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# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 14 **Issue:** III **Month of publication:** March 2026

**DOI:** https://doi.org/10.22214/ijraset.2026.78316

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 14 Issue III Mar 2026- Available at www.ijraset.com*

# Production of Biogas from Press Mud, Cow Dung and Water Hyacinth

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***Abstract:*** ***This project focuses on the production of biogas from press mud, cow dung, and water hyacinth using an anaerobic batch reactor. Biogas production through anaerobic digestion is an effective method of converting organic waste into a renewable and eco-friendly energy source. Press mud, a by-product of the sugar industry, along with cow dung and water hyacinth, was selected as the substrate due to its high organic content and easy availability. Initially, an acclimatization process was carried out to allow microorganisms to adapt to the substrate mixture for efficient biogas production. Different ratios of press mud to water hyacinth (1:1, 1:2, 1:3, and 1.5:2.5) and cow dung to water hyacinth (1:1, 1:2, 1:3, and 1.5:2.5) were prepared and tested for a period of 42 days under anaerobic conditions.***
***Based on the results, the optimum ratios were identified as press mud to water hyacinth (1.5:2.5) and cow dung to water hyacinth (1:3), which produced higher biogas yield and better microbial activity.***
***Key words: Press mud, cow dung, water hyacinth, Biogas Measurement, Anaerobic batch reactors***

## I. INTRODUCTION

The worldwide energy crisis has directed attention toward alternative sources of energy instead of relying only on underground fossil fuels. Among these alternatives, biogas has become an important renewable energy source derived from plant-based organic materials that store solar energy through the process of photosynthesis. Anaerobic digestion is considered a waste-to-energy technology and is widely used for the treatment and management of various types of organic wastes. Examples include the organic fraction of municipal solid waste, sewage sludge, food waste, and animal manure. During the digestion process, different gases are produced such as methane, carbon dioxide, hydrogen sulfide, and small amounts of ammonium compounds. These processes are usually carried out under mesophilic digestion conditions, typically maintained between 20°C and 35°C. Several important parameters are measured during the process to evaluate system performance, including pH, total solids (TS), volatile dissolved solids (VDS), total suspended solids (TSS), electrical conductivity (EC), chemical oxygen demand (COD), and biological oxygen demand (BOD). Biogas is produced by microorganisms that break down organic materials in the absence of oxygen, a process known as anaerobic digestion. This digestion process mainly consists of three stages: hydrolysis, acid formation (acidogenesis), and biogas formation (methanogenesis), which together convert organic matter into useful biogas energy.

## II. LITERATURE REVIEW

Biogas production through anaerobic digestion has been widely studied as an effective method for converting organic wastes into renewable energy. According to Angelidaki Irini et al. (2003), anaerobic digestion is an efficient biological process in which microorganisms break down organic materials in the absence of oxygen to produce methane-rich biogas. Agricultural and industrial wastes such as animal manure, crop residues, and organic sludge are commonly used as substrates for this process.
Several researchers have investigated the use of cow dung as an effective inoculum in biogas production. R. K. Singh et al. (2010) reported that cow dung contains a large population of anaerobic bacteria that enhance the digestion process and increase methane yield. The co-digestion of different organic wastes also improves the stability and efficiency of biogas production.
Press mud, a by-product of the sugar industry, has also been identified as a suitable substrate for biogas generation due to its high organic content. R. K. Budiyono et al. (2014) found that press mud can significantly enhance methane production when mixed with other organic substrates. Water hyacinth is another potential biomass used in anaerobic digestion. According to S. Abbasi et al. (2012), water hyacinth contains large amounts of cellulose and hemicellulose, which can be converted into biogas through microbial degradation. Co-digestion of water hyacinth with animal manure improves nutrient balance and enhances gas production. Therefore, the combination of press mud, cow dung, and water hyacinth can improve the efficiency of anaerobic digestion and increase overall biogas yield.

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## III. MATERIALS AND THEIR PROPERTIES

The materials used for the anaerobic digestion process include press mud, cow dung, and water hyacinth. These materials were selected because of their high organic content and their ability to support microbial activity during biogas production.

