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P: 2
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Abstract

The purpose of this project is to discover ways to produce energy with alternate sources. It is hypothesized that the cow manure will have a higher production of biogas with the eggs.

Different types of biomass: eggs, bananas, and horse manure were mixed with cow manure and water and then placed in empty soda bottles with a balloon secured onto the mouth with duct tape. No biomass served as a control.

In each of the soda bottles with the balloon, a production of methane was observed, blowing the balloon. In the horse and cow manure (test#1), trial #4 produced the most biogas. On the other hand, trial#1 had the least production of biogas. In the cow manure and bananas (test#2), there was a variation in the most, and least production. Finally, in the Cow manure and eggs (test#3), there was also a variation. At the end of the experiment, test#1 had produced the most biogas.

After the completion of these tests, the following conclusions were formulated. The horse manure has a higher impact on the bacteria-producing biogas.

Future experiments may change the types and amounts of biomass. Another type of biogas generator may be used under different environmental conditions. Other further research may also include the variation of animal manure used. Other liquids, rather than water, may be used to see if there is an effect of the production of biogas, and to see if the Ph of the substances used kill or help the growth of the biogas-producing gases. (Methane)

Background Information

What is biogas? Biogas, known as a source of renewable energy, is made mostly of methane. (60-70%) Biogas, as known by many scientific associations and universities, is made from a mixture of CH4 (methane), CO2 (carbon dioxide), H2S (hydrogen sulfide), NH3 (ammonia), and SO2(sulfur dioxide). This gas is formed when biological matter (usually cow manure), is decomposed in an environment with no oxygen present by bacteria. Biogas has been popular as a source of energy for over 200 years

In order to create In order to produce biogas, the individual has to first build an anaerobic (no oxygen present) digester, or an enclosed tank (usually made of steel), where specific types of organic wastes are placed in order for bacteria to decompose them. In the environment, biogas is produced naturally in deep soils, lake bottoms, and wetlands.

Safety first! Since biogas is made mostly of methane, it is highly explosive, and dangerous. There should be no flames or electrical items around the digester. Some elements and molecules present in biogas can cause suffocation. The digester should be placed in a well-ventilated area. After handling the digester or any organic matter, that person should ALWAYS wash his/her hand thoroughly with plenty of soap and water.

Carbon dioxide will asphyxiate a person if he/she breathes it. Gas produced by rotten egg (H_2S) will destroy the lungs and other tissues that serve in smelling.

In order to make an anaerobic digester, biomass is needed. For example, cow manure, grass clipping with soil or any other waste, as long as you use cow manure as a starter, can be used to produce biogas. A digester needs some conditions in order to work properly. For example, there should be a water-biomass ratio of 1 to 5. The pH of this mixture should always remain around 7. An acid or base level will kill the bacteria that causes this gas. A temperature of 0°C to 69°C, although there is a higher production between 29°C and 60°C. Production will be at its peak when it reaches 35°C. The biogas generator should be "fed" daily a small amount of biomass in order to have enough fresh bacteria to produce large quantities of biogas. After this step, the digester should be agitates (shaken if it is a small bottle) in order to mix the biomass with the water. The recommended time for a home-made project is a minimum of 2 weeks, when 1/3 of all the biogas production will be made. When using manure from any animal remember: NO ANTIBIOTICS SHOULD BE GIVEN TO THE ANIMAL!!

Why is biogas good? The commercial production of this gas has many benefits to both our atmosphere and to our forests. With the burning of biomass, the deadly gas, methane, is destroyed. Methane contributes to global warming. The use of this source of renewable energy also protects the forests because it reduces the need of firewood. Fossil fuels cause respiratory diseases, which are prevented with biogas.

Rough Null and Alternate Hypothesis

Null hypothesis:

If different types of biomass (horse manure, eggs and bananas) are put to rot for a period of 2 weeks in a home-made biogas generator, then there will be no difference in the amount of biogas produced.

