Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 2937-2942
Received: 01-07-2018
Accepted: 03-08-2018

B Prasanna Kumar
Department of Agricultural Microbiology and Bioenergy, Professor Jayashankar Telangana State Agricultural University (PJTSAU), College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Dr. S Triveni
Department of Agricultural Microbiology and Bioenergy, Professor Jayashankar Telangana State Agricultural University (PJTSAU), College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Dr. A Vijaya Gopal
Department of Agricultural Microbiology, Acharya N.G Ranga Agricultural University (ANGRAU), Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh, India

Correspondence
B Prasanna Kumar
Department of Agricultural Microbiology and Bioenergy, Professor Jayashankar Telangana State Agricultural University (PJTSAU), College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Experiment on biogas production by anaerobic fermentation of maize straw and cattle dung in lab-scale fermentor

B Prasanna Kumar, Dr. S Triveni and Dr. A Vijaya Gopal

Abstract
Anaerobic digestion is becoming more and more attractive for the treatment of high strength organic wastes. It is a microbial process for production of biogas, which consists of primarily methane (CH_4) & carbon dioxide (CO_2). Mixture of maize straw residues along with cattle dung was anaerobically digested in a 3 Lit capacity lab scale batch reactors. Biogas can be used as energy source and also for numerous purposes. But, any possible application requires knowledge & information about the composition and quantity of constituents in the biogas produced. Anaerobic co-digestion strategies are needed to enhance biogas production when treating certain residues such as cattle dung. Co-digestion of agricultural waste i.e., maize straw with cattle dung or other feedstocks with low carbon content can improve process stability and methane production. In this study, anaerobic digestion and co-digestion of cattle dung with maize straw using microbial consortium have been experimentally tested to determine the biogas potential. Among two treatments and intervals the TS % was found highest with the treatment T_2 (Biogas production with pretreatment) i.e., 9.30 % as when compared to T_1 (Biogas production without pretreatment) i.e., 7.00 %. pH was found to be highest in the treatment T2 (Biogas production with pretreatment) i.e., 6.30 as when compared to T_1 (Biogas production without pretreatment) i.e., 6.20. At the end of the anaerobic fermentation process the methane gas production was significantly more in AW-T_2 (Biogas production with pretreatment) 3531.10 ml, compared to AW-T_1 (Biogas production without pretreatment) 3381.00 ml, HW-T_2 (Biogas production with pretreatment) 2620.70 ml and less in HW-T_1 (Biogas production without pretreatment) 2381.40 ml.

Keywords: Experiment, biogas production, anaerobic fermentation, lab-scale fermentor.

Introduction
One of the burning problems faced by the world today is management of all types of wastes and energy crisis. Rapid growth of population and uncontrolled and unmonitored urbanization has created serious problems of energy requirement and solid waste disposal. Vegetable market wastes contribute to a great amount of pollution; hence, there has been a strong need for appropriate vegetable waste management systems [8]. One of the renewable energy sources is biogas. These gases derived from a wide range of organic wastes such as biomass waste, human waste, animal waste through the process of anaerobic digestion and it can be used as energy. Production of biogas from animal manure, especially cow is very potential and has an advantages, energy derived from it is very environmentally friendly since in addition to utilizing the waste from livestock, left over from the process (biogas slurry) can be used as organic fertilizer that is rich in the elements required by plants. The process of digestion and production of biogas depends on the composition of feedstock and the fermentation products of the vegetable wastes. The main objective of this research is to employ anaerobic digestion process as a sustainable technology for digesting the vegetable wastes, produced in large amounts during harvesting, handling, transportation, storage, marketing and processing, and to provide the renewable source of energy as well as to reduce the potential greenhouse gas emission [9]. The specific objectives are (i) to optimize the methane gas evolution from the vegetable waste. (ii) To get an understanding of the anaerobic digestion of the vegetable wastes under ambient temperature conditions by conducting a lab scale study and hence to investigate the biogas yield and the kinetics of anaerobic digestion of vegetable waste fed.
Several factors that affect the production of biogas are the condition of the digester, pH, nutrients, temperature, the ratio C / N, and starter [10, 11]. The condition in the anaerobic digester must be kept in equilibrium and dynamic. The degree of acidity is maintained in the range of 6.6 to 7.6 for bacteria metanogenic can only work in above range of pH [12]. Adequate levels of nutrients such as nitrogen and phosphorus must be added in the system to ensure the availability of nutrients for bacterial growth [13].

