BAJOPAS Volume 12 Number 2, December, 2019 **http://dx.doi.org/10.4314/bajopas.v12i2.5**

Bayero Journal of Pure and Applied Sciences, 12(2): 33 - 39
Received: March, 2019
Accepted: August, 2019
ISSN 2006 – 6996

COMPOST MAKING FROM REFUSE SOURCED FROM KANO METROPOLITAN, KANO STATE, NIGERIA

Yola, I. A., and Diso, I. S.
Department of Mechanical Engineering, Faculty of Engineering, Bayero University, P.M.B 3011 Kano, Nigeria.
iayola.mec@buk.edu.ng and isdiso.mec@buk.edu.ng

ABSTRACT
Municipal-solid waste (MSW) in towns and cities of Nigeria are either allowed to rot or burnt which causes the release of greenhouse gases in the process. The heap of uncollected refuse in Kano municipal causes serious health hazards and menacing public disorder. This research investigated the Kano municipal refuse for compost making, instead of using waste disposal technique such as landfilling. Refuse samples from Dorayi/Zage and Rimin Kira refuse dumping sites Kano Municipal, Kano State Nigeria were collected. The refuse samples were sorted and all the non-biodegradables materials were removed. A compost was made from Sample N in 20 days while 9 days was required to produce a compost from sample P. Kjeldahl Nitrogen determination method and simple procedure for total carbon determination method were used to determine the percentages of nitrogen and carbon in the samples. The results have shown that, the percentages of nitrogen in the samples were found to be 1.64% for sample N and 1.71% for sample P. The percentages of carbon in the samples are 6.8% for sample N and 6.3% for sample P. The C/N ratio for sample N was 4.15:1 and that of sample P was 3.69:1.Kano municipal refuse contains a lot of organic wastes which are very difficult to incinerate. Therefore, Composting method is the best option for the disposal of the refuse rather than directly dumped in the streets.
Key words: Refuse, Solid Waste and Composting.

INTRODUCTION

Municipal solid waste is defined as the refuse from households, non-hazardous solid from industrial, commercial and institutional establishments, market waste, yard waste and street sweepings (Ogwuleke, 2009). Sometimes the solid waste generated may have some traces from hospital, industrial and construction wastes. Refuse in municipality are generally residential waste generated by households living either in single family or multi –family. Composition of municipal solid waste provides a description of the constituents of the waste and it differs widely from place to place (Kuruparam *et al.*,2003). The waste generated contains organic, non-recyclable and hazardous wastes. An increase in waste is directly related to population growth, economic growth and industrial revolution (Wirachapan, 2014) . It is an index of socio-economic development and economic prosperity of the area. Population and economic growth increase solid waste generation rates and also changes its composition. It is estimated that in 2006 the total amount of municipal solid waste generated globally reached 2.02 billion tones, representing a 7% annual increase since 2003 (Mohammed, 2014). The volume of refuse in Kano municipality presents a problem in handling and transportation. Sometimes the refuse is kept for many days up to the time when decomposition takes place. In recognition of the environmental threats posed by heaps of uncollected wastes around the populace constituting serious health hazards and menacing public disorder, it is time to start thinking on how this refuse can be recycled instead of using waste disposal techniques such as landfilling. Landfill and incineration are mostly used for solid waste disposal throughout the world. The land filling of biodegradable waste is proven to contribute to environmental degradation, mainly through the production of highly polluting leachate and methane gas (Saleh *et. al* 2011). Biodegradation of Municipal solid in non-regulated landfill eventually generate methane that is emitted to the atmosphere. The methane gas is the contributor to the greenhouse effect and global warming(Nickolas 2007).Landfills are estimated to be responsible for 35-69Tg CH_4 $year^{-1}$ and their emission constitutes 30% of the global anthropogenic emissions of methane to the atmosphere (Marion et. al.,2008).