Press mud slurry is obtained by mixing press mud with water to form a semi-liquid mixture suitable for anaerobic digestion. It contains a high amount of organic matter and nutrients that support microbial activity. The slurry form helps in easy handling, uniform mixing, and efficient decomposition during the digestion process. This improves the breakdown of organic materials and enhances biogas production.

Cow dung is commonly used in biogas production as it contains a large population of anaerobic microorganisms that aid in the breakdown of organic matter. It acts as an inoculum and helps to initiate and stabilize the anaerobic digestion process. Cow dung also provides essential nutrients and maintains favorable conditions for microbial growth.

Water hyacinth is an aquatic plant that grows rapidly in water bodies and often causes environmental problems due to its excessive growth. However, it contains a significant amount of cellulose, hemicellulose, and organic matter, making it suitable for biogas generation. When combined with other substrates such as press mud and cow dung, water hyacinth improves the digestion efficiency and enhances overall biogas production.



Fig 1: Press mud, Cow dung, Water hyacinth

## IV. MIXTURE PROCESS

The process begins with the collection of raw materials such as press mud, cow dung, and water hyacinth. These materials are properly cleaned and prepared before use. Water is then added and the materials are mixed thoroughly to form a uniform slurry. The prepared mixture is fed into an anaerobic digestion tank. Inside the tank, the organic materials undergo anaerobic digestion in the absence of oxygen. Microorganisms break down the organic matter during this process. As a result, biogas is produced as the main energy product. Along with biogas, sludge is also formed as a by-product of digestion. The produced biogas can be utilized as a renewable energy source for cooking, heating, or electricity generation. The remaining sludge can be used as a nutrient-rich organic fertilizer for agricultural purposes.

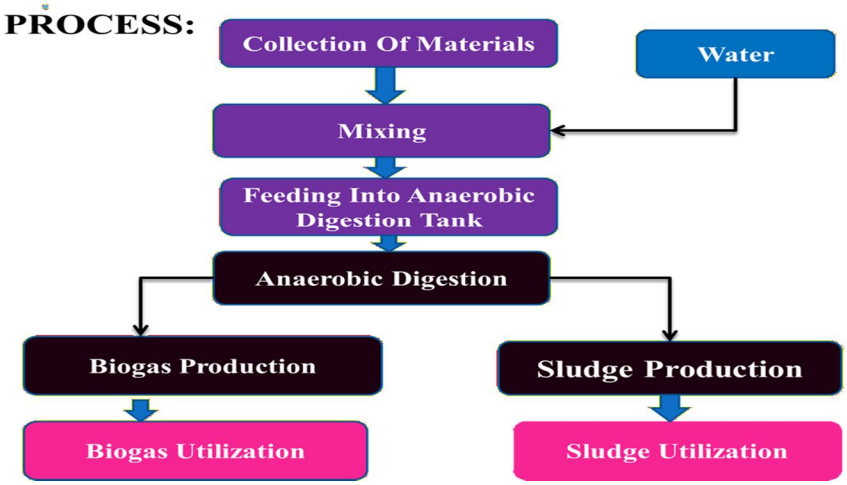



Fig 2: Process of Mixing

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## V. METHODOLOGY

*1)* Press mud and cow dung: Press mud was obtained from the sugar mill, and cow dung in a wet condition. The water is added to 1:1 ratio. Then continuously mixed and stored into the anaerobic batch reactor.



Fig 3: Press Mud and Cow Dung

*2)* Water hyacinth plant: Water hyacinth plant was obtained from the oxidation pond .it is stored into the anaerobic batch reactor. Then water is added same 1:1 ratio.



Fig 4: Pieces of water hyacinth plant

*3)* Biogas Measurement: The biogas generation during the batch mode operation was measured downward displacement of water.Mesured by unit of ml/day using “water displacement method.

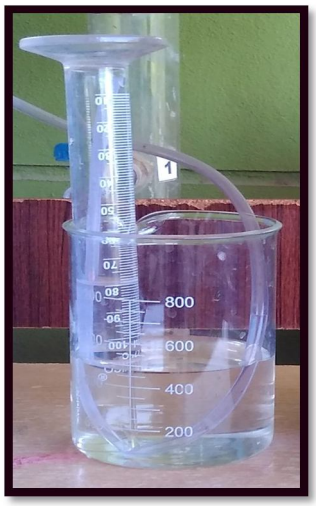



Fig :5 Water Displacing Method

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## VI. EXPERIMENTAL INVESTIGATIONS

The experimental investigation was carried out to study the production of biogas using different ratios of press mud (PM) and water hyacinth (WH) in an anaerobic digestion system. The substrates were first collected and prepared by cutting and mixing them properly to obtain a uniform slurry. Water was added to maintain the required moisture content for effective digestion.