The techniques used for the conversion of organic materials to biogas have been in existence for many years. Methane generation has been applied to meeting the energy needs in rural areas. In the England, India, Taiwan, for example, methane generating units as well as plants using cow manure and municipal waste have been in operation for years. In United States there has been considerable interest in the process of anaerobic digestion as an approach to generating a safe clear fuel as well as source of fertilizer [14, 15]. The rate of biogas production depends: the nature of the substrate, temperature, pH, loading rate, toxicity, stirring, nutrients, slurry concentration, digester construction and size, carbon to nitrogen ratio, retention time, alkalinity, initial feeding, total volatile acids, chemical oxygen demand (COD), total solid (Ts), volatile liquids etc. This paper presents results of the study on biogas production from fruits and vegetable wastes aimed and at comparing the quantity of biogas produced from the substrates [15].

Materials and Methods

1. Sources and generation of maize straw and cattle dung sample

Agricultural waste which is maize straw and other items is taken for studies. The generation of maize straw is a process that must be accomplished by different farming conditions. The agricultural waste i.e a substantial amount of biomass residues are available as by-product from other agricultural produce through milling and packaging process. Realising the limited crop level database in the country, it was felt necessary to create local database of biomass for decentralized energy production. Traditionally cow dung has been used as a fertilizer, though today dung is collected and used to produce biogas. This gas is rich in methane and is used in rural areas.

2. Sample collection

Sample i.e maize straw was collected from the farmer fields and cattle dung was collected from the cattle sheds of the farmers at different locations which are collected about different quantities and mixing together, forms semi solid state.

3. Reactor set-up

Biogas production was studied in the lab with four treatments and three replications each and with 250 grams cowdung, 500 grams substrate and 1000 ml water (1:2:5). A completely recycled anaerobic glass bottle made from cylindrical column of borosilicate glass with total volume of 3 L was utilized in the study. The glass bottle was blanketed with a corkborer to avoid entry of direct sunlight and escape of process heat. Reactor system for anaerobic fermentation with arrangement for feed, recirculation and biogas measurement is made by using 1 liter container (Measuring cylinder), Solid tape, M – seal, Rubber or plastic cape (to seal container), Funnel (for feed input), Cape 0.5" (to seal effluent pipe), Pipe (for gas output, I was used level pipe) (3-5 m), Bucket (15-20 litter) and Bottle – for gas collection (2-10 lit.

4. Reactor operation

The maize straw and cattle dung slurry was fed to the reactor from the top by a one way funnel and the equal quantity of the reactor dig estate was withdrawn for the physico chemical analysis. The complete recycle was done to obtain complete mixing/agitation of the reactor dig estate. The controlled up flow pattern of maize starw with cattle dung slurry through the reactor renders stratification of the phases such as hydrolysis, acidogenesis and methanogenesis. Such a pattern of single phase reactor operation provides advantages of two phase reactor.

5. Inoculum

Cattle dung slurry along with some cellulose degrading bacterial consortium was used as a source of inoculum since rumen of cattle dung contains anaerobic microbial population. The cow dung slurry was prepared by mixing water in 1:2:5 proportions and sieved to remove coarse particles. The cow dung slurry and the starw were mixed in 1:2 proportion and the mix was poured in the reactor. The reactor content was mixed thoroughly by 100 % recirculation from the outlet (top) to the inlet (bottom) of the reactor with manual stirring process.

6. Anaerobic digestion tests

The biodegradability and biogas yield of feedstock were determined at 37 °C using three batches anaerobic digestion tests with the total volume of each reactor 3 L. Cellulose degrading bacterial consortium used as inoculums for the anaerobic reactors. The dosage of substrate was adjusted by VSS content to avoid overloading of reactors. Daily biogas production from each digester was measured by using measuring cylinder. Along with the estimation of biogas production different parameters like Total Solids (TS %), Total Volatile Solids (TVS %), Volatile Fatty Acids (VFA), pH, Nitrogen (N %), Phosphorous (P %), Potassium (K %), Organic carbon, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), cellulose %, microbial population count, methane and bioethanol percentage were estimated.