Composting

Composting is defined as "intense microbial activity leading to decomposition of most biodegradable materials (Boulter *et al*.,2002). Composting or controlled decomposition of organic materials requires green and brown organic materials. "Green" organic materials include grasses, food wastes and manure. These materials contain large amount of Nitrogen. "Brown" organic materials include: dry leaves, wood and branches of trees which contain large amount of carbon but little nitrogen. Shredding the materials of the compost into smaller pieces, adding the right quantity of water and ensuring proper aeration by regularly turning the mixture will increase the speed and the decomposition process (Jayaprakash *et. al*., 2018). Homogeneuos mixture improves compost insulation which helps in maintaining optimum temperatures and serves as a signs of microbial activiries in the compost bin (Misra *et.al*.,2003). However, if the materials of the compost are too small, they might prevent air from flowing through the compost bin. A compost needs enough water for the microorganisms living in the compost bin to survive and support the metabolic activity of the micro-organism(Misra et.al., 2003).The use of composted organic wastes produces changes in soil physical, chemical and biological properties which will enhance plant growth(Gabiala 2010). Maria *et al*., (2011) conducted a research on organic fertilizer using fish remains and seaweed. A compost was produced by mixing fish remains and seaweed to obtain a fertilizer suitable for use in organic agriculture. Hardly and Bruno (2012) conducted a research, the study was to test whether biochar effects on soil quality and plant growth could be improved by addition of mineral and organic fertilizers. The research was conducted under tropical conditions (26^{o}C and 2600mm annual rainfall) on an infertile sandy soil in greenhouse in five folds replication. The result showed that, pure compost application has higher yield during two growth periods followed by the biochar plus compost mixture. Paut *et al*., (2008) conducted a reach on rapid microbial dynamics and enzyme activities during rapid composting of municipal solid waste. The result revealed that, degradation of organic substance were quick in rapid composting as indicated by reduction of C/N ratio (below 20) while normal composting took more 20days to attain C/N ratio(below 20). Drozd (2003) conducted a research on the risk and benefits of utilizing compost from MSW in agriculture. The research revealed that, the use of compost from MSW improves the restoration of degraded soils and allows an appropriate final disposition. This research is based on how organic fertilizer (compost) can be made locally using the dumped refuse in Kano metropolis when mixed with a cow-dung by a method called composting.

MATERIALS AND METHODS

Preparation of Reagents

The reagents used in this research are : 1000ml of 0.1M Hydrochloric Acid; 1000ml of 0.1M Sodium hydroxide solution; 500ml of 0.1M Hydrochloric Acid; 250ml of 0.4M Sodium;2M chromic acid; Concentrated sulphuric acid; Sample K(Grass (Kansuwa)); Sample L(Saw-dust); and Sample M(Leaves (Neem)). Sample N is the compost from first analysis (Refuse from Dorayi/Zage) ; Sample P is the compost from second analysis (Refuse from Rimin Kira)

Quantitative Analysis of Nitrogen

Quantitative analysis is used to determine the relative amounts of components that are identified in a sample. Kjeldahl Nitrogen determination was used to determine the percentages of Nitrogen in the constituents of the refuse and in the composts in accordance with (Tadeusz *et. al*., 2013).

One gram of the sample was measured into a dry pyrex Kjeldahl flask and 20mL of hot concentrated sulphuric acid (purity = 98%, S.G = 1.84g) was added into the flask. The flask was shaken until the contents were well mixed. When the digestion was completed, the solution was allowed to cool. The flask was then connected to a distilling apparatus. 50 ml of 0.1 M HCl was placed in the receiver and the end of the condenser was just dipped into the acid. 50mL of 5% NaOH solution was then run into the flask, as soon as the alkali entered the flask, the tap was closed. The flask was shaken until the layers mixed. Then the flask was heated gently until the contents started boiling. The distillation continued for 40min so that the ammonia in the sample should have passed into the receiver that contained standard hydrochloric acid which neutralizes the ammonia and prevent loss by volatilization. 0.1MNaOH was used to neutralize the H_2SO_4 acid and evolved ammonia from the samples. Few drops of methyl red were added to NH_4Cl and the excess HCl acid in the solution was titrated with 0.1M sodium hydroxide. The same procedure was used to determine the percentages of nitrogen in the samples (Tadeusz *et. al.,* 2013)

