Study On The Amount Of Biogas And Preparation Of Organic Fertilizers

Thida Kyaw[1], Kyi Kyi Khaing[2], Khin Thandar Win[3], Mya Aye Soe [4], Pa Pa San[5], Khin Htwe Kyaing [6], Tin Lay Nwe[7], Hlaing Hlaing Myat[8]

[1]Dr, Associate Profssor, [2,3,4,5,6]Dr, Lecturers [7]Dr, Assistant Lecturer, [8]Dr, Professor & Head, [1,2,,3,4,5,6,7,8]Department of Chemistry, [1,2,,3,4,5,6,7,8]Yadanabon University, Mandalay, Myanmar
Email: thidasein27@gmail.com

ABSTRACT

Biogas is a renewable source of energy and organic fertilizer comes from natural waste materials. In this research, EM (Effective microorganism) solutions were prepared by four different conditions: (i) vegetable wastes only, (ii) vegetable wastes and soil, (iii) vegetable wastes, dung and (iv) vegetable wastes, dung and soil by anaerobic digestion. During the digestion, biogas was evolved. The amount of evolved biogas for all conditions was determined hr by hr and day by day till five days. Total amounts of biogas for five days in conditions 1 were found to be 13000mL, condition 2 was 3600mL, condition 3 was 8000mL, 29500mL and 20000mL in bat dung, cow dung and chicken dung, condition 4 was 6600mL, 13385mL and 10200mL respectively. The organic fertilizers were also prepared by using vegetable wastes, soil, dung, straw and EM solution under aerobic and anaerobic method. Moreover, physicochemical properties such as pH, moisture, available nitrogen, phosphorus, potassium, organic carbon, carbon-nitrogen ratios of three prepared organic fertilizers(aerobic and anaerobic conditions) were determined revealing the values of pH 7.07,7.18, 7.17 and 7.16, 7.20, 7.18, moisture was 3.46%, 3.75%, 3.38% and 2.75%, 3.43%, 2.64%, available nitrogen was 1.69%, 1.09% 1.05% and 1.66%, 0.97%, 0.78%, available phosphorus was 1.41%, 1.65%, 1.33% and 1.33%, 1.59%, 1.15%, available potassium was 0.82%, 1.65%, 1.34% and 1.57%, 1.60%, 1.30%, organic carbon was 13.03%, 13.51%, 13.40% and 17.48%, 19.19%, 17.70%, carbon- nitrogen ratio was 7.71, 11.51, 9.96 and 10.53, 19.19, 12.76 which are based on aerobic and anaerobic conditions. The yield percent of these fertilizers of bat dung were found to be 50.56% and 46.21%, cow dung was 55.23% and 52.13%, chicken dung was 51.99% and 51.05%. The elemental contents were examined by using EDXRF Spectrometer.

Keywords : EM solutions; biogas; prepared organic fertilizers; NPK; EDXRF

1 INTRODUCTION

Nowadays, there are many factors that cause environmental pollution and global warming. In today's fast-growing world, the rate of energy consumption is rising at unexpected rates day by day. Deforestation is a very big problem in developing countries, most of the part depends on charcoal and fuel-wood for fuel supply which requires cutting down the forest. [1]

Due to the scarcity of petroleum and coal, supply of fuel is a problem throughout the world and it is also problem of their combustion which led to research in different concerns to get access to the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy and biogas are all renewable energy sources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic waste and at the same time producing fertilizer water dioxide. Trace amounts of nitrogen, oxygen, hydrogen, hydrogen sulfide, ammonia and water vapor are occasionally present in the biogas. [4]

Vegetables are in our daily diet and are the sources of proteins, vitamins, minerals, dietary fibers, micronutrients, antioxidants and phytochemicals. The vegetable markets sweep out plently of vegetable waste per day. [3] Biogas is a product of the microbial decomposition of organic matter in a moist environment that excludes air (an anaerobic medium). This decomposition is also termed anaerobic digestion. Biogas is popularly known as renewable energy. [2] At the end of anaerobic digestion, the slurry and residues from the biogas process could be used as an organic fertilizer to replace the use of chemical fertilizer on the farm for crop production. [5]

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

2 MATERIALS AND METHODS

2.1 Sample Collection and Preparation

The natural waste materials such as vegetable wastes, bat dung, soil and rice straw were collected from Tamokesoe Village, Amarapura Township, Mandalay Region. Vegetable waste samples were cut into small pieces and then used throughout experiment. Bat dung samples were pounded and sieved with 60 seive mesh size to get the size of powder. This condition was ready to use. Soil samples were pounded and sieved with 60 seive mesh size to get powder sample. Rice straw samples were cut into small pieces.