In the experiment, different ratios such as 1:1 and 1:2 of press mud to water hyacinth were prepared and fed into separate anaerobic digestion containers. The digesters were tightly closed to maintain oxygen-free conditions necessary for anaerobic microbial activity. The generated biogas was collected using a gas collection system connected to measuring cylinders placed in water-filled containers.The digestion process was carried out under mesophilic temperature conditions, and the reactors were monitored regularly. Important parameters such as pH, gas production, and stability of digestion were observed throughout the experimental period. The volume of biogas produced from each reactor was measured daily to determine the efficiency of different substrate ratios.he experimental results helped in identifying the suitable ratio of substrates for higher biogas production and effective anaerobic digestion.

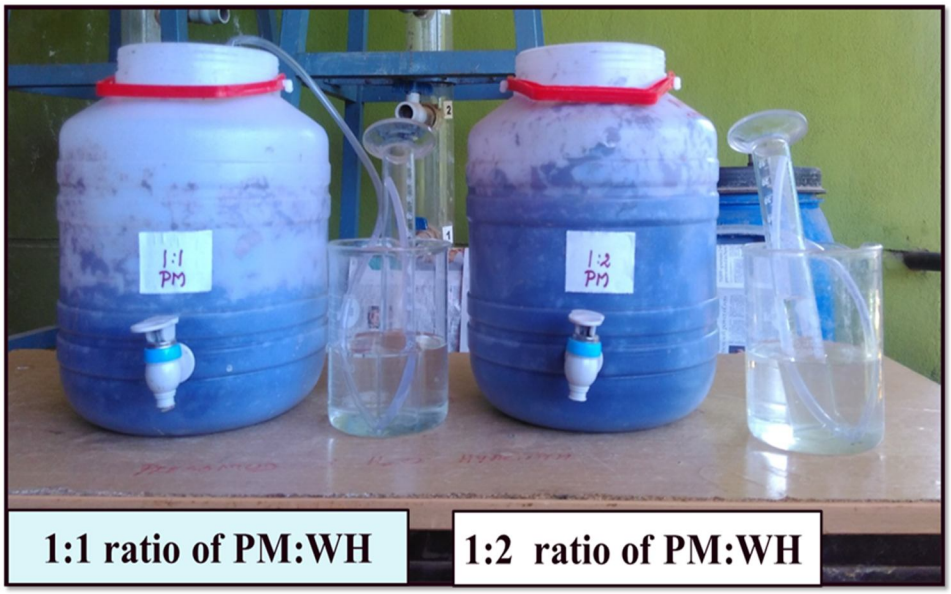



Fig6: Anaerobic batch reactors: (1:1) and (1:2) ratio of (Press mud: water hyacinth)