Percentages of Nitrogen

The percentages of nitrogen in the samples were calculated using the following equation adopted by Tadeusz *et. al.,* (2013).:

$$ml_A \times N_A \times eq.wt_B \times 100/mg_{sample} = \% B$$

Equation 1

Where :

Subscript A is for the titrant

Subscript B is for the titrated substance

ml_{A} = this depends on the final volume of the titrant

mg_{sample} = 1000mg

N_A = Normality of the titrant = 0.1N

$eq.wt_B$ = is the equivalent weight of the titrated substance = 53.5g

mg_{sample} = milligram of the sample

Quantitative Analysis of Carbon

Carbon in the soil and plant materials can be determined by wet and dry combustion method. In both instances soil and plant carbon is converted into carbon dioxide absorbed in alkali and then determined either by titration against a standard acid or by weighing.The percentages of carbon in the refuse samples were determined using simple procedure for the determination of total carbon and it's radioactivity in soil and plant materials presented by Dalal (1979).

20mg of a sample was measured and poured into McCartney bottle and 5mL of 2M Chromic acid was added into the bottle rapidly. A test-tube containing 5ml of 0.4M sodium hydroxide solution was lowered into the bottle which was immediately stoppered tightly. Four blanks were prepared simultaneously. The bottle was heated on hot plate for 30mins then left overnight at room temperature. The test-tube was then removed from the bottle and the 0.4M sodium hydroxide solution was transferred into a graduated tube fitted with a stopper. The volume was made up to 10mL with carbon dioxide free distilled water and then transferred into a beaker. 1mL of saturated barium chloride solution and 0.05mL of phenolphthalein solution (prepared in ethanol) were added into the remaining 9.0mL of sodium hydroxide in the tube. The mixture was titrated against 0.lM hydrochloric acid until the colour of the solution changed from red to colourless. The same procedure was used to determine the percentages of carbon in the samples (Dalal, 1979).

If cow-dung is taken as an example, 2.6ml of HCl was used for the titration.

If 1mL of 0.1M hydrochloric acid = 0.6mg (Dalal, 1979)

Therefore,2.6mL = 2.6 x 0.6mg of carbon = 1.56 mg of carbon.

The percentage of carbon in the cow-dung sample is given as

1.56/20 x 100 = 7.8%.

Compost Bin

A bin is a receptacle either constructed from wood or some other appropriate vessel with or without a roof (NEH, 2000). The bin was constructed from two different sizes of hardwood (timber). The frame was constructed from 5cm x 5cm wood and the legs were constructed using 8cm x 5cm wood. The size of the compost bin was 1041.4cm x 812cm x762cm .The floor of the compost bin was made using cement, sand and gravel.

In-Vessel Composting

This type of composting method accommodates any type of organic waste, it also allows good control of temperature, moisture and air-flow. The materials are fed into the compost bin and frequently turned to make sure that the material is aerated. The size and capacity of the compost bin can vary (EPA 2017).

Composting I

8.2kg of refuse was collected from Dorayi/zage refuse dumping site. All the non-biodegradable materials were removed and the biodegradable materials were placed in the compost bin. .82kg of cow-dung and 0.006m^3 of water were added into the bin for compost making. The mixture was frequently turned and the temperature in the compost bin was recorded. The variation of temperatures with days in the compost bin is shown in Figure 1 and the compost was produced within 20 days(EPA 2017).

Composting II

3 kg of refuse was collected from Rimin Kira refuse dumping site. All the non-biodegradable materials were removed and the biodegradable materials were placed in the compost bin.300 grams of cow dung and 0.004m^3 of water were added in the compost bin. The mixture was thoroughly mixed in the bin and allowed to decompose. The variation of temperatures with days in the compost bin is shown in figure 2 and the compost was produced within 9 days.

