e-ISSN:2347-7830
p-ISSN:2347-7822

Research & Reviews: Journal of Ecology and Environmental Sciences

Quality of kitchen waste generated at VIT University, Vellore

Aslam AM[1]*, Aleem Abdullah M[2]
[1]Chemical Engineering Division, VIT University, Vellore, Tamil Nadu, India.
[2]Department of Environmental Management, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

Research Article

Received date: 16/09/2015
Accepted date: 22/11/2015
Published date: 29/11/2015

***For Correspondence**

Aslam AM, Chemical Engineering Division, VIT University, Vellore, Tamil Nadu, India

E-mail: aslamset@gmail.com

ABSTRACT

Disposal of kitchen waste is a serious environmental problem all around the world as these wastes are generated in large quantities in highly populated and urban areas and due to its inappropriate disposal and lack of reuse. India has number of universities having large campuses in which they have hostels, colleges, messes cafeteria and staff colonies. They generate large amount of organic waste. Lots of money and manpower is required for its safe disposal. The aim of this investigation is to analyze the feasibility to create an organic waste processing facility in VIT University to produce biogas which will be more cost effective, eco-friendly, and reduce carbon dioxide & methane emissions. The present investigation involves theoretical and experimental estimation of biogas from kitchen waste of the students mess in university campus. The anaerobic fermentation of kitchen waste such as mixed food waste, uncooked waste and fruit waste was attempted using plastic digesters of 20 liter capacity. During this period, the temperature, solar radiation has been measured. All collected biodegradable food waste samples were used without mashing and shredding to homogenous size to find out the percentage of organic material broken down in that condition. Proximate and ultimate analysis for theoretical estimation has been made. We found that from experimental results biogas yield is 0.16834m^3/kg. However, using ultimate analysis theoretical estimation indicates biogas yield is 0.9689m^3/kg. This indicates that, there is a large gap between theoretical estimation and experimental results in the yield of biogas because no shredding has been done.

INTRODUCTION

Food and vegetable waste forms a large component of municipal, commercial and industrial waste [1]. Which continues to pose an environmental and health issue in both industrialized and developing countries [2]. A study of global food waste published in 2011 by the Food and Agriculture Organization of the UN found that roughly one third of all food produced for human consumption each year goes to waste totaling 1.3 billion tones. Applying anaerobic digestion (AD) to this amount of food waste has the potential to generate 367 m^3 of biogas per dry tone at about 65% of methane [3]. Utilizing this waste in the proper way by generating the biogas through anaerobic digestion seems viable economic option for the country like India [4]. In most of the institutions where campus is available, the kitchen waste disposed in landfill method or discarded, not only leads polluting earth's surface but also promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also it emits methane which is a major greenhouse gas contributing to global warming. The main purpose of this investigation is to characterize the food waste produced in the messes of VIT University campus and to determine the quality of biogas produce through anaerobic digestion.

Methodology and experimental observation

To assess the biogas production potential of University kitchen wastes, laboratory test was conducted at the Chemical Engineering department of VIT University. Food waste collected from hostel messes of VIT University are used as input material for the fermentation process. The sample was predominantly Daal, rice, onion and uncooked vegetables. The samples are analyzed for Proximate and Ultimate Analysis **(Figure 1).**

e-ISSN:2320-0189
p-ISSN:2347-2308

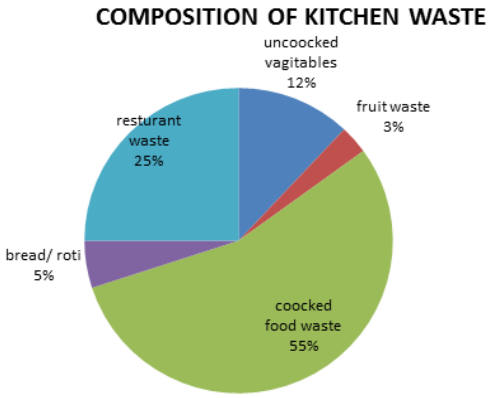

Figure 1. Composition of kitchen waste.

Ultimate analysis of food waste for Theoretical prediction of Biogas

Anaerobic degradability greatly depends on the composition of the input material. It's very difficult to estimate or measure the percentage of carbohydrates, lipids, and proteins in a food waste due to the dynamic and sensitive nature of the biological process to the input composition. Ultimate analysis of food waste for biogas prediction is one of the best methods. This technique of biogas characterization involves breaking food waste down into its elemental composition of carbon, hydrogen, oxygen, and nitrogen by ultimate analysis of food waste **(Table 1).**

Table 1. Ultimate analysis of food waste sample.

