American Journal of Environment, Energy and Power Research
Vol. 2, No. 2, November 2014, pp. 1 - 7, ISSN: 2329 - 860X (Online)
Available online at http://www.ajeepr.com/

Research article

Effects of Chemical on Biogas Production from *Euphorbia tirucalli*

Taddese Girmay

Departments of Chemistry, Debre Tabor University, P.O. Box 272, Debre Tabor, Ethiopia

Weldegebriel Berhe

Department of Animal Sciences, Debre Tabor University, P.O. Box 272, Debre Tabor, Ethiopia
Cell phone: +2519106673
E-mail: woldberh@gmail.com

Abstract

The study was conducted to evaluation of biogas production from Euphorbia tirucalli, to determine the amount of biogas production from Euphorbia tirucalli. Biogas production from three batch digesters containing varying ratios chemicals and Euphorbia tirucalli. Biogas production from Euphorbia tirucalli with 600g ash in 1:10, 1:15 and 1:20 Euphorbia tirucalli to water ratio was attained 49.23, 27.20 and 14.13 liters, respectively. The highest biogas production was observed in 1:10 Euphorbia tirucalli to water ratio with 300 g lime from in 1:15 and 1:20 Euphorbia tirucalli to water ratios. The yield of biogas from Euphorbia tirucalli with 25g Na_2CO_3 in 1:10, 1:15 and 1:20 Euphorbia tirucalli to water ratio was 20.33, 11.17 and 4.20 liters, respectively. There is highly significant difference among the biogas generated from Euphorbia tirucalli with 600 g ash, Euphorbia tirucalli with 300 g lime, Euphorbia tirucalli with 25g sodium carbonate in 1:10 slurry to water ratio. There is no significant difference among the treatments of Euphorbia tirucalli with 600g ash and Euphorbia tirucalli with 300g lime in 1:15 Euphorbia tirucalli to water ratio. Generating biogas from Euphorbia tirucalli is economically very significant to produce sufficient amount of biogas to solve energy deficiency.

Keywords: Biogas, Chemicals, Deficiency, Economically, Energy, Euphorbia tirucalli

INTRODUCTION

Biogas is a type of biofuel which is excellent source of energy. It is a mixture of methane and carbon dioxide as the major components and H_2, NH_3, H_2S as minor components. Methane is representing a valuable renewable energy source and reduces greenhouse gas emissions when it is collected and substituted for fossil fuels. Biogas is produced when bacteria decompose organic material especially in the absence of oxygen (anaerobic). The anaerobic process involves four major steps hydrolytic, acidogenic, acetogenic and methanogenic process [1, 2 and 3].

Euphorbiaceae plants posse sufficient amounts of latex, sugars and cellulose, which can be converted to biogas through anaerobic digestion. The major constituents of latex are isomers of triterpenes ($C_{30}H_{50}O$) (MW: 426), such as euphol, tirucallol, glut-5-en-3-β-ol, cycloeuphordenol, euphorginol, α-amyrin, lanosterol, cycloartenol, and others[4].

Euphorbia tirucalli is a type of Euphorbiaceae plant species. Euphorbia tirucalli is relatively easy to grow in different soil types, under diversified conditions, and does not require special management practices. It is widely used as a live fence and in hedge rows to control soil erosion. Under optimal conditions, *Euphorbia tirucalli* produces between 200 and 500 metric ton of fresh biomass per hectare per year. The gross energy content of dry Euphorbia tirucalli is 17,600 kJ/kg [5].

Ethiopia has high resources of natural euphorbia tirucalli. For instance, it is found in Wello, Gojam, Gonder, Shoa, Tigray, Harerge, Sidamo, Gamo gofa, Ilubabor and Bale [6]. In Ethiopia, *Euphorbia tirucalli* is used as a live fence, fire wood and in hedge rows but not used for other purposes. So, Ethiopia can be generated high biogas production from natural *Euphorbia tirucalli*. Because this plant species is only vegetative material is needed and can generate high biomass production. No need to wait up to flowering and fruit time production; when cut back, the plant rapidly grows back by itself, and plantation can easily be established by vegetative propagation. It also has large volume of cow dung generated from feedlot farming which is disposed into landfills or applied to the land without treatment. Anaerobic digestion provides an alternative option for biogas generating and waste treatment to decrease disposal costs. The biogas produced can be used as a source of renewable energy and the residue can be used as a soil conditioner (fertilizer).