Vegetabel Waste	Dung Powder	Soil Powder	Rice Straw

2.2 Preparation of Effective Microorganism (EM) solution

Effective microorganism (EM) solution was prepared from vegetable wastes in four different conditions by anaerobic digestion. These conditions are (1) vegetable wastes only (2) vegetable waste and soil, (3) vegetable waste and dung, (4) vegetable waste, dung and soil. The fermentation time took about one month to obtain effective microorganism (EM) solution.

2.3 Production of Biogas

The biogas was also produced from these four different conditions. In the first condition, small pieces of vegetable waste only (6kg) were put into the anaerobic digester. The neck of the digester was entwined with Teflon. It was also tightly sealed with the lid connecting delivery tube (pipe). While the preparation of effective microorganism solution, the biogas was evolved. The biogas was collected by downward displacement of water. After the digester was kept for five days, the gas production was checked. The amount of liberated biogas was recorded as day by day. The prepared digester was shown in fig (1). Similarly, according to the above procedure, biogas was produced from the condition 2, 3 and 4.

2.4 Preparation of Organic Fertilizer

The organic fertilizers were prepared from vegetable waste, soil, dung, straw and EM solution by two different conditions such as aerobic condition and anaerobic condition.

The following successive layers are piled on top to this.

1. A layer of 0.25 kg of rice straw
2. A layer of 0.175 kg dung
3. A layer of 0.75 kg soil
4. A layer of 0.25 kg vegetable wastes
5. A layer of 0.8 kg EM solution
6. A layer of 0.25 kg rice straw
7. A layer of 0.175 kg dung
8. A layer of 0.75 kg soil
9. A layer of 0.25 kg vegetable wastes
10. A layer of 0.8 kg EM solution
11. A layer of 0.25 kg rice straw
12. A layer of 0.175 kg dung
13. A layer of 0.75 kg Soil
14. A layer of 0.25 kg vegetable wastes
15. A layer of 0.8 kg EM solution
16. A layer of 0.25 kg rice straw

In this way, the container was composed of sixteen layers. The layers were arranged in order of increasingly easier to decompose from the bottom to the top.

2.5 Turning Over for the Sample under Aerobic Condition

During decomposition, the layers were turned over regularly in order that it remains well aerated and all the materials were converted into compost. The first turning over was done after two weeks. The second turning over took place after two weeks. Then, each turning over

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

was done after one week. During the process, water was sprinkled over the container, if necessary. After two months, decomposition was complete because the plant materials were changed into an unrecognizable crumbly dark mass. However, some stalks do not decompose completely and can still be seen.

2.6 Determination of Yield Percent of Prepared Organic Fertilizer (POF)

The prepared organic fertilizers were dried and the yield percent of these fertilizers were determined based upon the total weight of selected materials used.

Table 1. Determination of Physicochemical Properties of Organic Fertilizer

No.	Analytical items	Analytical methods / Instruments
1.	Elemental contents	EDXRF Spectrophotometer
2.	pH	pH meter
3.	Moisture content	Oven drying method
4.	Available N	Alkaline Permanganate method
5.	Available P	Olsen's method
6.	Available K	Atomic absorption spectrophotometer
7.	Organic carbon	Walky and Black's method

2.7 Determination of Elemental Analysis of Prepared Organic Fertilizer

Elemental Analysis of prepared organic fertilizers was performed at Department of Physics, University of Mandalay, by applying EDXRF (Energy Dispersive X- Ray Fluorescence) Spectroscopy.

3 RESULTS AND DISCUSSION

Table 2. Results of evolved Biogas (mL) from the first 5 hours

No.	*Sample*	*1hr*	*2hr*	*3hr*	*4hr*	*5hr*	*Total amount(mL)*
1.	Vegetable waste (6kg)	600	700	300	700	300	2600
2.	Vegetable waste (3kg) + soil (3kg)	200	350	425	300	300	1675
3.	Vegetable waste (3kg) + Bat dung (3kg)	400	450	475	365	310	2000
4.	Vegetable waste (3kg) + Cow dung (3kg)	500	400	800	300	250	2250
5.	Vegetable waste (3kg) + Chicken dung (3kg)	200	600	300	200	200	1500
6.	Vegetable waste (2kg) + Bat (2kg) + Soil (2kg)	275	300	550	450	425	2000
7.	Vegetable waste (2kg) + Cow (2kg) + Soil (2kg)	500	675	635	685	600	3095
8.	Vegetable waste (3kg) + Chicken (2kg) + Soil (2kg)	300	800	900	300	200	2500

According to this table, it was observed that for the first 5 hours [Vegetable waste (2kg) + Cow dung (2kg) + Soil (2kg)] the highest amount of biogas than the others.

