock was sustained at a pH within a favorable range for methanogenesis at 6.8-7.2 [2].

DATE	NO 1(g)	NO 2(g)	NO 3(g)	NO 4(g)	NO 5(g)	NO 6(g)	NO 7(g)	NO 8(g)	NO 9(g)	NO 10(g)
2/4/2024	420.00	420.00	420.00	670.10	421.00	420.00	420.00	420.00	419.70	420.00
3/4/2024	426.10	430.00	424.20	690.00	423.00	427.10	421.30	424.20	444.00	428.40
4/4/2024	428.10	434.20	428.10	702.30	429.20	430.30	422.10	429.00	461.10	431.50
5/4/2024	432.50	438.20	439.20	710.50	431.50	433.40	424.00	432.40	470.50	436.70
6/4/2024	460.30	447.50	448.10	721.70	447.00	440.10	424.50	452.10	488.00	445.10
7/4/2024	480.50	455.70	450.10	750.40	450.80	449.10	424.50	461.50	490.80	452.80
8/4/2024	486.90	478.30	455.50	757.80	455.60	453.80	424.60	472.00	497.20	459.40
9/4/2024	493.60	480.50	461.70	770.60	470.40	460.20	424.70	481.10	510.10	465.60
10/4/2024	494.10	487.20	476.30	778.60	473.50	465.30	424.50	487.90	517.00	468.50
11/4/2024	495.00	495.00	499.00	785.70	478.00	466.00	424.50	489.00	520.70	494.10
12/4/2024	498.00	498.00	510.00	795.20	479.90	467.10	424.50	495.00	523.40	495.00
13/4/2024	498.70	499.70	510.70	880.10	480.00	468.00	424.50	496.00	540.10	498.00
14/4/2024	499.10	499.80	510.90	890.00	480.00	468.40	424.50	497.10	549.00	498.70
15/4/2024	499.30	500.30	511.30	892.80	481.10	468.90	424.00	498.20	550.00	499.10
16/4/2024	500.20	503.20	512.20	891.90	483.00	469.00	423.50	499.00	550.40	499.30
17/4/2024	500.20	510.20	513.20	899.10	484.00	470.00	423.40	500.00	556.90	500.20
18/4/2024	500.10	515.10	515.10	901.40	484.00	477.20	423.40	500.00	556.90	500.20
19/4/2024	500.00	515.00	520.00	902.90	483.80	478.00	423.40	500.20	557.00	500.10
20/4/2024	500.00	515.00	520.00	902.00	483.82	478.00	423.40	500.20	556.10	510.00
21/4/2024	500.00	515.00	520.00	901.20	483.82	478.00	423.40	500.00	556.00	510.00

Table 1

DAY	with raw Na2CO3	with *shigella*	with *bacillus*	with bovine blood	With protein or meat	with solution of charcoal water	with zinc nitrate	with water only (control)	with mgso4 (hard water)	with water of ph 8.
1	0	0	0	0	0	0	0	0	0	0
2	6.1	10	4.2	19.9	2	7.1	1.3	4.2	24.3	8.4
3	8.1	14.2	8.1	32.2	8.2	10.3	2.1	9	41.4	11.5
4	12.5	18.2	19.2	40.4	10.5	13.4	4	12.4	50.8	16.7
5	40.3	27.5	28.1	51.6	26	20.1	4.5	32.1	68.3	25.1
6	60.5	35.7	30.1	80.3	29.8	29.1	4.5	41.5	71.1	32.8
7	66.9	58.3	35.5	87.7	34.6	33.8	4.6	52	77.5	39.4
8	73.6	60.5	41.7	100.5	49.4	40.2	4.7	61.1	90.4	45.6
9	74.1	67.2	56.3	108.5	52.5	45.3	4.5	67.9	97.3	48.5
10	75	75	79	115.6	57	46	4.5	69	101	74.1
11	78	78	90	125.1	58.9	47.1	4.5	75	103.7	75
12	78.7	79.7	90.7	210	59	48	4.5	76	120.4	78
13	79.1	79.8	90.9	219.9	59	48.4	4.5	77.1	129.3	78.7
14	79.3	80.3	91.3	222.7	60.1	48.9	4	78.2	130.3	79.1
15	80.2	83.2	92.2	221.8	62	49	3.5	79	130.7	79.3
16	80.2	90.2	93.2	229	63	50	3.4	80	137.2	80.2
17	80.1	95.1	95.1	231.3	63	57.2	3.4	80	137.2	80.2
18	80	95	100	232.8	62.8	58	3.4	80.2	137.3	80.1
19	80	95	100	231.9	62.82	58	3.4	80.2	136.4	90
20	80	95	100	231.1	62.82	58	3.4	80	136.3	90
21	80	95	100	231.1	62.82	58	3.4	80	136.3	90

Table 2

Table 1&2: After the hydraulic retention time of 21 days, the raw masses of the tubes were recorded. The masses of the gas produced were calculated from the raw data.