7. Total solids percentage (TS %) in the slurry samples

Total solids % in the slurry samples were determined by drying a 100 g of sample for 105 ^{o}C for 24 h (APHA, 1992).

$$\text{Total solids} = \frac{\{(\text{Dry weight of the sample} + \text{weight of crucible}) - (\text{weight of the crucible})\}}{\text{fresh weight of the sample}} \; x \; 100$$

8. pH in the slurry samples

pH of the slurry samples were determined in 1:2.5 substrate: water suspension by using digital pH meter (Systronics µ pH system361) (Jackson, 1973).

9) Total N, P, K content in the slurry samples

9.1) Total Nitrogen content

Total nitrogen in slurry samples were estimated by modified Kjeldahl method using sulphuric and salicylic acid mixture. One gram of slurry sample was taken into 100 ml conical flask, 30 ml of sulphuric acid - salicylic acid mixture and 0.5 g of sodium thio-sulphate was added mixed well and kept aside for half an hour and digested on flame. After 30 min of digestion, one gram of copper sulphate and 10 g of potassium sulphate was added, digestion was continued till colourless solution obtained. The digested material was washed with distilled water and only supernatant liquid was transferred to a beaker. From that beaker solution was transferred to kjeldhal flask. 50 ml of 4 % boric acid taken into 250 ml conical flask to which two drops of mixed indicator was added and kept at the flask at the receiving end of distillation set in such a way that the receiving end immersed into the solution. Few Zn pieces, little quantity of paraffin and 120 ml of 40 % NaOH was added to the Kjeldhal flask and immediately mouth of the

flask was closed. The distillation continued till no more ammonia was evolved at the receiving end of the distillation set. At the end of distillation, the tip of receiving end was washed with distilled water, contents of the flask were cooled and titrated against 0.01 N H_2S0_4 till blue colour changed to pinkish red colour.
Burette reading was noted and nitrogen % was calculated as:

Weight of the plant sample taken = 0.1 g
Blank titre value = B ml of 0.01 N H_2SO_4
Sample titre value = S ml of 0.01 N H_2SO_4
Actual titre value = (S - B) ml
1000 ml of 1 N H_2SO_4 = 14 g N
(S – B) ml of 0.01 N H_2SO_4 = $\frac{(S-B)0.01 \times 14}{1000}$
Present in 0.1 g plant sample = $\frac{(S-B)\ 0.01 \times 14 \times 100 \text{ g of N}}{1000 \times 0.1}$
100 g of plant sample contains = (S – B) × 0.14 % of N

9.2) Total Phosphorus content
Total phosphorus content in slurry samples were determined by perchloric acid digestion method using Barton's reagent as described by Jackson (1967). One gram of slurry sample was taken into 100 ml conical flask and 12-15 ml of tri acid mixture was added (Nitric acid: Sulphuric acid: Perchloric acid at 9:2:1). The mouth of the flask was covered with a funnel. The contents were digested over a sand bath till clear solution was obtained. The filtrate was collected and 5 ml was taken into 25 ml volumetric flask and 5 ml of Barton's reagent was added and volume made up to 25 ml with distilled water. Yellow colour was developed in 30 minutes and intensity of colour was measured in a photoelectric colorimeter using blue filter (470 nm). The colour will be stable for 24 h. Standard curve was prepared and the concentration of phosphorus in the solution was deduced from that value and the percentage of phosphorus in the sample was calculated.