According to this table, for the first hours, it was observed that [Vegetable waste (2kg) + Cow dung (2kg) + Soil (2kg)] was the highest amount of evolved biogas than the others.

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

Table 3. Results of evolved Biogas (mL) within five days

No.	*Sample*	*Day 1*	*Day 2*	*Day3*	*Day4*	*Day5*	*Total amount(mL)*
1.	Vegetable waste (6kg)	5400	4200	3200	100	100	13000
2.	Vegetable waste (3kg) + soil (3kg)	3600	-	-	-	-	3600
3.	Vegetable waste (3kg) + Bat dung (3kg)	3500	2500	1200	600	200	8000
4.	Vegetable waste (3kg) + Cow dung (3kg)	13000	6600	5400	3600	900	29500
5.	Vegetable waste (3kg) + Chicken dung (3kg)	9600	6200	4200	-	-	20000
6.	Vegetable waste (2kg) + Bat (2kg) + Soil (2kg)	3500	2000	500	400	200	6600
7.	Vegetable waste (2kg) + Cow (2kg) + Soil (2kg)	6185	3200	2100	1700	200	13385
8.	Vegetable waste (3kg) + Chicken (2kg) + Soil (2kg)	4800	2000	1800	1000	600	10200

From these experiment data, it was found that the production of biogas from vegetable waste (3kg) vegetable waste (3kg) and cow dung (3kg) gave rise to the highest amount.

Table 4. Results of Phytochemical properties of prepared organic fertilizers

No.	Properties	With bat dung	With cow dung	With chicken dung
1.	pH (Aerobic POF)	7.07	7.18	7.17
2.	pH (Anaerobic POF)	7.16	7..20	7.28
3.	Moisture (%) (Aerobic POF)	3.46	3.75	3.38
4.	Moisture (%) (Anaerobic POF)	2.75	3.43	2.64
5.	Available Nitrogen (%) (Aerobic POF)	1.69	1.09	1.05
6.	Available Nitrogen (%) (Anaerobic POF)	1.66	0.97	0.78
7.	Available phosphorus (%) (Aerobic POF)	1.41	1.65	1.33
8.	Available phosphorus (%) (Anaerobic POF)	1.33	1.59	1.15
9.	Available potassium (%) (Aerobic POF)	1.67	1.65	1.34
10.	Available potassium (%) (Anaerobic POF)	1.57	1.60	1.30
11.	Organic carbon (%) (Aerobic POF)	13.03	13.51	17.70
12.	Organic carbon (%) (Anaerobic POF)	17.48	19.19	13.40
13.	Carbon-nitrogen ratio (Aerobic POF)	7.71	11.51	9.96
14.	Carbon-nitrogen ratio (Anaerobic POF)	10.53	19.19	12.76

This table showed that pH of two prepared organic fertilizers was nearly neutral. In moisture contents, it can be seen that anaerobic prepared organic fertilizer was less moist than the aerobic prepared organic fertilizer. The optimal range for most plant is between 5.5 and 7.0, however, many plants have adapted to thrive at pH values outside this range. Because pH levels control many chemical processes that take place in the soil, specifically plant nutrient availability, it is vital to maintain proper level for plants to reach their full yield potential.

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

From N,P,K determination, it can be observed that available nitrogen, phosphorus and potassium values of aerobic prepared organic fertilizer were higher than that of anaerobic prepared or fertilizer. According to organic carbon content and carbon-nitrogen ratio, the values of aerobic prepared organic fertilizer were found to be less than that of anaerobic organic fertilizer. The most important elements that are required by plants are nitrogen, phosphorus and potassium because these three elements are essential for the growth of plants.

Table 4. Yield Percent of Organic Fertilizers

No.	Dung	Total weight of adding materials (g)	Dried weight of prepared organic fertilizers (g)	Yield Percent (%)
1.	Bat (Aerobic)	6925	3500	50.56
2.	Bat (Anaerobic)	6925	3200	46.21
3.	Cow (Aerobic)	6925	3825	55.23
4.	Cow (Anaerobic)	6925	3610	52.13
5.	Chicken (Aerobic)	6925	3600	51.99
6.	Chicken (Anaerobic)	6925	3535	51.05

According to this table, the yield percent of aerobic prepared organic fertilizer was found to be higher than that of anaerobic prepared organic fertilizer. Therefore, aerobic condition should be selected for the mass production of organic fertilizer.