The C/N Ratio

The optimum C/N ratio of raw materials varies between 25:1 and 30:1. A compost having a C/N ratio less than 20:1 leads to underutilization of nitrogen and the excess nitrogen is released to the atmosphere as ammonia or nitrous oxide (Misra et.al., 2003). If C/N ratio is very high, nitrogenous materials like cow-dung may be added to bring down the C/N ratio to the desired level.(Kvitra and Sabramarian,2007).

Two samples from the produced composts were collected and labeled as sample N (8.2kg of refuse mixed with 0.82kg of cow-dung) and Sample P(3kg of refuse mixed with 0.3kg of cow-dung). Kjeldahl Nitrogen determination method and simple procedure for the determination of total carbon and it's radioactivity in soil and plant materials were used to determine the percentages of nitrogen and carbon in the produced composts.

RESULTS AND DISCUSSION

The average end points of the titrations for samples (A-M) are presented in table 1. Tables 2 and 4 present the percentages of N, C and Cl in samples (A-M) and composts (N and P). The percentages of carbon in samples (A-M) and composts (N and P) are presented in tables 3 and 5 respectively. Table 6 presents the C/N ratio of composts (N and P).

Table 1: End Point Average of Titration

S/No	Samples	Titrant final volume in ml	Titrant final Volume in ml	End Point (Average) in ml
1	A	16.40	16.40	16.40
2	B	14.85	14.85	14.85
3	C	15.80	15.80	15.80
4	D	16.00	16.10	16.05
5	E	l5.20	15.20	15.20
6	F	l7.00	17.00	17.00
7	G	13.60	13.60	13.65
8	H	15.20	15.30	15.25
9	I	16.90	l7.00	16.95
10	J	16.60	16.70	16.65
11	K	15.90	15.90	15.90
12	L	16.50	16.40	16.45
13	M	16.30	16.20	16.25

Table 2: The Percentages of Nitrogen, Hydrogen and Chlorine in the Samples.

NO	SAMPLE	NH_4Cl	%N	%H	%Cl
1	A	8.77	2.30	0.66	5.81
2	B	7.95	2.08	0.59	5.28
3	C	8.45	2.21	0.63	5.61
4	D	8.59	2.25	0.64	5.71
5	E	8.13	2.12	0.61	5.40
6	F	9.10	2.38	0.68	6.04
7	G	7.30	1.91	0.55	4.84
8	H	8.16	2.13	0.61	5.42
9	I	9.07	2.36	0.68	6.01
10	J	8.91	2.33	0.67	5.91
11	K	8.51	2.22	0.64	5.65
12	L	8.80	2.30	0.66	5.85
13	M	8.69	2.23	0.65	5.81

Table 3: Percentages of Carbon in the Samples

No	Sample	End-Points in ml	Amount Taken Dry/mg	Carbon Content 1mL=0 .6mg	%Carbon Content
1	A	2.6	20	0.56	7.80
2	B	2.9	20	1.74	8.70
3	C	5.1	20	3.06	15.3
4	D	5.2	20	3.12	15.6
5	E	3.0	20	1.80	9.00
6	F	8.7	20	5.22	26.10
7	G	3.3	20	1.98	9.90
8	H	6.6	20	3.96	19.8
9	I	5.0	20	3.0	15.00
10	J	10	20	6.36	31.80
11	K	3.4	20	2.04	10.20
12	L	4.0	20	2.4	12
13	M	4.4	20	2.64	13.2

Table 4: Percentages of Nitrogen, Hydrogen and Chlorine in the two Composts

NO	Sample	ml_A (ml)	N_A (ml)	mg_{sp}	eq. Wt_B	NH_4Cl (%)	%N	%H	%Cl
1	N	11.70	0.1	1000	53.5	6.26	1.64	0.47	4.15
2	P	12.20	0.1	1000	53.5	6.53	1.71	0.49	4.33