Alternate Hypothesis:

If different types of biomass (horse manure, eggs and bananas) are put to rot for a period of 2 weeks in a home-made biogas generator, then the eggs will produce the most biogas.

Materials and Procedures

Materials:

-15 empty 2-litre bottles of soda
-36.75 grams of cow manure (as fresh as possible)
-15.25 grams of eggs
-12.25 grams of horse manure
-12.25 grams of mashed bananas
-25.2 liters of distilled water or sometimes more, depending on the exact volume of the bottle
-15 large-mouthed (about 3.5am in diameter) latex balloons
-Metric tape ruler
-Thermometer

-15, 30-centimeters long, 3-5 cm in diameter, pieces of PVC pipe
-Duct tape

Procedures:

1) Clean the 15 bottles of soda
2) Fill each bottle with 2.45 grams of cow manure
3) Fill 5 of the bottles with 2.45 grams of horse manure
4) Fill 5 of the bottles with 2.45 grams of eggs
5) Fill the last 5 bottles with 2.45 grams of mashed bananas
6) Fill up all the bottles until the top-about 1680 ml- of distilled water
7) Place the cut pieces of PVC pipe of the mouth of the bottles
8) Place the latex balloon over the PVC pipe, uninflated
9) Secure the balloon with some Duct tape
10) Measure the diameter of the balloon twice a day for a period of two weeks