Table 5. Elemental Analysis of Prepared Organic Fertilizer in Aerobic Condition

No.	Element	Concentration (%)		
		Bat dung	Cow dung	Chicken dung
1.	Si	10.7100	12.4700	11.5300
2.	K	1.5060	2.4860	2.1110
3.	Ca	2.1180	2.1820	4.2330
4.	Cl	0.5168	2.0870	0.9061
5.	Al	1.8750	1.9500	2.0460
6.	Fe	1.7770	1.7860	1.7230
7.	P	0.9306	0.4059	0.9869
8.	Ti	0.1819	0.1823	0.1976
9.	S	0.1740	0.1028	0.1337
10.	Mn	0.0806	0.0656	0.0769
11.	Ba	0.0405	0.0423	0.0406
12.	Zn	0.0231	0.0112	0.0207

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

Table 6. Elemental Analysis of Prepared Organic Fertilizer in Anaerobic Condition

No.	Element	Concentration (%)		
		Bat dung	Cow dung	Chicken dung
1.	Si	8.6990	10.9800	9.9320
2.	K	3.0520	2.8870	3.2620
3.	Ca	1.0520	2.7080	3.1560
4.	Cl	1.7590	2.1540	3.4180
5.	Al	1.3800	1.8050	1.7250
6.	Fe	0.1221	1.5480	0.1726
7.	P	1.1010	1.4890	1.7940
8.	Ti	0.7185	0.4623	0.8624
9.	S	0.2290	0.1125	0.1736
10.	Mn	0.0715	0.0701	0.0681
11.	Ba	0.0364	0.0505	0.0139
12.	Zn	0.0189	0.0705	0.0175

From these elemental data, it can be seen that silicon was the highest value in both prepared organic fertilizers. Phosphorus was found to be relatively low amount in both fertilizers. Because of the high amount of silicon, both prepared organic fertilizers may resist in many plants to disease and pests. Calcium is one of the elements necessary for the growth of all crops.

4 Conclusion

In this research conditions, the renewable energy, biogas was produced from four different by anaerobic digestion. From the experimental data, the production of biogas form vegetable wastes and cow dung was found to be the highest amount of biogas. Two different kinds of organic fertilizers (aerobic and anaerobic) were prepared by using vegetable wastes, soil, dung, rice straw and EM solution. From pH value determination, it can be examined that the two prepared organic fertilizers were nearly neutral. Anaerobic organic fertilizer was found to be less moist than aerobically prepared organic fertilizers. From the comparison of N, P, K value, organic carbon content and carbon-nitrogen ratio, it can be observed that anaerobic prepared organic fertilizer can supply more N, P, K than aerobic prepared organic fertilizers.

Nitrogen is an essential and important constituent of the plant's body. Likewise, phosphorus is another important constituent. Potassium is not a constituent element, of the plant body. It however, occurs in the plant as soluble salts. Its role is catalytic. Leaf crops like cabbage, require abundant nitrogen, a fair amount of phosphorus but not much potassium. Root crops require a good amount of potassium, fair amount of phosphorus but very little nitrogen. Seed bearing plants such as peas, beans and tomatoes require a good amount of phosphorus and potassium, but little nitrogen. Flowering needs a fair amount of phosphorus and potassium, but little nitrogen. Fruiting and seed formation require higher potassium but very little nitrogen.

The elemental analysis indicated that silicon was the highest value in both prepared organic fertilizers. Since silicon generates the resistance in many plants to disease and plants, it may contribute to reduce the rate of application of pesticides and fungicides. It was concluded that the natural waste material could be used as the sources of renewable energy and organic fertilizer.

Acknowledgement

I would like to express many thanks to Rector Dr Maung Maung Naing and Pro-rectors of Yadanabon University for their permissions to do this research. I wish to mention my deepest thanks to Professor Dr Hlaing Hlaing Myat, Head of the Department of Chemistry, Yadanabon University for their interest, valuable guidance and encouragements throughout this research work.

References

[1] Donald, L., (1998) "Biomass for Renewable Energy, Fuels and Chemicals", Academic Press.; pp. 445-491.

IEEE-SEM, Volume 7, Issue 8, August-2019
ISSN 2320-9151

[2] Demirbas, A. and T. Ozturk., (2005) “Anaerobic digestion of agricultural soild residues”. *International Journal of Green Energy* 1(4); pp .438-94.

[3] Kumar S., Bhattacharyya L.K., Chakrabarti AV., Devotta T. and Akolkar A., (2009) “Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: An insight, Waste Management”, 29, pp.883-895.

[4] SUYOF VIJ. Odhisha, (2010-2011). [107BT016] Guided by Prof. Krishna Parmanik, “Biogas Production From Kitchen Waste, *Department of Biotechnology and Medical Engineering”,* National Institute of Technology, Rourkela-769008.

[5] Singh, S. P., and Prema, P(2009) “ Review of recent advances in anaerobic packed-bed biogas reactors”. Renew. & Sustain. Energy Rev. 13:1569-1575.