Table 5: Percentages of Carbon in the two Composts

No	Sample	Name	End Points	Amount taken Dry/mg	Carbon Content 1mL=0.6mg	%Carbon content
1	N	1st compost	4.9ml	20	2.9	6.80%
2	p	2nd compost	2.lml	20	1.26	6.30%

Table 6: C/N Ratio of the Compost

No	Sample	Name	% Nitrogen	% Carbon	C/N Ratio
1	N	1st compost	1.638	6.80	4.15 1
2	P	2nd compost	1.708	6.30	3.69 1

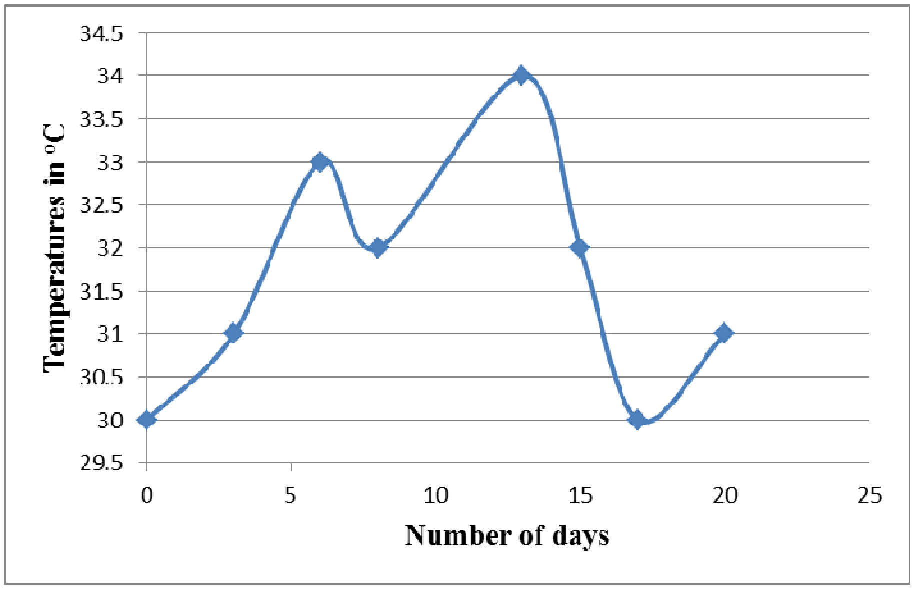

Figure 1: Variation of Temperatures with days for Composting I

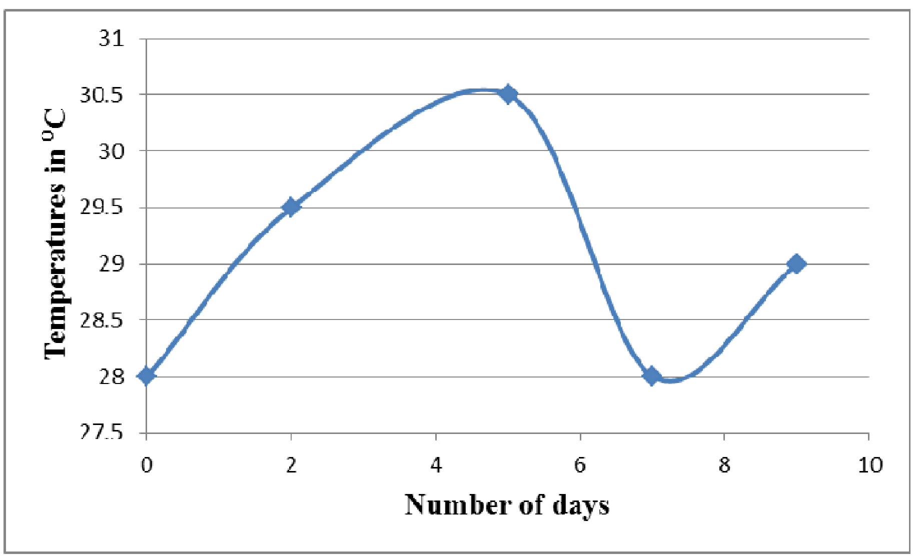

Figure 2: Variation of temperatures with days for composting II

DISCUSSION

Table 1 presents, the average results of the two titrations conducted on the samples. The results have shown that, sample F (Feather) has the highest end point of 17ml and sample G (Orange peel) has the lowest end point of 13.65ml. The average end points of the titrations were used to calculate the quantity of ammonium chloride (NH_4Cl) in the samples.

Table 2 shows the results of the quantity of ammonium chloride and the various percentages of nitrogen(N), hydrogen(H) and chlorine (Cl)in each sample. The results have shown that Cl has the highest percentage which varied between(4.84 – 6.04%); then nitrogen varied between (1.91 – 2.38%) and lastly, hydrogen varied between (0.55 – 0.68%).

Table 3 shows the end points of titrations and the percentages of carbon in the samples. The results have shown that, sample J (Grass (Komaiya)) has the highest carbon content of 31.80% and sample A (Cow -dung) has the lowest carbon content of 7.80%.

The quantity of NH_4Cl and the percentages of N, H and Cl are presented in Table 4. The results have shown that, compost P (Refuse from Rimin Kira) has higher nitrogen content of 1.71% than sample N(Refuse from Dorayi/Zage) with nitrogen content of 1.64%.

Table 5 presents the percentages of carbon in the two composts. Sample N has higher carbon content of 6.8% than sample P which has carbon content of 6.30%.

Table 6 presents the result of C/N ratio obtained from the two composts. The results have shown that, sample N has higher C/N ratio of 4.15 compared to sample P having 3.69.