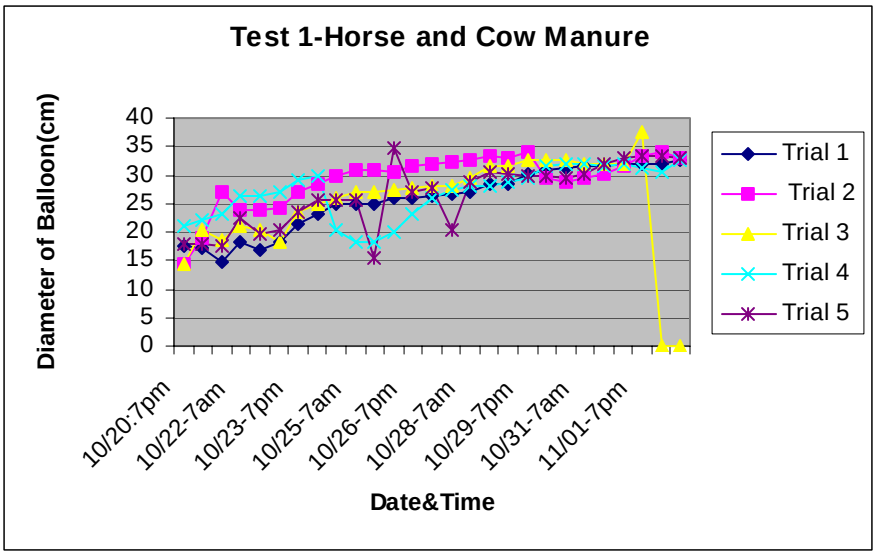
Results

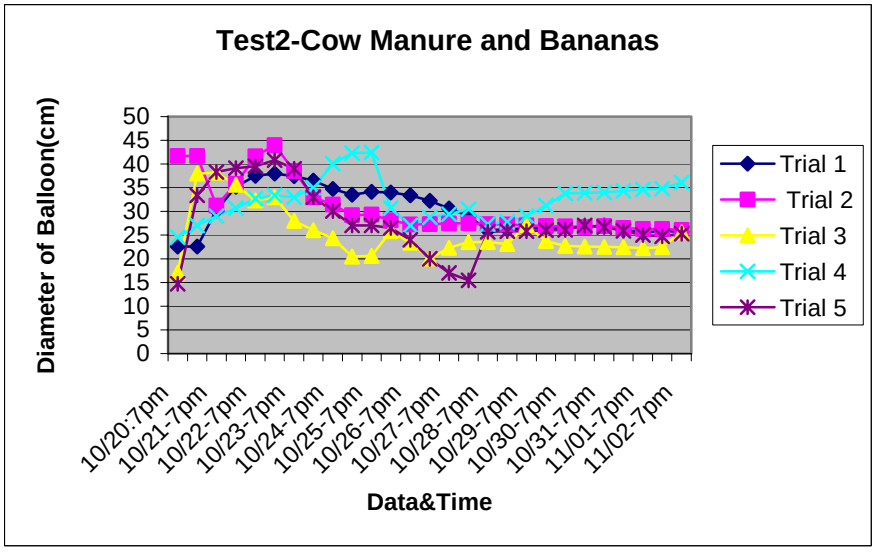
In my experiment, I have conducted 3 tests. Test #1-Cow and horse manure, Test#2-Cow manure and Bananas, and Test#3-Cow manure and eggs. My control test had absolutely no biomass at all. Cow and horse manure was the one with the greatest production of biogas, with the diameter of the balloon at an average of 26.7cm, a median of 28.1cm, a mode of 31.5cm, and a range of 34.2cm. On the other hand, Test #2 followed Test #1 very closely with an average of 29.24cm, a mode of 27cm, and a median of 25.7cm along with a range of 36.9cm. The test that produced the least amount of biogas was test#3, with an average of only 21.94cm, a median of 22.9cm, a mode of 23cm, and a range of 30.6cm. The control test showed absolutely no inflation, with the mean, median, mode, and range at 0cm. Test#1 inflated the balloon more than Test#2, and Test#3. Test #2 blew less than Test#1, but more than Test#3. Finally, Test#3 inflated the balloon less than Test#1, and Test#2.

Data Table

	Horse & cow manure					Cow manure & bananas					Cow manure & eggs				
Date/Time	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
10/20 7pm	14.4 Cm	14.3 cm	14.3 cm	21.2 Cm	17.8 Cm	22.6 Cm	41.7 Cm	7.1 Cm	24.5 cm	14.7 Cm	12.7 Cm	214 Cm	23.7 Cm	13.7 Cm	17.3 Cm
10/21 7am	17.2 Cm	19 Cm	20.2 Cm	22 Cm	17.8 Cm	22.6 Cm	41.7 Cm	38 Cm	17 Cm	33.4 Cm	12.7 Cm	37.5 Cm	23 Cm	13.7 Cm	17.3 Cm
10/21 7pm	14.7 Cm	22 Cm	18.6 Cm	23.3 Cm	17.7 Cm	30.2 Cm	31.2 Cm	38.2 Cm	19 Cm	38.3 Cm	8.3 Cm	25.5 Cm	8 cm	20 Cm	10.5 Cm
10/22 7am	18.4 Cm	23.9 Cm	21.1 Cm	26.3 Cm	22.5 Cm	35.2 Cm	35.8 Cm	35.6 Cm	30.7 Cm	39.1 Cm	11.4 Cm	27.2 Cm	11.6 Cm	23.1 Cm	15 Cm
10/22 7pm	17 Cm	24 Cm	20.3 Cm	26.4 Cm	19.6 Cm	37.5 Cm	41.6 Cm	32.3 Cm	32.7 Cm	39.5 cm	11.4 Cm	27.2 Cm	11.6 Cm	26.5 Cm	15.3 Cm
10/23 7am	18.2 Cm	24.3 Cm	18.2 Cm	27.1 Cm	20.2 Cm	38 Cm	44 Cm	33 Cm	33.4 Cm	40.8 Cm	12.3 Cm	27.4 Cm	13.6 Cm	29.9 Cm	15.4 Cm

