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Alternative Sources of Fuel: Biogas from Chicken and Pig Dung -A Comparative Approach

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Abstract

This study investigated the biogas production potential of chicken dung and pig dung, individually and in combination, under anaerobic digestion conditions with and without the use of a yeast catalyst as control. The results revealed that chicken dung, especially when treated with yeast, consistently produced higher biogas yields than pig dung, with a peak of 0.2250 g on Day 7, compared to 0.1375 g from pig dung. The superior performance of chicken dung is attributed to its higher nitrogen content and lower fiber composition, which promoted faster microbial digestion. Co-digestion of both wastes resulted in the highest cumulative gas output of 0.2013 g on the 7th day, thus demonstrating the effectiveness of combining substrates with complementary characteristics. The addition of yeast catalyst significantly enhanced biogas yields across treatments, while untreated and low-quantity mixtures exhibited poor and delayed gas production. The study concludes that chicken dung is a more efficient substrate for biogas generation. It recommends the use of catalysts, proper waste preparation, and farmer education as key strategies for improving rural biogas systems.

Key words: Anaerobic digestion, Biogas, Catalyst, chichen dung, Pig dung, Organic residues.

Introduction

The rapid growth of urban populations has led to increased waste generation and heightened concerns about sustainable energy alternatives. Biogas production through anaerobic digestion has gained global attention as a viable technology for converting organic waste into renewable energy while reducing environmental pollution [1]. Among various substrates, chicken dung and pig dung have been identified as promising feedstock's due to their availability and biodegradability [2].

Chicken dung, which constitutes a major fraction of municipal solid waste, poses serious environmental challenges when mismanaged, as it releases methane, a greenhouse gas with a global warming potential far higher than carbon dioxide [3,4]. Anaerobic digestion not only reduces this emission but also produces biogas for energy and digestate for organic fertilizer [5,6]. Similarly, pig dung, widely available in livestock-rearing communities, offers a relatively balanced carbon-to-nitrogen ratio and stable composition that support efficient digestion and predictable gas yields [7]. Its utilization in biogas systems also addresses rural waste management issues and enhances sustainability.

Although both substrates present benefits, challenges such as the heterogeneity of chicken dung and the relatively lower volatile solids content of pig dung create uncertainties about their efficiency as single substrates [8]. Comparative research is growing in recent time and help in the identification of the optimal substrate or combination for biogas production. Therefore, this study investigates the individual and combined performance of chicken dung and pig dung in order to determine their potential for maximizing methane yield, ensuring process stability, and enhancing economic and environmental sustainability [9].

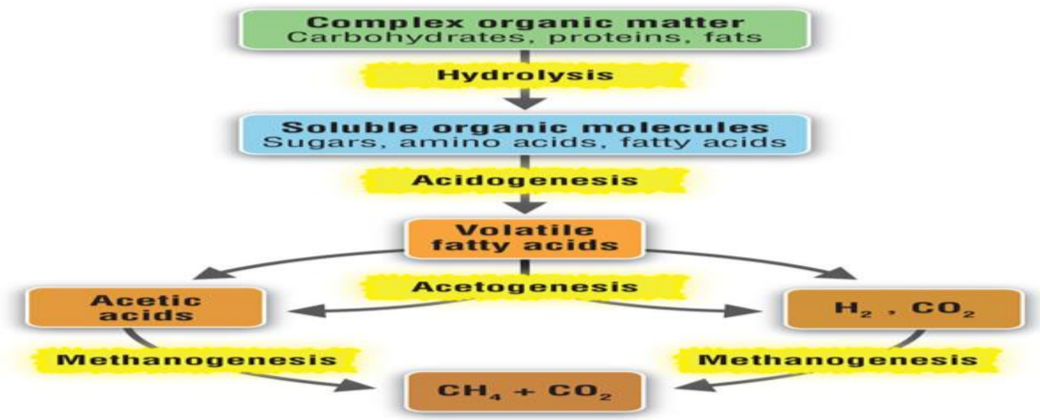

Figure 1: Stages in Anaerobic process.

2.0 Material and Method

2.1 Sample Preparation

The Chicken dung was air-dried, for 3–5 days to reduce excess moisture and then crushed to achieve uniform texture.

Pig dung was air-dried for 3–5 days to reduce excess moisture and then crushed to achieve uniform texture.

Each substrate was mixed with distilled water in a ratio sufficient to form a slurry.

For the co-digestion experiment, Chicken dung and Pig dung were blended in measured ratios to determine their combined effect on biogas yield.

2.2 Experimental Procedure

Four gram each of the prepared samples was weighed and transferred into five separate digesters (250 ml). Next, 0.18 g of baking yeast (fungi) and 25 ml of distilled water was added into the bio-digesters. Two of the digester (composite A and B with 4 g and 6 g respectively) served as control without baking yeast. The other three digesters (chicken, pig dung and mixture of chicken dung and pig dung) had baking yeast of 0.18 g. The content in the digesters were thoroughly blended with the aid of stirrer and corked with glass tubing projecting from the cork. The other end of the glass tubing was also fixed to rubber tubing connecting 250 volumetric flask which also was connected by delivery tubes under water into water filled 250 ml measuring cylinders in an inverted position. The digesters were placed in a thermostatic water bath at ambient mesophilic temperature (33–34°C). The reading of biogas produced was recorded every 24 hours from the measuring cylinders (where there was water displacement) for seven days.