Element	Percentage content	Kg/Mole
C	49	4
H	8.5	8.33
O	34.5	2.11
N	2.5	0.175
S	0.5	0.0175

If 1mol of N is assumed, then $C_{23}H_{48}O_{12}N$ is the chemical formula. Then Using Buswell's Equation, the amount of biogas produced can be predicted

$$C_aH_bO_cN_d + \left(\frac{4a-b-2c+3d}{4}\right)H_2O \rightarrow \left(\frac{4a-b-2c+3d}{8}\right)CH_4 + \left(\frac{4a-b+2c+3d}{8}\right)CO_2 + dNH_3$$

By putting the value of a= 23, b=48, c=12, d=1

$$C_{23}H_{48}0_{12}N + 5.75\ H_2O \rightarrow 14.125\ CH_4 + 8.87\ CO_2 + NH_3$$

Above Equation describes the complete degradation of all the carbon present in the substrate. Moreover, it is assumed that the biogas is simply a binary mix of methane and carbon dioxide. This general balance and in particular its expression as the maximum theoretical biogas production is applied to the considered samples.

$$B_{th}\left(m^3/Kg\right) = \frac{a \times 22.415}{(12\times a)+b+(16c)+(14d)} = \mathbf{0.9727}$$

Value obtained from this is assumed that 100% of the food waste substrate is broken down. But practically, only 40 to 65% of the organic material is broken down.

Experimental setup

Lab scale experiment was performed in 20 liter bottle digesters under batch system. In the batch system, the slurry has been added once to the digester for whole duration of the process. In this experiment kitchen waste and water mixed with the ratio of 1:2 with fixed amount of inoculum (Cow dung). Inoculums are the anaerobically digested slurry containing anaerobic bacteria which are responsible for biogas production. Following are the materials used for the construction of equipment.

- 20 liter container (used for drinking water storage)
- Taplon tape & Aldilite
- PVC pipe 2.5'' (length ~ 1 m)
- plastic cape (to seal container)
- Funnel (for feed input)
- Cape 2.5" (to seal effluent pipe)
- Ball Valve 0.5 " (for gas output, I was used it with G.I. nipple 0.5")

e-ISSN:2320-0189
p-ISSN:2347-2308

- Air bag – for gas collection

This analysis has been done under 5week's observation for kitchen waste in the time period of August 4, 2014 to September 9, 2014. This time period comes under monsoon season. Kitchen waste synthesis of gas has been started from the fifth day of the slurry feeding inside the biogas chamber but methane fraction was obtained on seventh day. Solid waste of kitchen waste rapidly disintegrated by microorganism so the production of biogas stopped after 25th day. The slurry temperature is always more than ambient temperature during the period of experimentation. Parameters taken for experimental setup are tabulated in **Table 2.**

Table 2: Parameters for Experimental setup.

Parameters	Value
Amount of Kitchen Waste	6 kg
Amount of water added	12 lit
Amount of in coloum added	2 lit
Waste to water ratio	1:2
Retention time	25 days
P^H	3.5

Table 4. Results obtained from chromatography Sample.

Biogas Production (m^3)	0.26157
Biogas Production (m^3/kg)	0.17438
CH_4 (%)	58
CO_2 (%)	38
H_2S (%)	2
Water Vapour (%)	0.8

RESULTS AND DISCUSSION

Results from Proximate analysis are in **Table 3 and Table 4** indicates the results of biogas chromatography (Table 3 and 4).

Table 3. Characterization of food waste.

Moisture content (%)	75
Total Solid (%)	25
Volatile Solid (%)	95
Ash Content (%)	19.4

Kitchen waste is composition of various food wastes and thus the effects of mixing various types of food waste and their proportions should be determined on case by case basis. In this analysis kitchen waste without shedding and meshing was used and found that from experimental observation biogas yield is 0.16834m^3/kg. However using ultimate analysis theoretical estimation indicates biogas yield is 0.9689m^3/kg. This indicates that, there is a large gap between theoretical estimation and experimental results in the yield of biogas because no shredding has been done. Utilization of kitchen waste in universities is more useful where a lot of other energy sources can be saved or reduced for cooking purposes like LPG, kerosene, coal etc. Present investigation is on lab scale model where as one can produce biogas on a larger scale

ACKNOWLEDGMENT

Proximate analysis of food sample was performed at Department of Pure and Applied Chemistry, IIT Madras.

REFERENCES

1. Tchobanoglous G, et al, Integrated Solid Waste Management, McGraw-Hill Inc, New York, 2010.
2. Shimelis B, Generation Composition and Characteristics of Urban Solid Waste in a Major Khat Producing and Marketing Area in Eastern Ethopia , International Journal of Environmental Protection 2011;1: 9–16.
3. Curry N and Pillay P, Biogas prediction and design of a food waste to energy system for the urban environment. Renewable Energy 2011; 41: 200 -209.
4. Agrahari R and Tiwari GN, Comparitive Study of Biogas Production: Utilization of Organic Waste, International Journal of Environment and Resource 2014; 3: 1-6.

This article was published under the special issue, **Integrated Waste management and Energy Recovery** handled by Editor. Dr. P. Prashanthi Devi, Bharathidasan University , India.