10/23 7pm	21.4 Cm	27 Cm	23.5 Cm	29 Cm	23.5 Cm	37.4 Cm	38.5 Cm	28 Cm	33 Cm	39 Cm	16 Cm	20.8 Cm	11.6 Cm	27.7 Cm	15.8 Cm
10/24 7am	23 Cm	28.5 Cm	25 Cm	30 Cm	25.5 Cm	36.5 Cm	33 Cm	26 Cm	35 Cm	33 Cm	21 Cm	25.5 Cm	11.6 Cm	28.5 Cm	17 Cm
10/24 7pm	24.8 Cm	29.7 Cm	26.1 Cm	20.5 Cm	25.5 Cm	34.7 Cm	31.4 Cm	24.3 Cm	40.1 Cm	30.1 Cm	23 Cm	25 cm	15.4 Cm	29.1 Cm	18.7 Cm
10/25 7am	25 Cm	30.8 Cm	26.9 Cm	18.2 Cm	25.6 Cm	33.5 Cm	29.2 Cm	20.5 Cm	42.3 Cm	27 Cm	23.5 Cm	24.9 Cm	21.4 Cm	35.1 Cm	20.6 Cm
10/25 7pm	25 Cm	30.9 Cm	26.9 Cm	18.5 Cm	15.5 Cm	34.1 Cm	29.3 Cm	20.6 cm	42.4 cm	26.5 Cm	23.4 Cm	24 Cm	22.3 Cm	35.2 Cm	20 Cm
10/26 7am	25.9 Cm	30.4 Cm	27.4 Cm	20.1 Cm	24.8 Cm	34 Cm	28.1 Cm	25.8 Cm	30.9 Cm	24 Cm	31.7 Cm	24.1 cm	23.9 Cm	30.1 Cm	20.1 Cm
10/26 7pm	26 Cm	31.5 Cm	27.7 Cm	23.3 Cm	27.1 Cm	33.4 Cm	27.2 Cm	23.4 Cm	27 Cm	20 Cm	38.6 Cm	25.5 Cm	23.1 Cm	18.7 Cm	20.5 cm
10/27 7am	26.3 Cm	31.8 Cm	27.9 Cm	26.1 Cm	27.8 Cm	32.2 Cm	27.3 Cm	20.1 Cm	28.7 Cm	17 Cm	15 Cm	26.6 Cm	23 Cm	25.7 Cm	21.4 Cm
10/27 7pm	26.7 Cm	32.3 Cm	28.2 Cm	27.4 Cm	20.3 Cm	30.6 Cm	27.4 Cm	22.3 Cm	29.4 Cm	15.5 Cm	14.3 Cm	24.5 Cm	22.5 Cm	30.2 Cm	22.9 Cm
10/28 7am	27 Cm	32.5 Cm	29.5 Cm	27.9 Cm	28.5 Cm	29 Cm	27.5 Cm	23.5 Cm	30.5 Cm	25.7 Cm	23 Cm	23.5 Cm	22.1 Cm	23 Cm	23.3 Cm
10/28 7pm	28.4 Cm	33.3 Cm	31.5 Cm	28.1 Cm	30.4 Cm	26 Cm	27.3 Cm	23.5 Cm	27.3 Cm	25.8 Cm	27.7 Cm	23 Cm	23.2 Cm	25.2 Cm	22 Cm
10/29 7am	28.5 Cm	33 Cm	31.6 Cm	28.6 Cm	30.3 Cm	26.2 Cm	27.2 Cm	23.1 Cm	27.8 Cm	25.8 Cm	25.8 Cm	22.8 Cm	22.8 Cm	25 Cm	22.2 Cm
10/29 7pm	30.2 Cm	34.1 Cm	32.5 Cm	29.5 Cm	30 Cm	26.4 Cm	27 Cm	27.1 Cm	29 Cm	26 Cm	24.7 Cm	22.6 Cm	22 Cm	24.8 Cm	22.1 Cm
10/30 7am	31 Cm	29.5 Cm	32.5 Cm	31.2 Cm	29.7 Cm	26.5 Cm	26.9 Cm	23.8 Cm	31.2 Cm	26.1 Cm	23.9 Cm	22.7 Cm	21.7 Cm	24.7 Cm	22.3 Cm
10/30 7pm	31.2 Cm	28.9 Cm	32.7 cm	32 Cm	29.4 Cm	26.6 Cm	26.8 Cm	22.7 Cm	33.8 Cm	27 Cm	23.5 Cm	22.4 Cm	21.8 Cm	24.7 Cm	22.3 Cm
10/31 7am	31.5 Cm	29.6 Cm	32.1 Cm	32 Cm	30.1 Cm	26.7 Cm	26.7 Cm	22.6 Cm	33.9 Cm	26.7 Cm	23.7 Cm	22 Cm	21.9 Cm	24.9 Cm	23 Cm
10/31 7pm	31.7 Cm	30.1 Cm	31.9 Cm	31.6 Cm	32.1 Cm	27 Cm	26.9 Cm	22.5 Cm	34 Cm	25.9 Cm	24 Cm	22.7 Cm	22.1 Cm	25.2 Cm	22.5 Cm
11/01 7am	31.9 Cm	31.7 Cm	31.8 Cm	31.9 Cm	32.9 Cm	26.1 Cm	26.5 Cm	22.4 Cm	34.3 Cm	25 Cm	23.7 Cm	24 Cm	22 Cm	25.7 Cm	20 Cm
11/01 7pm	32 Cm	33.4 Cm	32.4 Cm	31.2 Cm	33.2 Cm	25.5 Cm	26.3 Cm	22.2 Cm	34.6 Cm	24.7 cm	23.2 Cm	23.9 Cm	22 Cm	25.5 Cm	19.5 Cm
11/02 7am	32.1 Cm	34.2 Cm	0 cm	30.4 Cm	33.5 Cm	25.9 Cm	26.1 Cm	22.4 Cm	34.8 cm	25.3 cm	23.5 cm	23 Cm	23 Cm	25.2 Cm	18.7 Cm
11/02 7pm	32.5 Cm	33.1 Cm	0 Cm	32.7 Cm	33 Cm	25.7 Cm	26 Cm	25.6 Cm	36.1 Cm	25 Cm	24.7 Cm	29.7 Cm	23.6 Cm	26 Cm	19 Cm