Concentration of phosphorus in coloured solution = X ppm
i.e., 1 ml of coloured solution contains = X µg P
50 ml of coloured solution contains = 50 × X µg P
Which is present in 5 ml of the diluted digest = $\frac{50 \times X \times \frac{100}{5}}{P}$ = X × 1000 µg
100 ml of diluted plant digest contains of = $X \times 1000 \times \frac{100}{1}$
Which is obtained from 1 g sample = $X \times 10^5 \times 10^{-6}$ % of P
100 g of sample consists of = X × 0.1 %

9.3) Total Potassium content
Tri-acid extract was directly aspirated to the flame photometer to estimate the total potassium content (Systronics flame photometer 128) by Jackson (1967). 5 ml of tri-acid extract was taken into 25 ml volumetric flask and volume made upto the mark with distilled water. The concentration of K in the solution was measured using flame photometer. Standard curve was prepared and the concentration of K in the solution was deduced from that value and the percentage of K in the sample was calculated. Amount of K present in the sample (% of K) =

Concentration of K in the sample = X ppm
1 ml of the sample = X µg of K
100 ml of the sample =?
= 100 × X µg of K
1 g of sample = 100 × X µg of K
100 g of sample =?
= $\frac{100}{1}$ × 100 × X µg of K
= $X \times 10^4 \times 10^{-6}$ g K
= X × 0.01 %

10) Total Organic Carbon content
Organic carbon content of the slurry sample was estimated by Walkley and Black's wet oxidation method as outlined by Walkley and Blacks (1934). One gram of slurry sample was taken 500 ml conical flask and to it 10 m1 of 1 N $K_2Cr_2O_7$ and 20 ml of Conc. H_2S0_4 was added. Diphenylamine indicator was added and titrated with 0.5 N ferrous ammonium sulphate solution until green colour appearing. A blank was run along with the sample.
Organic carbon % in slurry sample =

$$\frac{10\ (B - S)}{B \times 0.003 \times \frac{100}{\text{weight of the sample taken (g)}}}$$

Titre value of the blank in ml = B
Titre value of the sample in ml = S

11) Measurement of Gas production
The biogas production readings were taken on an alternate day by water displacement method with the measuring jar.

11.1) Estimation of methane percentage using gas chromatography
Methane percentage in the biogas was estimated by using gas chromatography (Bruker-450) with a Flame Ionization Detector (FID) temperatures were maintained at 300 °C in the detector, 75 °C in the injector and 50 °C in the oven. The column used was porapak Q. The gas flow in the column was maintained as 60 ml min^{-1}.

Fig 1: Experimental set up of a laboratory scale anaerobic tubular digester.

Experimental Result

Table 1: Composition of different substances at initial stage of the experiment:

Agricultural Waste	Total solids % (TS)	pH	N %	P %	K %	Organic Carbon %
T_1	7.00	6.20	1.68	1.50	1.09	33.40
T_2	9.30	6.30	1.50	1.30	1.00	45.60
C.D.	1.033	0.535	0.079	0.037	0.037	2.125
SE(m)	0.332	0.172	0.025	0.012	0.012	0.682
C.V.	4.068	3.950	3.285	2.444	2.444	4.103

AW-T_1-M_1-C_1- Biogas production without pretreatment
AW-T_2-M_1-C_2- Biogas production with pretreatment

Among two treatments and intervals the TS % was found highest with the treatment T_2 (Biogas production with pretreatment) i.e., 9.30 % as when compared to T_1 (Biogas production without pretreatment) i.e., 7.00 %. pH was found to be highest in the treatment T_2 (Biogas production with pretreatment) i.e., 6.30 as when compared to T_1 (Biogas production without pretreatment) i.e., 6.20. Among Nitrogen, Phosphorus and Potassium percentages were highest in the treatment T_1 (Biogas production without pretreatment) on an average as when compared to T_2 (Biogas production with pretreatment). Percentage of Organic carbon was also showing highest in the treatment T_2 (Biogas production with pretreatment) i.e., 45.60 % as when compared to T_1 (Biogas production without pretreatment) i.e., 33.40 % (Table. 1).