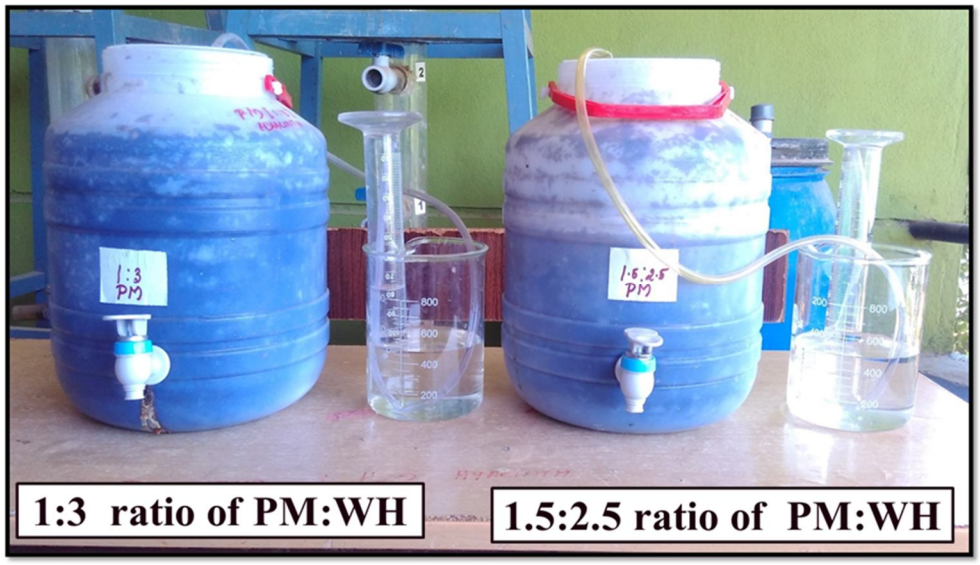



Fig :7 Anaerobic batch reactors : (1:3) and (1.5:2.5) ratio of (Press mud: water hyacinth)

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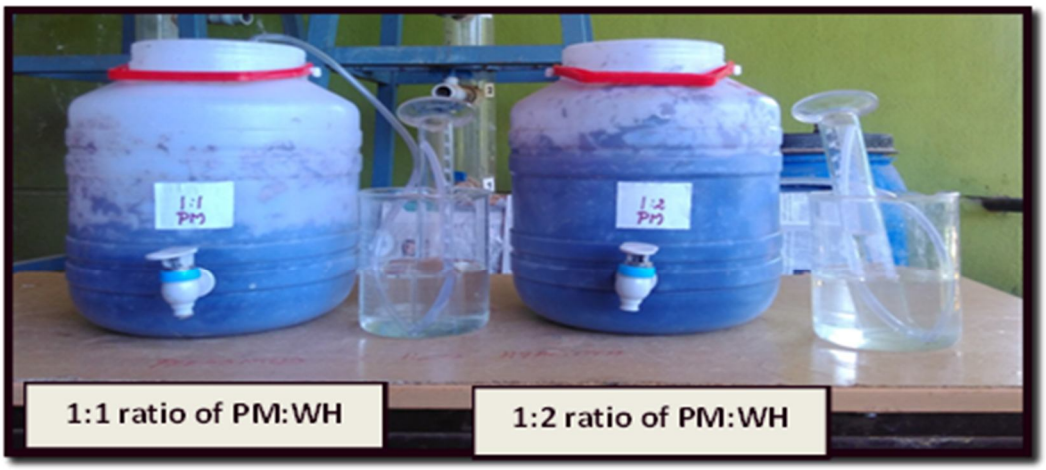



Fig 8: Anaerobic batch reactors : (1:1) and (1:2) ratio of (Cow dung: water hyacinth)

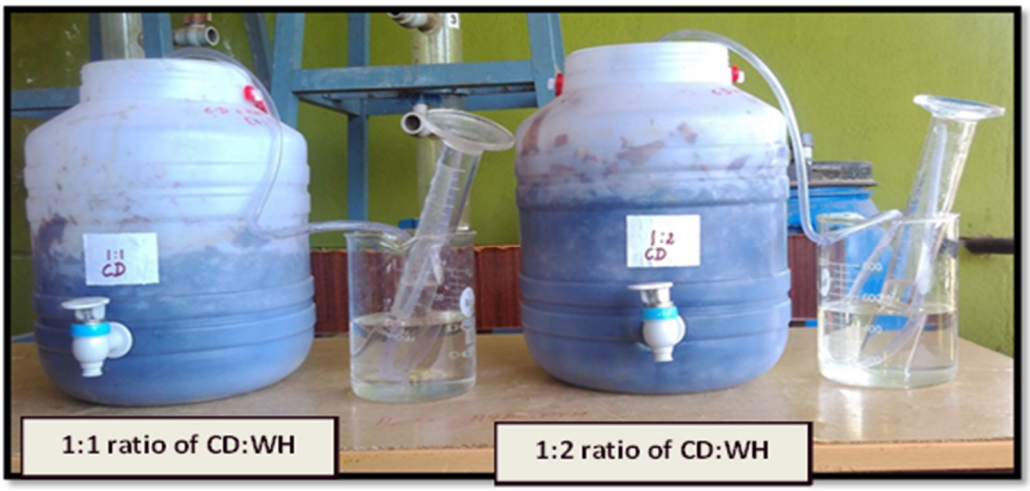



Fig 9: Anaerobic batch reactors: (1:1) and (1:2) ratio of (Cow dung: water hyacinth)