Test 1-Horse and Cow Manure
Diameter of Balloon(cm)
40
35
30
25
20
15
10
5
0
10/20:7pm
10/22-7am
10/23-7pm
10/25-7am
10/26-7pm
10/28-7am
10/29-7pm
10/31-7am
11/01-7pm
Date&Time
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5


Test2-Cow Manure and Bananas
Diameter of Balloon(cm)
50
45
40
35
30
25
20
15
10
5
0
10/20:7pm
10/21-7pm
10/22-7pm
10/23-7pm
10/24-7pm
10/25-7pm
10/26-7pm
10/27-7pm
10/28-7pm
10/29-7pm
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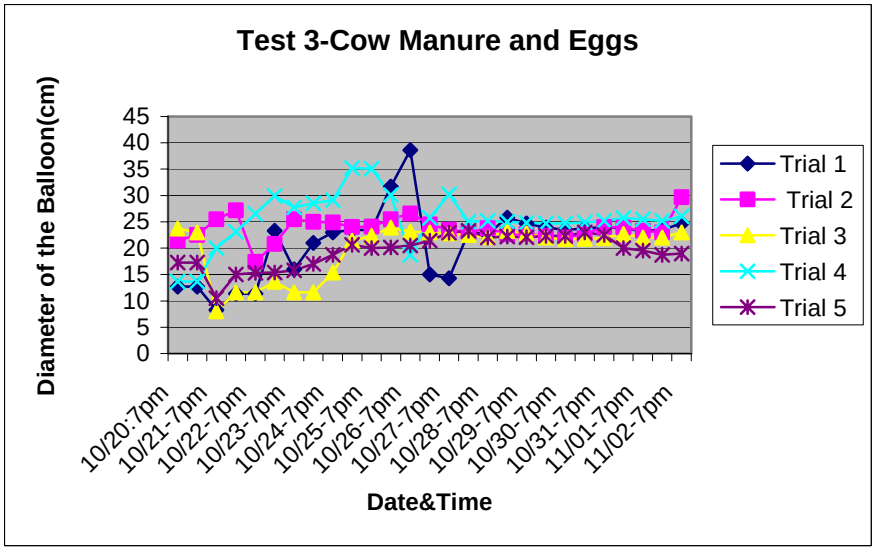
11/02-7pm
Data&Time
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5