Table 2: Composition of different substances at end of the experiment:

Agricultural Waste	Total solids % (TS)	pH	N %	P %	K %	Organic Carbon %
T_1	13.59	6.38	1.80	1.85	1.24	35.20
T_2	10.43	6.61	1.69	1.43	1.11	46.00
C.D.	0.968	0.543	0.124	0.062	0.034	2.192
SE(m)	0.311	0.174	0.040	0.020	0.011	0.704
C.V.	3.950	3.931	4.388	3.584	1.899	4.097

AW-T_1-M_1-C_1- Biogas production without pretreatment
AW-T_2-M_1-C_2- Biogas production with pretreatment

During the fermentation process, the organic matter can be distributed into the product (biogas) and the remaining unfermented material in the residue. It means the organic content of the waste is reduced with simultaneous production of biogas in a fermentation process. The above results are giving that the Percentage of Total solids in both the treatments of initial and end of the experiment. At the end of the experiment among two treatments and intervals the TS % was found highest with the treatment T_1 (Biogas production without pretreatment) i.e., 13.59 % as when compared to T_2 (Biogas production with pretreatment) i.e., 10.43 %. pH was found to be highest in the treatment T_2 (Biogas production with pretreatment) i.e., 6.61 as when compared to T_1 (Biogas production without pretreatment) i.e., 6.38. Among Nitrogen, Phosphorus and Potassium percentages were highest in the treatment T_1 (Biogas production without pretreatment) on an average as when compared to T_2 (Biogas production with pretreatment). Percentage of Organic carbon was also showing highest in the treatment T_2 (Biogas production with pretreatment) i.e., 46.00 % as when compared to T_1 (Biogas production without pretreatment) i.e., 35.20 % (Table. 2).

Table 3: Biogas production in ml at different intervals

Biogas (ml)	End of 7^{th} day (ml)	End of 15^{th} day (ml)	End of 30^{th} day (ml)	End of 45^{th} day (ml)	End of 60^{th} day (ml)
T_1	550.00 (57.51)	720.30 (58.12)	980.20 (59.02)	580.00 (46.20)	550.50 (35.22)
T_2	680.30 (57.33)	700.20 (58.35)	950.30 (58.89)	620.30 (45.70)	580.00 (36.24)

All the biogas production units with four treatments and three replications were set on the same day with 250 grams cow dung, 500 grams substrate and 1000 ml water (1:2:5 ratio). The results of biogas production revealed that, the end of the 7^{th} day in AW-T_2 (Biogas production with pretreatment) 680.30 ml of biogas was released followed by (550.00 ml) in AW-T_1 (Biogas production without pretreatment). At the end of 15^{th} day 720.30 ml of biogas was released in AW-T_1 (Biogas production without pretreatment). At the end of 30^{th} day in AW-T_1 (Biogas production without pretreatment) more amount of biogas was evolved (620.30 ml). At the end of 60^{th} day highest gas production was observed in AW-T_2 (Biogas production with pretreatment) (580.00 ml). Based on the water displacement readings more biogas evolved in AW-T_1 (Biogas production without pretreatment) at 15^{th} day (550.00 ml), 30^{th} day (980.20 ml), AW-T_2 (Biogas production with pretreatment) having more biogas evolution at 7^{th} day (680.30 ml), 45^{th} day (620.30 ml) and 60^{th} day (580.00 ml) (Table 3).
The above results were similar to that of Vikrant and Shekar. (2013) who studied on the anaerobic digestion of horticulture waste for production of biogas with combination of the mixed inoculum was used for biogas production at 37 ºC in laboratory (small scale) reactor and results were obtained as in between 10 to 150 ml during the process of anaerobic digestion.
In the above result methane (CH_4) in the four treatments was similar to that of Ziganshin *et al.* (2013) [6] who conducted an experiment was anaerobic digestion in laboratory scale biogas reactors fed with different agricultural waste materials and obtained the results of methane (CH_4) (57.50, 51.70 and 44.20 % in different biogas reactors).