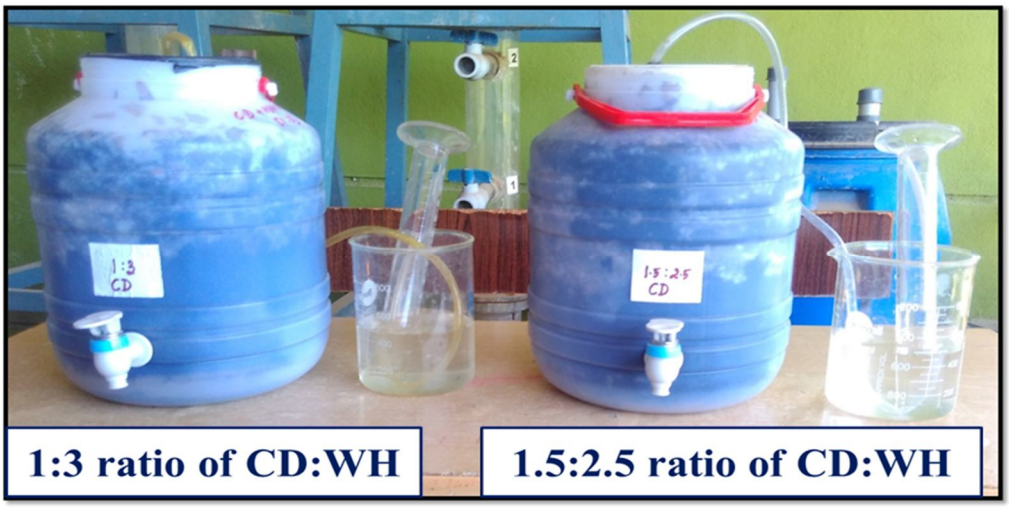



Fig :10 Anaerobic batch reactors: (1:3) and (1.5:2.5) ratio of (Cow dung: water hyacinth)

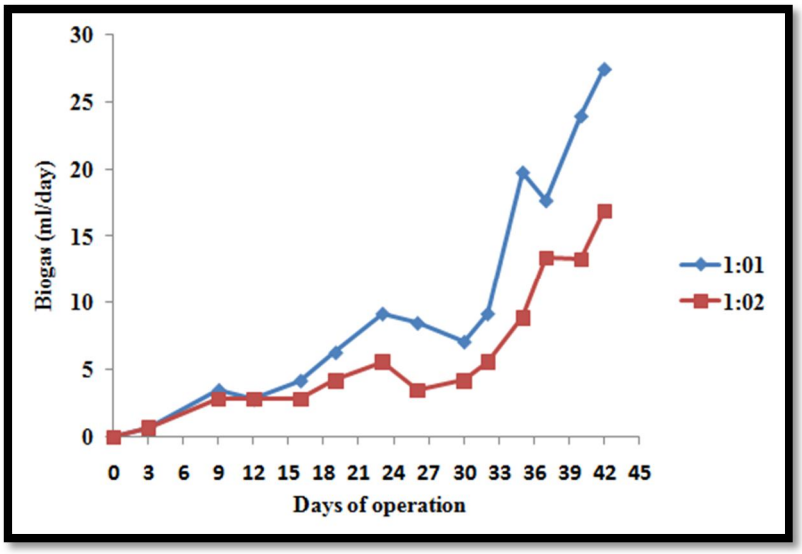
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## VII. RESULTS AND DISCUSSION

The experimental results of press mud with water hyacinth (press mud: water hyacinth) and cow dung with water hyacinth plant for different (cow dung: water hyacinth plant) ratios under batch mode operations are presented.