Recently, peoples of the world have worried about whether fossil fuel is reliable global energy sources due to the ever-increment of vehicles and different industries that are not balanced with the supply of petroleum. In Ethiopia also there are several indicators point out an energy crisis including: rapid deforestation, a biomass energy scarcity and deterioration in electricity generation and distribution systems. However, Ethiopia has considerable opportunities for energy development from hydro sources, wind, solar and biogas. Most of these energy sources have not been fully exploited. As such, wood is still the major source of energy for the population and imported petroleum products from foreign country. To solve this problem, the non-renewable natural fuel can be substituted by renewable plant based energy sources.

The significance of this work may solve the energy scarcity of the country. It can also use to increase the access rate of modern energy resources such as new and renewable energies; produce large quantity and quality energy for urban and rural areas as improving security of electricity and petrol product supplies; and meet needs of domestic energy to protect environmental pollution. Therefore, this study was conducted with the following specific objective

- To evaluate biogas production from *euphorbia tirucalli* with ash, lime and sodium carbonate

MATERIALS AND METHODS

Description of Study Area

Sample that was utilized in this research work is *Euphorbia tirucalli* which was obtained from Tachgayint. It is located in South Gondar Zone, Amahra Region, Ethiopia. It is about 770 kms northeast of Addis Ababa and about 200 kms from Bahir Dar. The Woreda lies within the geographical grid coordinates of 11°22′N latitude and 37°41′E longitude. In terms of altitude, the Wereda ranges from 750 m to 2800 m above sea level with highest and lowest temperature of $27^{o}C$ and $13^{o}C$ respectively. The rainfall ranges in mean annual amount between 900 mm to 1000 mm. fresh cow dung was obtained from a ranch of Bahir Dar University. The experiment was done in Bahir Dar and Haramaya University.

Materials and Chemicals

drums of different volumes, plastic containers, graduated cylinders of different volumes, refluxing apparatus, vacuum filtering system with trap in line, desiccator, berzelius beakers, sintered glass crucibles (coarse porosity), electronic balance, digital pH meter, Plastic bags, get valve, rubber tube, vacuum pump machine, mixer grinder, Na_2CO_3, ash, lime, $C_{12}H_{25}O_4S$, EDTA, $C_{12}H_{25}O_4S$, $Na_2B_4O_7.10H_2O$, Na_2HPO_4, $C_4H_{10}O_2$, muffle furnace, oven, H_2SO_4, boric acid solution, NaOH and HCl are the materials and chemicals used during the experiment.

Experimental Design

The experiment was conducted by using three factorial complete randomized designs (chemicals, water level and materials) with three replications. The experimental design for the anaerobic digestion of Euphorbia tirucalli and cow dung were carried out at ambient temperature in 3 batch digesters labeled A–C as follow:

- Digester A: comprise *Euphorbia tirucalli* with 600g ash

- Digester B: comprise *Euphorbia tirucalli* with 300g lime
- Digester C : comprise *Euphorbia tirucalli* with 25g sodium carbonate

Procedure

To build this digester, a hole was cut in the lid of one of the larger drums, near the outer edge. The pipe was slide into the hole. Then, a smaller hole was cut near the opposite edge and another hole in the bottom of the medium drum. Pieces of plastic tubing was attached to the larger drum and run the tubing into the medium drum. All the connections were sealed with epoxy.

A second hole was cut in the bottom of the medium drum and attaches the valve to the hole. The medium drum was inverted and the valve was opened and pushed it down into the large drum with water. The digester was filled with slurry and necessary chemicals in required quantity such as sodium carbonate, ash and lime were added. Then, anaerobic digestion was allowed to continue for different intervals of time. As gas is produced it was bubbled up through the water and filled the medium drum making it float. This floating drum collector was connected with gas collector (plastic container). Ambient temperature measurement was determined with a mercury bulb thermometer.

