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Biogas Production from Different Ratios of Kitchen Waste and Mustard Cake

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ABSTRACT: Production of Biogas produced from different ratios of Kitchen Waste and Mustard Cake was conducted. The experiment included mixing of Kitchen Waste and Mustard Cake in three different ratios of 3:1, 1:3 and 1:1 diluted with some amount of water. The ratios were taken in three different digesters namely A, B and C. Digester A consisted of 75g of Kitchen Waste, 25g of Mustard Cake and 150mL of water. Digester B consisted of 50g of Kitchen Waste, 50g of Mustard Cake and 150mL of water. Digester C consisted of 25g of Kitchen Waste, 75g of Mustard Cake and 150 mL of water. The Biogas production was measured for a period of 15 days and the volume of gas produced was determined by water displacement method at different temperatures. The Biogas production started on the very first day of the experiment and reached apex on the same day for all the three digesters. For digester A, production of Biogas stopped on the 13th day, for digester B, the production of Biogas stopped on the 10th day and for digester C, the production of Biogas continued till 15th day. The total gas production for digesters A, B and C were 141.7ml, 268.9ml and 457.9ml respectively. The study showed that largest production of Biogas was obtained with digester C with ratio 1:3 and the minimum production was in digester A having ratio 3:1. Hence, wastes can be productively utilised and effectively managed through conversion into Biogas.

KEYWORDS: Biogas, Digester, Kitchen Waste, Ratio, Mustard Cake, Temperatures.

I. INTRODUCTION

Biogas is a type of biofuel that is naturally produced from the decomposition of the organic wastes. When organic matter, like food scraps and animal waste, break down in an anaerobic environment (i.e., an environment not containing oxygen) they release a mixture of gases, primarily methane and carbon dioxide. As this decomposition takes place in an anaerobic environment, the process of producing biogas is also called as [anaerobic digestion](#). Anaerobic digestion is simply a natural form of waste-to-energy, that includes the process of fermentation to breakdown the organic matter. Animal manure, wastewater, food scraps and sewage are all examples of organic matter that can be used to produce Biogas by anaerobic digestion. Due to the high content of methane gas in Biogas (typically 50-75%), Biogas is flammable and hence produces a deep blue flame and can be used as an energy source like for cooking and even generating electricity.

Biogas is produced in Biogas digesters. These digesters are the systems that process waste into Biogas and then channel that Biogas so that the energy can be productively used for different purposes.