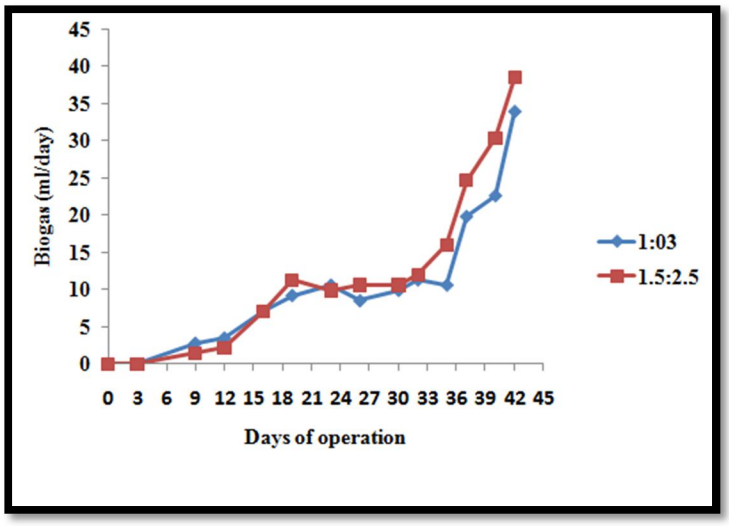
As explained in chapter the results of acclimatization using various ratios of press mud: water hyacinth and cow dung: water hyacinth plant was presented and interpreted for determining optimum ratio in terms of monitoring parameter as explained below.

The graph shows the biogas production for the ratios of press mud to water hyacinth (1:1) and (1:2) over 42 days of operation. Initially, the gas production was low in both reactors due to the acclimatization of microorganisms. As the digestion process progressed, biogas production gradually increased. The 1:1 ratio produced a higher amount of biogas compared to the 1:2 ratio throughout most of the experimental period. By the end of the experiment, the 1:1 ratio showed the highest biogas yield, indicating better substrate utilization and microbial activity.



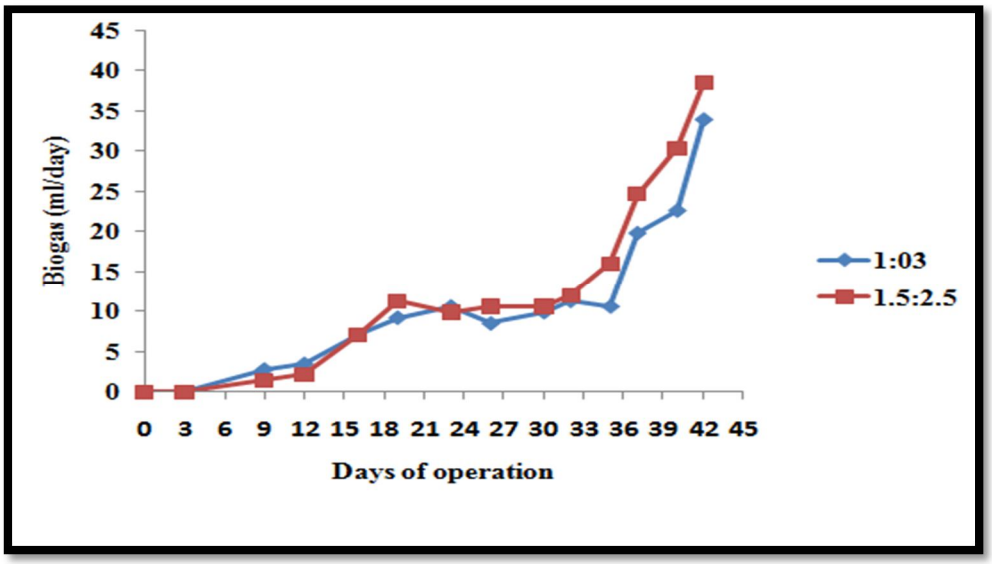

Variation of Biogas during acclimatization –PM:WH-250 ml of PM is added

The graph shows the biogas production for the ratios of press mud to water hyacinth (1:3) and (1.5:2.5) over a period of 42 days. In the initial days, biogas production was low due to the acclimatization of microorganisms in the digestion system. As the digestion process progressed, the biogas yield gradually increased in both ratios. The ratio of 1.5:2.5 produced higher biogas compared to the 1:3 ratio during the later stages of the experiment. By the end of the operation, the 1.5:2.5 ratio showed the maximum biogas production, indicating better substrate composition and microbial activity.