Fig 2. Biogas set-up

3. Results and Discussion

3.1 Table 1: Biogas Production Data

Day	Chicken Dung (cm^3)	Pig Dung (cm^3)	Chicken Dung + Pig Dung (cm^3)	Composite A	Composite B
1	44	37	58	40	32
2	121	79	66	40	32
3	156	100	88	48	40
4	158	104	104	48	40
5	160	104	120	48	60
6	165	110	145	48	60
7	180	110	193	98	65

Key: Composite A = 6 Grams (g) (without catalyst)   Composite B = 4 Grams (g) (without catalyst)

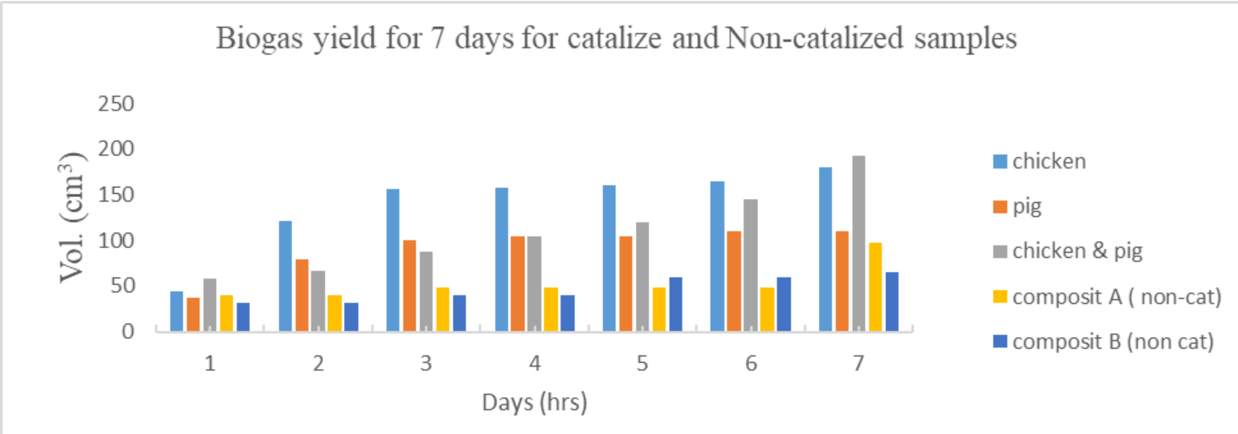

Fig 3 Biogas yield for Catalyzed and Non-catalyzed samples

Table 2: Biogas Production Data in Grams

Day	Chicken Dung **(g)**	Pig Dung (g)	Chicken + Pig (g)	Composite A (g)	Composite B (g)
1	0.0550	0.0463	0.0725	0.0500	0.0400
2	0.1513	0.0988	0.0825	0.0500	0.0400
3	0.1950	0.1250	0.1100	0.0600	0.0500
4	0.1975	0.1300	0.1300	0.0600	0.0500
5	0.2000	0.1300	0.1500	0.0600	0.0750
6	0.2063	0.1375	0.1688	0.0600	0.0750
7	0.2250	0.1375	0.2413	0.1225	0.0813

Table 3: Comparison of the biogas yield of maize cobs and cow dung through Anaerobic digestion

Substrate	**Total Biogas Yield (g)**
Pig dung	0.1375
Chicken dung	0.2250

4.2 Discussion of Results

Table 2 presents the daily biogas yields (in grams) from five organic substrate treatments for seven days anaerobic digestion period. The treatment includes; chicken dung, pig dung, a mixture of chicken and pig dung all treated with yeast catalyst and two composite samples

(Composite A and Composite B), which were digested without the use of catalyst.

Chicken dung, treated with catalyst, demonstrated a gradual and consistent increase in biogas production, starting at 0.0550 g on Day 1 and rising steadily to 0.2250 g by Day 7. This progressive trend suggests efficient microbial digestion supported by the catalyst, which likely enhanced microbial activity and enzyme production. Chicken dung's relatively high nitrogen content also provides favorable conditions for microbial growth [10]

Pig dung, also with catalyst, produced biogas consistently but at slightly lower yields than chicken dung. It increased from 0.0463 g on Day 1 to 0.1375 g on Day 7. The lower yield may be attributed to higher fiber or lignin content, making pig dung more resistant to microbial degradation. However, the presence of catalyst still enabled steady gas production, confirming pig dung's usefulness as a substrate when aided by catalytic enhancement [10].

The mixture of chicken and pig dung, with catalyst, showed the highest overall biogas yield. It rose from 0.0725 g on Day 1 to 0.2125 g by Day 7. This indicates a synergistic effect—chicken dung contributed microbial populations and nitrogen, while pig dung supplied additional organic matter. The catalyst likely amplified this synergy by accelerating substrate hydrolysis and fermentation. This supports earlier findings that co-digestion with complementary substrates and catalysts can significantly improve biogas output [8].