Discussions
The chemical composition in the treatments of biogas production differed significantly. Nutrient content in different treatments depended mainly on substrate used, ratio of the dung and supplementing substrate used, maintenance of moisture in the treatments, environmental conditions and the time kept for running the experiment.
The fatty acids and alkalinity concentration showed fast changes when the stability of the anaerobic digestion process is upset. Because, when the process is not stable, the volatile fatty acids concentration increases, and the alkalinity decreases. The ratio of these two parameters can be a good indicator for the observation of the stability of the anaerobic digestion process. Although, variations in digester performance were observed in the early period of digestion, the observed pH of 6.65-7.81 were primarily within the acceptable range for anaerobic digestion for the entire operations. This implies average buffering capacity of the mixed substrate. Generally, degradation of substrates starts between day one to day three before it commences the production of biogas.
The slight change in pH from slightly acidic to neutral is due to increase in N, P and K content or Organic matter content. The results found that pH of the substrate has a significant effect on biogas production, because it affects the activity of bacteria to degrade organic matter into biogas. A low pH in the digester inhibits the activity of microorganisms involved in the digestion process particularly methanogenic bacteria.
There was a significant variation in available nitrogen content in substrates between different treatments. This variation in available nitrogen content of substrates was noticed in all the stages of biogas production period.
It is evident from this experiment that increase in phosphatase activity by microorganisms leads to increase in amount of phosphorus which support the phosphate availability in the substrates. More increase in phosphorus in different treatments is probably due to mineralization and mobilization of phosphorus due to microbial population. During organic matter decomposition by the microorganisms is the major

mechanism for solubilisation of insoluble phosphorus, which subsequently results in increase in phosphorus content.

This could be attributed to the fact that with the passage of time the substrate composition changes and becomes suitable for microorganisms to work upon, in turn increasing the activity of potassium in substrates between different intervals.

The breakdown of organic matter during the biogas production process is dependent on several factors working in concert. These include moisture, microbial populations, Oxygen (O_2), and a balance of Carbon (C) and Nitrogen (N). Microorganisms in the organic matter (OM) consume the readily available carbon. As it is metabolized, temperatures increase in the compost pile and Carbon dioxide (CO_2) is released. As a result, the pile is newly populated with thermophilic, or heat-loving, bacteria that consume the rest of the degradable carbon. As microbial activity slows, temperature decreases, allowing for colonization by fungi that slowly consume much of the remaining recalcitrant forms of lignins and cellulose. The resulting crumbly, earthy humus is considerably more stable than manure, meaning that its nutrients are less likely to be lost to leaching or volatilization into the atmosphere. Nitrogen losses impact negatively on the manure composting process, by decreasing nutrient concentration and hence compost quality, and generate health and environmental problems. Nitrogen losses through composting can occur by NH_3-volatilisation, leaching and denitrification. Denitrification can occur as a result of the development of anaerobic microsites within the material.

Biogas production resumption time was longer with longer low temperature duration; and increased rapidly, then decreased slightly when temperature was restored in the low temperature duration of 12 h and 24 h. The delay in recovery was presumably due to the slow degradation of relatively low methane-yielding cellulosic materials. The products resulting from fermentation require an additional transformation before being able to produce methane. It is here that intervene the acetogenes reducing bacteria and the sulfato-reducing bacteria, producing hydrogen sulphide (H_2S). The ultimate phase during which two types of methanogenes bacteria take over: the first ones (acetogenes) reduce methane acetate, CH_4 and bicarbonate. The second ones reduce methane bicarbonate. Rises in the methane content of biogas as a result of a decrease in the bioreactor temperature. The increase in the quality of biogas is attributed to the raised solubility of carbon dioxide at the lower temperature cycle.

Conclusion

Biological pretreatment with complex microbial agents proved to be an efficient method to improve biodegradability to enhance composting, vermicomposting and biogas production of agricultural waste and horticultural waste. Compared to untreated controls the pre-treated agricultural and horticultural waste yielded higher manurial value and given more biogas production. The enhanced biogas production was attributed to the improved biodegradability of the straw and fruit waste as indicated by increased TS and VS reductions and a shortened digestion time. Cow dung along with other agricultural waste and horticultural waste were used for the biogas production and the same substrates were also used for compost, vermicompost making and alcohol production in lab scale. In the present study, results revealed that agricultural and horticultural wastes pretreatment with efficient microbes helped aerobic composting, vermicomosting, and bioethanol and biogas production under anaerobic condition. By the pretreatment of agricultural waste, horticultural waste were easily degraded by enriched cultures and their enzyme activities. In the present study vermicompost with microbial pretreatment enhanced degradation and nutrient values compared to regular composting methods. Compared to aerobic composting, vermicomposting and anaerobic digestion showed to be better, more useful for biogas production and manurial value.