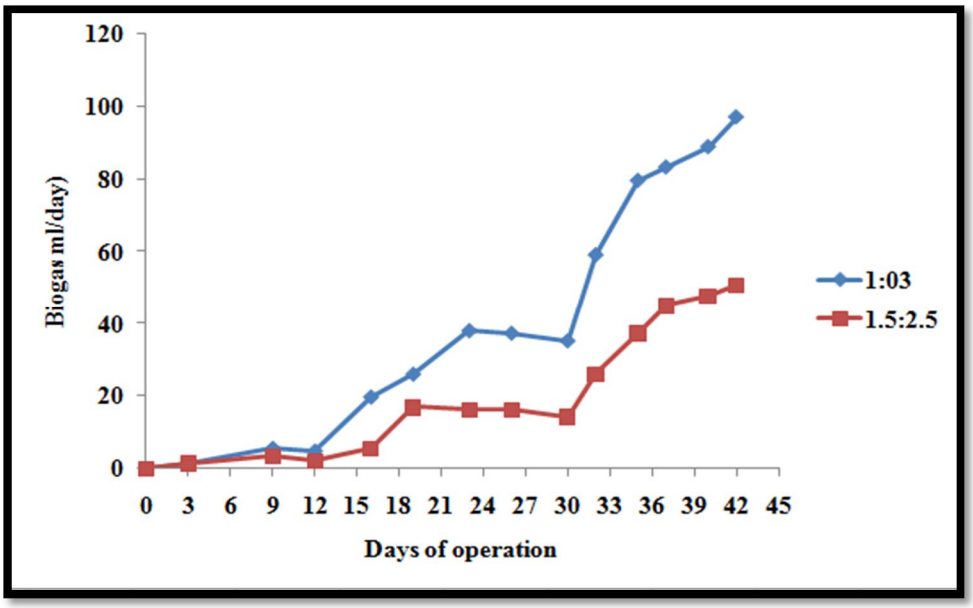



Variation of Biogas during acclimatization –PM:WH -250 ml of PM is added

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Variation of Biogas during acclimatization –PM: WH-250 ml of CD is added




Variation of Biogas during acclimatization –PM:WH- 250 ml of CD is added

Monitering Parameter

| S.NO | MONITORING PARAMETER | PM : WH 1.5 :2.5 on last day | C D: WH 1:3 On last day |
|---|---|---|---|
| 1 | Total solids(mg/l) | 102200 | 202600 |
| 2 | Total dissolved solids(mg/l) | 36600 | 212200 |
| 3 | Total suspended solids(mg/l) | 102200 | 1500 |
| 4 | Biogas production(mg/day) | 38.5 | 97.3 |
| 5 | pH | 5.71 | 6.24 |
| 6 | Electrical conductivity $x10^3$ Ms/cm | 1.43 | 1.18 |
| 7 | Chemical oxygen demand(mg/l) | 44360 | 8300 |
| 8 | Biochemical oxygen demand(mg/l) | 112 | 104 |

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## VIII. ADVANTAGES OF BIOGAS ENERGY

Biogas production helps in eliminating greenhouse gas emissions and contributes to environmental protection. It also reduces unpleasant odors that are commonly associated with organic waste. The process improves the quality of organic fertilizer produced from the digested slurry. Biogas is a renewable and sustainable source of energy that reduces dependence on fossil fuels. In addition, it helps reduce landfill waste and minimizes soil and water pollution, making it a clean and non-polluting technology.