Test 3-Cow Manure and Eggs
Diameter of the Balloon(cm)
45
40
35
30
25
20
15
10
5
0
10/20:7pm
10/21-7pm
10/22-7pm
10/23-7pm
10/24-7pm
10/25-7pm
10/26-7pm
10/27-7pm
10/28-7pm
10/29-7pm
10/30-7pm
10/31-7pm
11/01-7pm
11/02-7pm
Date&Time
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5

Conclusion

This investigation was conducted to see if different types of biomass: horse manure, bananas, and eggs, combined with cow manure, have an effect on the amount of biogas, and alternate source of energy. Biogas is a mixture of methane, carbon dioxide, hydrogen sulfide, ammonia, and sulfur dioxide. These gases, combined, are known to produce electricity when burned, which relates to the purpose of my experiment, to see which ones produce the most.

The data showed that the bananas combined with cow manure produced the most biogas at first, but then the production stopped. At the end of the experiment, this combination had inflated the balloon an average of 26.67 cm in diameter. On the other hand, the combination of cow and horse manure had blown the balloon a mean of 29.24cm in diameter. The last test, cow manure and eggs, had the least production, with only 21.94 cm in diameter. The control test produced 0cm. Looking at the averages, the null and alternate hypotheses were not supported by the data.

Between the first and last day of the (range of the) experiment, test#1 produced 34.2cm, test #2 36.9cm, and finally, test#3 blew the balloon 30.6cm. The mode for test #1 was 31.5. 27 was the one for test #2, and, finally, the mode for test#3 was of 23. The control test remained at 0cm. On the other hand, the median for test#1 was 28.1, that of test#2 was 25.7, and the median for test #3 was 22.9. The control test also remained 0cm.Looking at the data provided above; the mixture of cow and horse manure produced the most biogas, followed closely by cow manure and bananas. The cow manure and eggs produced the least amount of biogas

I think I got these results because of the molecular components of each of the mixtures. The eggs contain silicon, which might have killed the biogas-producing bacteria. The temperature and the humidity might also have influenced the production of biogas in each test. I also think that there was a high production of bacteria, since there was no air present, which inflated the balloons. Also, since cow and horse manure have about the same components, the horse manure itself influenced the biogas-producing bacteria already present in the cow manure. This might have accelerated the production of the biogas in Test#1.

Future experiments may change the types and amounts of biomass used. Another type of biogas digester could also be used under different environmental conditions. Other further research may include the variation of animal manure used. Other liquids, with higher of lower Ph, rather than water, may be used. My experiment could have been better if the environmental conditions would have remained constant. The amount of time was also an important factor; I could have used a little bit more time. If I had had the time, I would have used a more complex digester, to get even more accurate answers. Besides, the diameter of the balloon was not always measured in the exact same place. This project could be useful to provide an alternate source of energy especially in rural areas. It could be an appropriate technology to meet the basic need for cooking fuel in rural areas. Because biogas is produced microbial conversion of organic manure into methane, it would also be an attractive method for waste treatment and resource recovery. Producing biogas from organic wastes could be an alternative to the growing fuel crisis.

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Others: Personal e-mail interviews with Paul Harris, engineer in Australia, and Carla Henriquez, biologist in Honduras