However, all the combinations were good in terms of their manurial value as the total solids, total volatile solids percentage will be higher in horticultural waste (pretreated one rather than without pretreated one) compared to agricultural waste. The N, P and organic carbon % increased in all the treatments of horticultural waste compared to agricultural waste. Considering the characteristics of the high moisture solid waste of agricultural and horticultural waste, anaerobic digestion represents a feasible and effective method to convert the waste to biogas fuel. The agricultural waste was found to be the best in biogas production as compared to horticultural waste. Horticultural waste was comparatively better in terms of N, P, K and organic carbon %.

After the thorough study on the performance of reactor and evolution of acido genic reactor, the following collusion have been reached, As a result of the treatment of food effluent using microorganisms, the useful bi product, bio-gas has been produced with a considerable rate of decrease in the values of COD, BOD, pH, acidity and alkalinity. Through the successful anaerobic processing inside the reactor in 90days food waste treatment, methanogen gradually converts the organic acids into the methane gas and carbon dioxide, which indicates that the waste has better anaerobic biodegradability. Thus achieves a waste of resource utilization. The results show that reactor can treat food waste with high contaminated load.

Acknowledgments

We would also like to show our gratitude to the members of my advisors for sharing their pearls of wisdom with us during the course of this research, I am grateful to the members of Department of Agricultural Microbiology and Bioenergy for their valuable encouragement, many useful discussions and acknowledged the facilities provided for conducting this research smoothly.

References

1. APHA. Standard methods for the examination of water and wastewater, 18th edition. Washington, DC: American Public Health Association, 1992.
2. Jackson ML. Soil chemical analysis. Prentice Hall of India, Ltd, New Delhi. 1973; 60:7-33.
3. Jackson ML. Soil chemical analysis. Prentice Hall of India, Ltd, New Delhi, 1967, 498.
4. Walkley W, Blacks CA. An examination of the degtjareff method for determination of soil organic matter and a prosed modification of the chromic acid titration method. Soil Science. 1934; 37:173-179.
5. Vikrant D, Shekhar P. Generation of biogas from kitchen waste-experimental analysis. International Journal of Engineering Science Invention. 2013; 2(10):15-19.
6. Ziganshin AM, Liebetrau J, Proter J, Kleinsteuber S. Microbial community structure and dynamics during anaerobic digestion of various agricultural waste materials. Applied Microbiology and Biotechnology. 2013; 97:5161-5174.
7. Velmurugan B, Ramanujam RA. Anaerobic digestion of vegetable wastes for biogas production in a fed-batch

reactor. International journal of emerging sciences. 2011; 1(3):478-486.
8. Dhanalakshmi SV, Ramanujam RA. Biogas generation in a vegetable waste anaerobic digester: An analytical approach. Research Journal of Recent Sciences. 2012; 1(3):41-47.
9. Khasristya A. Rancang Bangun dan Uji Kinerja Biodigester Plastik Polyethilene Skala Kecil (Studi Kasus Ds. Cidatar Kec. Cisurupan, Kab. garut), Tugas Akhir, Fakultas Pertanian, UNPAD, Indonesia, 2004.
10. Lusk PD. Methane recovery from animal manures. The Current Opportunities Casebook. NREL/SR-580-25145, 1998.
11. Metcalf E. Wastewater engineering: treatment disposal reuse, 2nd edition, McGraw-Hill Publishing Company, San Francisco, California, USA, 1979
12. Syamsudin TR, Iskandar HH. Bahan bakar alternatif asal ternak, sinar tani, Edisi. 2005; 21:3129.
13. Hilkiah IMFN, Abowei MJ, Ayotamuno Eze, CL. Effect of total solids concentration of municipal solid waste on the biogas produced in an anaerobic continuous digester. Agricultural Engineering International: the CIGR Ejournal. 2008; 10:1-11.
14. Kumar S, Gaikwad SA, Shekdar AK, Kshirsagar PK, Singh RN. Estimation method for national methane emission from solid waste landfills. Atmospheric Environment. 2004; 38:3481-3487.
15. Sagagi BS, Garba B, Usman NS. Studies on biogas production from fruits and vegetable waste. Bayero Journal of Pure and Applied Sciences. 2009; 2(1):115-118.