Composite A, a 6-gram blend of several organic materials without yeast catalyst, started at 0.0500 g on Day 1 and remained nearly constant (0.0600 g) from Days 3 to 6, before increasing sharply to 0.1225 g on Day 7. The lag in early gas production likely reflects microbial adaptation to the diverse and complex substrate mixture. The absence of catalyst delayed microbial efficiency, resulting in a slower digestion process. The late surge on Day 7 may indicate that microbes eventually acclimated and began breaking down the materials more effectively [10].

Composite B, also without catalyst and containing a lower total mass, followed a slower, more limited yield trend. It began at 0.0400 g and rose gradually to only 0.0813 g by Day 7. Unlike Composite A, it showed no sharp increase at the end, likely due to both reduced substrate quantity and the lack of catalyst. This indicates that small input volumes, when combined with the absence of catalyst, severely limit microbial performance and gas output [10].

Comparatively, the treatments with yeast catalyst (chicken dung, pig dung, and their mixture) demonstrated significantly higher and more consistent gas yields than the non-catalyzed composites, highlighting the catalytic role in enhancing microbial breakdown, accelerating digestion phases, and increasing biogas production. This aligns with findings by Ming et al. [10] and Mohamed et al. [9] who emphasized that catalysts substantially improve the efficiency and speed of anaerobic digestion.

Table 3 presents the total biogas yields obtained from chicken dung and pig dung over a seven-day anaerobic digestion period. The data reveal that chicken dung produced a higher yield of 0.2250 g, while pig dung yielded 0.1375 g. This indicates that chicken dung is more effective than pig dung in generating biogas under the conditions of this experiment. The higher performance of chicken dung may be due to its lower fiber content and higher nutrient availability, especially nitrogen, which enhances microbial growth and accelerates the digestion process. Chicken waste is generally rich in uric acid and other nitrogenous compounds, making it a favorable substrate for rapid microbial conversion during anaerobic digestion [11,12]. Moreover, the presence of a yeast catalyst likely further stimulated microbial activity, but the inherent qualities of chicken dung made it more reactive and efficient. On the other hand, pig dung yielded less biogas, which may be attributed to its higher fiber and lignin content and greater variability in composition. These characteristics reduce its biodegradability and slow down the digestion rate [8]. The results are consistent with findings by Mohamed et al [9], who observed that pig manure tends to have slower degradation rates and lower methane potential than poultry waste unless subjected to additional pretreatment methods.

This comparative outcome supports the conclusions of research by Ojo, O. M and Living et al [8,13], who emphasized the importance of substrate characteristics such as C/N ratio, moisture content, and biodegradability in determining the efficiency of biogas production. The significantly higher yield from chicken dung in this study underscores its potential as a preferred feedstock for biogas generation, particularly in agricultural regions where poultry farming is common.

Conclusion

The study concludes that chicken dung is a more effective substrate than pig dung for biogas production under catalyzed anaerobic digestion. It provides a higher yield due to its favorable composition, particularly its higher nitrogen content and lower fiber content. While pig dung has biogas potential, it performs less efficiently unless pretreated or combined with other substrates. The co-digestion of chicken and pig dung produced the best results, affirming that mixing waste types with complementary properties enhances overall biogas output. Additionally, the presence of a catalyst (yeast) proved essential in accelerating microbial activity, improving substrate breakdown, and significantly boosting gas production. Thus, the electrification of our rural settlements can be achieved by setting up biogas plant through funding by Government and internation bodies like world Bank. This will certainly stop migration from rural areas to the cities due to electricity. This will attract development in the rural areas, burst commercial activities and attract different investment that will make positve impart the people. The heavy depenance on cooking gas will drop and deforestation by villegers in search of fire wood for cooking will also cease because biogas can be use for same purpose. This will also enhance proper waste management and a healthy environment since the digestate is eco-friendly and can be used as fertilizer, animal bedding and soil amendment which improves soil quality and structure.

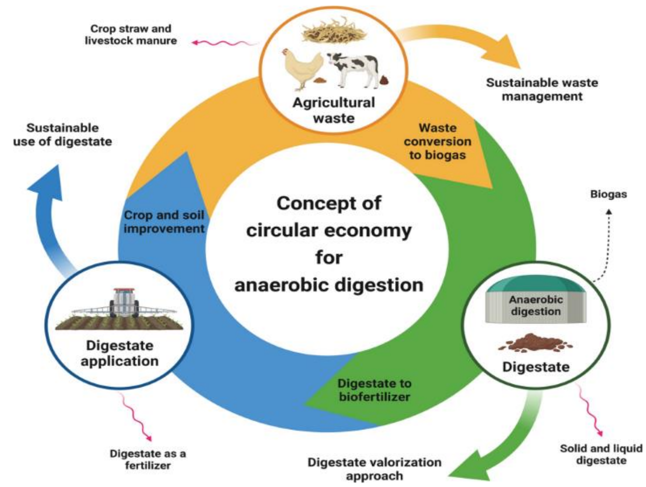

Fig 4: Benefit of Digestate

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