Chemical Analysis

Chemical analysis of these samples were carried out to determine their volatile matter, moisture content, total solid, pH, cellulose content, lignin content and carbon to nitrogen ratio. The volatile matter was determined by dried a portion of these samples and ashed in a muffle furnace at 550°C. Moisture content and total solid was determined by drying a sample to a constant value in a drying oven at 105°C. The pH of the sample was determined by digital pH meter. The carbon content in the sample was determined according to the following procedure. Aluminum pan was dried in oven at 100°C for 15 to 30 min. Then, the pan was cooled in desiccators, weighed and recorded. Samples were added and recorded weight of pan plus sample. Pan plus sample was dried in oven at 100°C for 12 h and cooled in desiccators, weighed back, and recorded. Pan plus samples were placed in muffle furnace and ashed at 500°C for 3 h. Then after pan plus samples were cooled in muffle for at least 8 h, and then in desiccators, weighed back, and recorded the weight. The neutral detergent fiber, acid detergent fiber and acid detergent lignin were determined using Van Soest procedure.

Methods of Data Collection

20 types of grab sample from each material (*Euphorbia tirucalli* and cow dung) were collected randomly from Tachgayint and a ranch of Bahir Dar University. The matured shoot part of *Euphorbia tirucalli* was collected, chopped, grinding and stored in safe place. Cow dung without urine was collected from Bahir Dar ranch in the

morning. After mixing these grab samples and homogenized, a composite samples from each material was taken to laboratory for analysis. After that, the quantitative data obtained from experiment was measured using water displacement method in which the amount of tap water displaced was proportional to the volume of biogas produced. Finally, the average three replicate results of these samples were calculated and used for the statistical analysis.

Data Analysis

After comprehensive data collection and analysis, the overall result was presented in the form of tables, graphs, figures and maps to make things clear and understandable. The collected data was analyzed using SAS (statistical analysis software 2004).

RESULT AND DISCUSSION

From the experiment performed in the laboratory, a set of results were obtained that contain cumulative biogas yields for different substrate loadings. Thus, the results of biogas production from *Euphorbia tirucalli* with addition of chemicals was present in Table 1.

Table 1. Volume of biogas in liter produced per 2kg with different chemicals

Treatment	1:10WR	Std	1:15WR	Std	1:20WR	Std	SL
ETA + 600g ash	49.23[a]	0.74	27.20[c]	0.10	14.13[e]	0.21	***
ETL + 300g lime	41.72[b]	1.63	29.57[c]	0.93	9.77[ef]	0.42	***
ETN + 25g $NaCo_2$	20.33[d]	0.68	11.17[e]	0.15	4.20[f]	0.19	***
Significance level= 0.01					Replication = 3		

WR = water ratio, Std = standard deviation, SL = significance level, *** = highly significance different, ** = significance different, ETA = *Euphorbia tirucalli* + 600g ash, ETL = *Euphorbia tirucalli* + 300g lime, ETN = *Euphorbia tirucalli* + 25g sodium carbonate,
Duncan Grouping

In this study, biogas production from *Euphorbia tirucalli* with 600g ash in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio was 49.23, 27.20 and 14.13 liters, respectively. 1:10 *Euphorbia tirucalli* to water ratio with 600g ash produced the highest biogas production potential of 49.23 liter when compared with 1:15 and 1:20 *Euphorbia tirucalli* to water ratios. There is highly significance difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 600g ash. The difference is due to the dilution and concentration effect of the material.

Biogas production from *Euphorbia tirucalli* with 300 g lime in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio had a production potential of 41.72, 29.57 and 9.77 liters, respectively. The highest biogas production was observed in 1:10 *Euphorbia tirucalli* to water ratio with 300 g lime from in 1:15 and 1:20 *Euphorbia tirucalli* to water ratios. In general, there is highly significant difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 300g lime.

The yield of biogas from *Euphorbia tirucalli* with 25g Na_2CO_3 in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio was 20.33, 11.17 and 4.20 liters, respectively. As shown in this result, the highest biogas production was observed in 1:10 *Euphorbia tirucalli* to water ratio from 1:15 and 1:20 *Euphorbia tirucalli* to water ratios with 25 g Na_2CO_3. As the result indicated, there is highly significance difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 25g Na_2CO_3.