## IX. DISADVANTAGES OF BIOGAS ENERGY

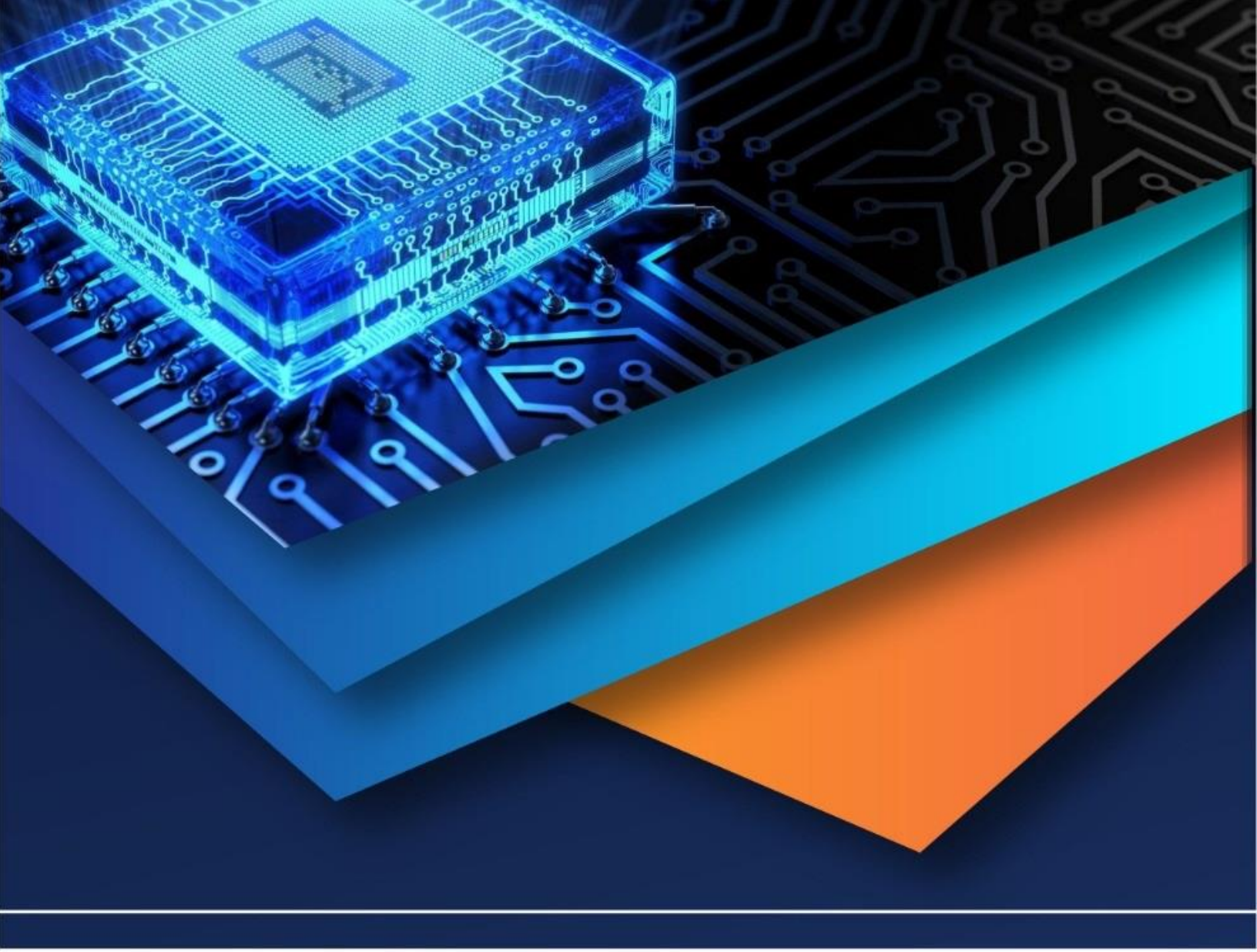
Biogas contains several impurities even after refining, which can affect its quality and efficiency. When used as a fuel, these impurities may cause corrosion in metal parts of engines and equipment. Another limitation is that biogas production can sometimes be unstable due to variations in the digestion process. Methane, the main component of biogas, is highly flammable and can become hazardous if it comes into contact with oxygen. Therefore, proper handling, storage, and safety measures are necessary during biogas production and utilization.

## X. CONCLUSIONS

The study examined the effect of different ratios of cow dung, press mud, and water hyacinth on acclimatization and biogas production using an anaerobic digestion system. The results showed that the inoculum to substrate ratio of cow dung and water hyacinth (1:3) produced better biogas yield. Similarly, the press mud to water hyacinth ratio of 1.5:2.5 was found to be the most effective for biogas production. The biogas generation from press mud and water hyacinth (1.5:2.5) was about 38.5 ml/day. In comparison, cow dung and water hyacinth (1:3) produced a higher biogas yield of about 97.3 ml/day.

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