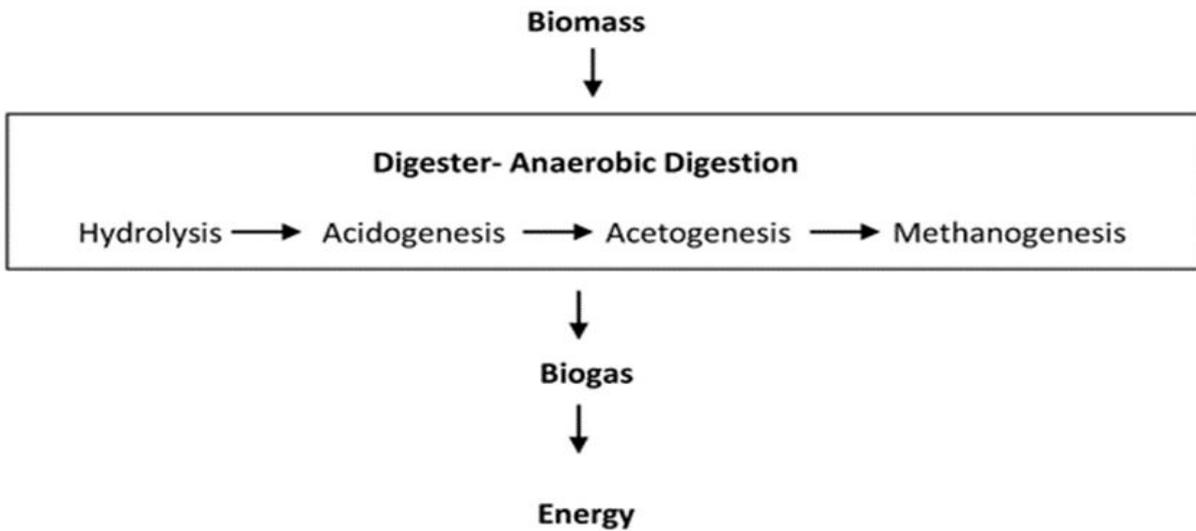


Fig 1. Biogas Flowchart

There are various types of Biogas systems and plants that have been designed to make efficient use of Biogas. While each type of biogas plant differs depending on input, output, size and type, the biological process that converts organic waste into biogas is uniform. Organic wastes are dumped into the Biogas digester, which decompose in a digestion chamber. The digester should be in such a way so that no oxygen should be present inside i.e. anaerobic environment should be present. For creating such environment, the digester should be either submerged fully in water or the biomass should be mixed with water in different ratios depending upon the type of biomass that is used. The anaerobic environment allows the microorganisms to break the organic material down and convert the waste into Biogas. Because the organic wastes are diluted into water to form a slurry, nutrients present in the waste dissolve into the water and hence create a nutrient-rich sludge, that is used as fertilizer for plants. This fertilizer is usually generated on daily basis and hence is a highly productive by-product of anaerobic digestion. It is estimated that by 2060, the fossil fuels might vanish from the surface of the earth if we keep using them at the current rate. So, there is a need to switch to a renewable and inexhaustible source of energy to fulfil our requirements and one such source is Biogas.

It will not only meet our needs but also help in providing a better environment by utilising the various kinds of waste products thereby cleaning our surroundings. Also, it doesn't contribute to air pollution as no greenhouse gas is emitted during its production.

II. RELATED WORKS

Ziana Ziauddin, Rajesh [1] published a research paper on "Production and Analysis of Biogas from Kitchen Waste" in International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 04, July-2015 in which they created an organic processing facility to create biogas using kitchen waste from canteens in Nehru College of Engineering and Research Centre, India which will be more cost effective, eco-friendly, cut-down on landfill waste, generate a high quality renewable fuel and reduce carbon monoxide and methane emissions. Orthevba, Onojitayoma [2] Published a research paper on "Production of Biogas from Different Ratios of Rice Husk and Kitchen Waste" in International Journal of Scientific & Engineering Research, Volume 6, Issue 10, October-2015, ISSN 2229-5518 in which different ratios of rice husk and kitchen waste were taken and the production of biogas was analysed and they concluded that mixing rice husk with kitchen waste generally increases biogas yield. Sera Sau, Manna T.K., ApurbaGiri and Nandi P.K. [3] did a research and an article was published on website: "www.researchgate.net" (January-2013) on "High Rate Methane Production from Mustard Oil Cake, Groundnut Cake and Rice water using Human Urine" in which they added different levels of human urine after predigesting MOC, GOC and RW separately and produced biogas and they concluded that due to improvement of C:N ratio biogas production increased. MOMOH, O.L. YUSUF; NWAOGAZIE, L. Ify [4] published a research paper on "Effect of Waste Paper on Biogas Production from Co-digestion of Cow Dung and Water Hyacinth in Batch Reactors" in Journal of Applied Sciences and Environmental management, December-2008, Volume 12 (4) 95-98, in which the effect of waste paper on biogas production from the co-digestion of fixed amount of cow dung and water hyacinth was studied at room temperature in five batch reactors for over 60 days and the effect of waste paper on fixed amount of cow dung and water hyacinth was found to increase biogas production in a parabolic manner. Emma Lindkvist [5], gave a thesis on "System studies of

biogas production- comparisons and performance”, Linköping Studies in Science and Technology, dissertation no. 2078. The aim of this thesis is to perform a systems analysis of biogas production systems and to explore how to analyse and compare biogas production systems.

III. MATERIALS AND METHODS

MATERIALS USED FOR THE EXPERIMENT ARE:

Mustard Cake and Kitchen Waste comprising of peelings of banana, onion, watermelon, potato and cucumber. The Mustard Cake was bought from Pulwama district, J&K.

A weighing balance was used to determine the weight of Kitchen Waste and Mustard Cake. 100g of Kitchen Waste and Mustard Cake were put in digester A,B and C with 150mL of water each to make slurry.

The whole experimental setup consisted of a digester bottle, an inverted measuring bottle kept in a large container filled with water and a pipe connecting them. The whole setup was made leak proof with the help of m-seal. The experimental setup was then monitored everyday and the readings were taken daily using water displacement method. The experiment lasted for 15 days and the total Biogas produced was determined on the 15th day i.e., at the end of the experiment.

3a. EXPERIMENTAL METHOD:

The experiment included loading of varied mix ratios of Kitchen Waste and Mustard Cake respectively diluted with 150mL of water. 75g of Kitchen Waste and 25g of Mustard Cake was mixed with water and loaded into digester A. 50g of Kitchen Waste and 50g of Mustard Cake mixed with water was loaded into digester B. 25g of Kitchen Waste and 75g of Mustard Cake mixed with water was loaded into digester C. Three digesters of the same design and size were taken for the experiment.