Figure 1 shows the result of composting I, it was found that, the temperature in the first day was 30^{o}C. The temperature continued to increase as the days increase until it reached 33^{o}C on the 6th day then dropped to 32^oC. The compost heap was then turned, which caused the temperature to rise again to 34^oC on the 13th day. The temperature then declined again to 30^oC, after turning the compost heap, the temperature started rising and the process continued. The compost heap was observed on the 20th day and found that, the refuse had completely become compost.

Figure 2 shows the variation of temperature with days in composing II. The result shows that, the initial temperature of the compost in the first day was 28^oC. The temperature continued to increase as the days increase until it reached the highest temperature 30.5^oC on the 5th day. The temperature started declining until it reached 28^oC on the 7th day. The compost heap was then turned which caused the temperature to start rising and the process continued. The compost heap was observed on the 9th day and found that, the refuse had completely become compost.

CONCLUSION

The materials and their percentages in the refuse samples depend on the location of the area. All bio-degradable materials were found to have Carbon, Nitrogen and Hydrogen. The experimental results have shown that, the amount of cow-dung to be added in the refuse, the time it took the refuse to become compost depended on the type of refuse. It was found that, dried materials required more water than fresh materials. Therefore, a refuse having fresh materials would require small quantity of water than dried refuse. The percentage of Nitrogen in bio-degradable samples varied between l.9% to 2.4% and that of carbon varied between 4.8% to 31.8%.The temperature in the compost varied between 28°C to 34°C.The percentage of Nitrogen in the compost varied between 1.64% to 1.71%. The percentage of Carbon in the compost varied between 6.3% to 6.8%. The C/N ratio in the compost varied between 3.69 to 4.15. From composting I, it was found that, it took 20 days for 8.2kg of the refuse when mixed with 0.82kg of cow-dung and 0.006m^3 of water to become compost. The result of composting II has shown that, it took 9 days for 3kg of refuse when mixed with 0.3kg of cow-dung and 0.004m^3 of water to produce a brown compost. Composting is an environmentally friendly method of waste recycling and is useful to convert organic waste to useful products rather than directly dumped into earth which causes serious health hazards and menacing public order.