Figure 1: Fabricated biodigesters and the agar slants containing the bacterial isolates

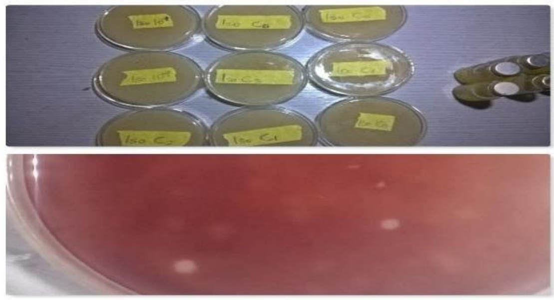

Figure 2: Plate ready for incubation and zone of clearing showing cellulosic ability

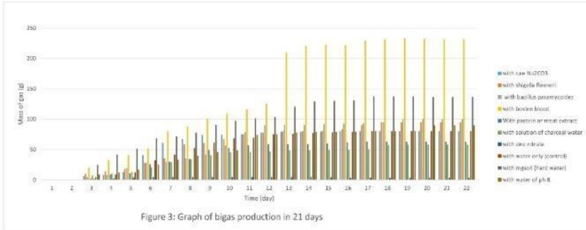

Figure 3: Graph of biogas production in 21 days.

Set up with Shigella flexneri and Bacillus paramycoides produced gas of masses 95g and 100g respectively. This shows that both are facultative anaerobes which can ferment sugar in absence of oxygen. The use of inoculum has been found to ensure a stable meth-anogenic community establishment in the shortest possible time of 5 to 10 days [3]. Up-on the addition of higher amounts of inoculum to a biodigester, more anaerobic microorganisms are addedleading to an increase in the biodegradation process.

- Set up with bovine blood gave the highest biogas yield of 231.1g. This is a result of bio-stimulation and high nutrient content of the blood. During anaerobic digestion, the micro-organisms need nutrients to produce optimum yield. Several nutrients including potassium, sodium, magnesium, calcium, iron, cadmium, chromium, nitrogen etc are re-quired for effective performance. Several scholars have reported that POME is rich in nutrients [4]. Bovine blood contains 80.9% water, 17.3% protein, 0.23% fat, 0.07% carbo-hydrate and 0.62% minerals.

- Set up with $MgSO_4$ gave the second to the highest yield of 136.3g. This was reported by [5] that calculated and measured amounts of Calcium or Magnesium Sulphate will enhance biogas production.

- Set up with $Zn(NO_3)_2$ gave the lowest yield of 3.4g. This is due to formation of am-monia during reaction with water.

$Zn(NO_3)_2 + H_2O$ ------------ $ZnO + NH_3$

The proportion of Free Ammonia (FA) is of importance, as FA has been suggested as the main cause of inhibition. Findings from several studies [6] indicated that methane fer-mentation of high ammonia-containing wastes is more prone to inhibition at thermo-philic temperatures than at mesophilic tem-peratures, supporting the view that it is the free ammonia which causes toxicity.

Conclusion and Recommendation

At the end of hydraulic retention time of 21days, substrate with sodium carbonate gave 80g, shigella flexneri gave 95g while the one with Bacillus parmycoides gave 100g. the one with bovine blood gave 231.1g and that with zinc nitrate gave the lowest of 3.4g. This correspond to work done by [7-8].

This research work recommends as follows

i. Bovine blood should be used in biogas optimization.

ii. Measured amount of magnesium sulphate should be used in biogas optimization.

iii. Shigella flexneri and Bacillus paramycoides should be isolated, improved and used as inoculum to help the in-digenous anaerobes.

iv. The pH should be maintained at alkaline range.

Contribution to Knowledge

1. Use and addition of cow blood which is nutrient-rich should be adopted in biogas optimization

2. Magnesium and calcium sulphate which can lead to water hardness have the ability to catalyse the reactions leading to biogas pro-duction.

Acknowledgement

The authors are grateful to the journal for publishing this work.

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