3b. PREPARATION OF SLURRY:

- The slurry was prepared by mixing 100g of Kitchen Waste and Mustard Cake with water in a ratio of 150g.
- The mixed slurry was transferred into a 350ml plastic bottle which was used as a digester.
- An opening was made on the top of the digester through which a pipe was inserted, and the sides were completely sealed using m-seal to prevent any gas leakage.



Fig 2. Biogas setup

IV. RESULTS AND DISCUSSIONS

4a. RESULTS

The results of the daily Biogas production at different temperatures for different ratios of Kitchen Waste and Mustard Cake is shown in the table below:

Days	Biogas production at different Ratios (kitchen waste:mustard cake) (ml)			Temperature (°C)	
	3:1 (A)	1:1 (B)	1:3 (C)	Min	Max
1.	90	188	288	19	33
2.	20	70	100	18	33
3.	11	7	25	18	34
4.	4.5	2.3	17	20	35
5.	0	1.4	9	19	34



6.	2	0	0	18	33
7.	0	0.1	0.2	17	28
8.	0	0	0.8	17	28
9.	0	0	7	17	28
10.	6	0	0.8	18	32
11.	3	0.1	3	18	33
12.	3	0	3	20	35
13.	2.2	0	2.2	20	35
14.	0	0	1.8	17	28
15.	0	0	0.1	19	28
Total	141.7	268.9	457.9		

4b. DISCUSSION OF RESULT

Digester C with the ratio 1:3 produced the highest gas amongst the three digesters on day one. It started from 0 and increased gradually to 288mL on day 1 which is the maximum gas produced in digester C and then it started to decrease moderately. Digester B with the ratio 1:1 produced less gas as compared to digester C on day one. It began from 0 and increased till 188mL and then dropped moderately. The maximum production of gas in digester B was 188mL obtained on the very first day. Digester A with the ratio 3:1 produced the least gas amongst the three digesters on day one producing 90mL of gas only. The maximum production obtained in digester A was 90mL only. The trend seen in the study shows that Biogas production first increases from 0 to a maximum value on day 1 and then starts decreasing after it has attained the maximum value. From the gas production inspection, the total volume of Biogas was highest in digester C which was 457.9mL followed by digester B which fabricated 268.9mL biogas and the digester A manufactured the least amount of Biogas which was 141.7mL only.

From the outcome procured it was seen that Mustard Cake produced more Biogas in comparison to Kitchen Waste. The observations and analysis obtained from the experiment are given in the table above. The table indicated that the volume of Biogas manufactured from Kitchen Waste and Mustard Cake and the simultaneous digestion of Kitchen Waste and Mustard Cake varies time and again.

The table above indicated that the Biogas production started from the very first day in all three digesters. The maximum peak for each digester occurred on the very first day at a temperature of 33°C. Nevertheless, it is observed that the digester C mixture produced the most notable maximum volume of biogas and the production was in the sequence: C>B>A.

V. FAILURE DURING WORK

In the first attempt, the gas produced was very high with respect to our measuring flask and also some amount of water was seen in the pipe connecting digester and the measuring flask resulting in the error of readings and disruption of the set up. So, to overcome these drawbacks, we replaced our small measuring flask with 1L measuring flask and hence we were able to record the correct readings.

VI. CONCLUSION

By mixing the pure sample of Kitchen Waste and Mustard Cake, the Biogas production increases. The utmost Biogas yield was obtained with the mix proportion 1:3. Hence, simultaneous digestion of Kitchen Waste and Mustard Cake can be used to overcome the problem of exhausting fuels. The mean gas production from the ratio's 3:1, 1:1 and 1:3 of Kitchen Waste and Mustard Cake were 9.44mL, 17.92mL and 30.52mL respectively. A ratio of 1:3 Kitchen Waste and Mustard Cake which is the composition of digester C gives the prime result out of the three digesters and this can be due to the presence of a large portion of Mustard Cake. Digester B with the ratio 1:1 also produces fair amount of Biogas while the digester A with ratio 3:1 gives the lowest amount of Biogas. Hence, it can be concluded that waste can be made useful through their proper disposal and utilisation i.e., converting the waste into Biogas, by mixing some particular substance to increase its production (exceptional), which in turn will provide the society with a good income and also could replace the rapidly diminishing fossil fuels.



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