REFERENCES

Boulter, J. I., Trevors, J.T. and Boland, G.J. (2002). Microbial studies of compost: bacterial identification and their potential for turf grass pathogen suppression. World Journal of Microbiology and Biotechnology **18**: 661-671.

Dalal, R. C. (1979). Simple Procedure for the Determination of Total Carbon and its Radioactivity in soil and Plant Materials. University of New England, Armidale. N.S.W.2351.Australia.

Drozd, J.(2003). The risk and benefits associated with utilizing composts from municipal solid waste(MSW) in Agriculture. Innovative soil-plant systems for sustainable agricultural practices. Organization for Economic Co-operation and Development(OECD), Paris, France.

EPA(2017). Types of Composting and Understanding the Process. Sustainable Management of Food, United States.

Gabiela, C.(2010).Influence of municipal solid waste compost on soil properties and plant reestablishment in Peri-Urban Environments. Chilean *Journal of Agricultural Research*. 70(3):446-453)

Hardly, S. and Bruno, G. (2012). "Effects of biochar compared to organic and inorganic fertilizers on soil quality and plant growth in greenhouse experiment". *Journal of plant Nutrition and Soil Science*. 175(3): 410 – 422.

Jayaparakash,S., Lohit, H.S, and Abhilash, B.S(2018). Design and Development of Compost in for Indian Kitchen. *International Journal of Waste Resour*, 8(1):1-5 DO1 : 4172/2251.10000323.

Kavitha,R. and Subramanian,P.(2007). Bioactive compost a value added compost with microbial inoculants and organic additives. *Journal of Applied Sciences*. 7(17):2514 - 2518

Kuruparan, P., Tubtimthai, O., Visvanathan, C and Tranker, J. (2003). Influence of Tropical

Seasonal variation, Operation Modes and Waste Composition on Leachate Characteristics and land Settlement. Proceeding of the workshop on sustainable landfill Management, centre for Environmental Studies, Anna University Chennai India.

Maria, E.L., Emillio, F. E., Roben, V., Rafael, C., Begona, A. and Concepcian, B.(2011).

"Composting fish waste and Seaweed to produce a fertilizer for use in organic agriculture". Procedia Environmental Sciences, l 9:113-117

Marion,H., Julia,G and Helene, H.(2008).Biotic Systems to Mitigate landfill Methane Emissions. Waste Management and Research. Los Angeles, London, New Delhi and Singapore. 26: 33-46

P. 211-226.

Misra, R.V., Roy,R,N and Hiraoka, H.,(2003).On-farm Composting Methods.Land and Water discussion paper 2. Food and Agriculture Organization of the United Nations, Rome. Pp.1- 48

Mohammed, A.L. (2014). Study of Characterization and Energy Potentials of Municipal Solid Waste in Bauchi Town and Environs, (Master's dissertation). Bayero University, Kano, Nigeria.

National Engineering Handbook(NEH,2000).637 Environmental Engineering, United State Department of Agriculture, National Resource Conservation Services.210-VI-NEH 2000. Pp 1- 88.

Nickoloas,J.T. and Priscilla, A.U(2007).Methane Generation in Landfills. Renewable Energy. 32(7): 124-1257

Ogwueleke, T.,(2009). Municipal Solid Waste Characteristics and Management in Nigeria. Iranian Journal of Environmental Health Science and Engineering, 6(3):173-180

Saleh, A. T., Rakmi, A. and Mohd S. K.(2011). A literature review on the composting. International Conference on Environmental and Industrial Innovation. IPCBEE, LACSIT Press Singapore.12:

Tadeusz, M., Agustin G. A and Slawomir, W. (2013). The titration in the Kjeldahl Method of Nitrogen determination: Base or Acid as Titrant. *Journal of Chemistry Education*. 90(2):191 – 197.

Wiratchapan, S., (2014) Characterization and Assessment of Municipal Solid Waste for Energy. In Phetchabara Thailand. Pp 1-39.