There is highly significant difference among the biogas generated from Euphorbia tirucalli, *Euphorbia tirucalli* with 600 g ash, *Euphorbia tirucalli* with 300 g lime, *Euphorbia tirucalli* with 25g sodium carbonate in 1:10 slurry to water ratio. There is no significant difference among the treatments of *Euphorbia tirucalli* with 600g ash and *Euphorbia tirucalli* with 300g lime in 1:15 *Euphorbia tirucalli* to water ratio.

CONCLUSION AND RECOMMENDATION

In this study, biogas production from *Euphorbia tirucalli* with 600g ash in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio was 49.23, 27.20 and 14.13 liters, respectively. In 1:10 *Euphorbia tirucalli* to water ratio with 600g ash produced the highest biogas production potential of 49.23 liter when compared with 1:15 and 1:20 *Euphorbia tirucalli* to water ratios. There is highly significance difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 600g ash. The difference is due to the dilution and concentration effect of the material.

Biogas production from *Euphorbia tirucalli* with 300 g lime in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio had a production potential of 41.72, 29.57 and 9.77 liters, respectively. The highest biogas production was observed in 1:10 *Euphorbia tirucalli* to water ratio with 300 g lime from in 1:15 and 1:20 *Euphorbia tirucalli* to water ratios. In general, there is highly significant difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 300g lime.

The yield of biogas from *Euphorbia tirucalli* with 25g Na_2CO_3 in 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio was 20.33, 11.17 and 4.20 liters, respectively. As shown in this result, the highest biogas production was observed in 1:10 *Euphorbia tirucalli* to water ratio from 1:15 and 1:20 *Euphorbia tirucalli* to water ratios

with 25 g Na_2CO_3. As the result indicated, there is highly significance difference among the biogas production from 1:10, 1:15 and 1:20 *Euphorbia tirucalli* to water ratio with 25g Na_2CO_3.

There is highly significant difference among the biogas generated from Euphorbia tirucalli, *Euphorbia tirucalli* with 600 g ash, *Euphorbia tirucalli* with 300 g lime, *Euphorbia tirucalli* with 25g sodium carbonate in 1:10 slurry to water ratio. There is no significant difference among the treatments of *Euphorbia tirucalli* with 600g ash and *Euphorbia tirucalli* with 300g lime in 1:15 *Euphorbia tirucalli* to water ratio. So, production of biogas from *Euphorbia tirucalli* with 600g ash in 1:10 *Euphorbia tirucalli* to water ratio was economically preferable.

A study conducted on synthesis of biogas from *Euphorbia tirucalli* has useful information to the government and voluntary organization. So, give attention to the plant in order to spread throughout the country specially to cultivate in areas which not favorable for crop production and plan for generations of biogas from *Euphorbia tirucalli.*

REFERENCE

[1] Emilia, S. R., 2009. Biogas composition and upgrading to biomethane, Jayvaskyla: University of Jayvaskyla, pp. 76.

[2] Ilaboya, I.R., F.F. Asekhame, M.O. Ezugwu, A.A. Erameh and F.E. Omofuma, 2010. Studies on Biogas Generation from Agricultural Waste; Analysis of the Effects of Alkaline on Gas Generation, World Applied Sciences Journal, Igbinedion University Okada, Nigeria, 9 (5): 537-545.

[3] Omolola A. M., 2007. Anaerobic digestion of ethanol distillery waste-stillage for biogas production, thesis research report in fulfilment of the award of M.Sc chemical engineering, University College of Boras School of engineering, Sweden.

[4] Uchida, H., K. Ohyama, M. Suzuki, H. Yamashita,T. Muranaka and K. Ohyama, 2010. Triterpenoid levels are reduced during Euphorbia tirucalli L. callus formation, Plant Biotechnology, Tokyo, Japan. 27, 105–109.

[5] http://www.worldagroforestry.org/treedb2/AFTPDFS/Euphorbia_tirucalli. Accessed 20 March 2011.

[6] Azene Bekele-Tesemma, 2007. Useful trees and shrubs of Ethiopia: identification, propagation and management for 17 agro-climatic zones; Technical manual number 6. World agro-forestry center.