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Physico–Chemical Evaluation of Agro–Waste Formulated Compost from Five Different Waste Source

Anukam Ngozichukwu Basil[1], Alisa Onyemeziri Christopher[1], Ogukwe Nwomyko Chinweizu[2], Chinwuba Jude Arinze[3], Uba Obidinma Bright[4], Ogukwe Ekwy Cynthia[1]

[1]Department of Chemistry, Federal University of Technology Owerri, Owerri, Nigeria

[2]Department of Animal & Environmental Science, University of Port Harcourt, Port Harcourt, Nigeria

[3]Department of Chemistry, Chukwuemeka Odimegwu Ojukwu University, Uli, Nigeria

[4]Department of Microbiology, Chukwuemeka Odimegwu Ojukwu University, Uli, Nigeria

Email address:

basilanukam32@gmail.com (A. N. Basil), alisallosa@yahoo.com (A. O. Christopher), ochinweizu@yahoo.com (O. N. Chinweizu), aryzrazy@yahoo.com (C. J. Arinze), ubabright4real@yahoo.com (U. O. Bright), cynthiaogukwe94@yahoo.com (O. E. Cynthia)

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Abstract: Annually, millions of tons of organic wastes are generated in Nigeria. More than half of this waste contains the animal waste. Immaturity of these animal wastes has been widely recognized as one of the major problems facing their composting process and their subsequent application to land use. Hence, the need to evaluate their physico-chemical properties for safe agricultural practices is necessary. The objective of this research work was to evaluate the physico-chemical indices of agro - wastes formulated compost from five different waste sources. The research was designed in five set ups comprising of plant and animal wastes for a period of seven weeks. The parameters measured were temperature, pH, conductivity, total organic carbon, nitrogen concentration, moisture content, bulk density, carbon-nitrogen ratio. Standard methods were used. The results revealed that the samples were moderate in temperature, lower acidity to alkalinity in pH, high conductivity, total organic carbon, bulk density, carbon nitrogen ratio, but low nitrogen concentration and moisture content. There were not significant differences ($P < 0.05$) among treatment setup. The evaluated parameters in each setup compared favorably with the control (matured compost) with sequel to time. Agro-waste should therefore be allowed to attain maturity and have acceptable range of physico-chemical parameter values before being applied as manure.

Keywords: Agro-waste, Compost, Maturity, Parameters

1. Introduction

Agricultural Wastes are nonedible organic materials produced from agricultural activities in agricultural premises. Agricultural wastes are often managed poorly because of the limited access to disposal facilities, hence most of agricultural wastes are burned or incinerated [1]. Composting is the natural process of "rotting" or decomposition of organic matter by microorganisms under controlled condition [2]. Composting as a natural biological process is the controlled decay of organic matter in a warm moist environment by action of bacteria, fungi and other organisms [3]. Composting of agricultural waste and municipal solid waste has a long history and is commonly employed to recycle organic matter back into the soil to maintain soil fertility [4-6]. The recent increased interest in composting however has arisen because of the need for environmentally sound waste treatment technologies [7, 8]. Composting is the decomposition of organic wastes in the presence of oxygen (air); products from this process include CO_2, NH_3, water and heat [9, 10].

1.1. Statement of Problem

Urban or municipal compost can be detrimental to farming if proper characterization is not done. Also inorganic fertilizers pose a lot of threat to the soil if used for a long time. Inherent low fertility of the soil is one of the major constraints facing most African countries [6, 14]. Nigeria as a typical African country also experiences inability to grow enough food for her ever-increasing populations. Hence there is need to evaluate the important physico chemical parameters of agricultural waste formulated compost in order to sustain the fertility factor of the soil in long term basis [11-13].

1.2. Objectives of the Studies

To establish the baseline physico-chemical properties of the prepared agro waste compost and animal waste compost using physico-chemical analysis as well as compare the value of the parameters with a standard stable and matured compost.

2. Material and Methods

2.1. Sample Collection, Processing and Preparation

The saw dust was collected from Ihiala Timber Shed, Ihiala. The grass straws were collected within Chukwuemeka Odumegwu Ojukwu University Premises while the corn stalks were collected from a local maize farm in Umuoma, Uli. The rabbit droppings were collected from a local animal farm in Nnobi town, Idemili – South Local Government Area, Anambra State. The sheep and goat manures were collected at Central Animal Market, Owerri, Imo State. Mature compost was obtained from Anambra State Government Compost Factory Awka

All the non-compostable materials contained in the waste were sorted out and not included in the compost preparation. The waste materials were shredded to 5mm in size with the shredder. Three kilograms dried weight each were prepared from air dried and shredded wastes containing saw dust, grass straw and corn stalks as bulking agents and placed in five 30 L plastic vessels. Different treatment patterns which includes: sheep manure placed in vessel I, goat manure placed in vessel II, rabbit dropping placed in vessel III, matured compost as positive control placed in vessel IV and bulking agent as negative control in vessel V.

2.2. Physico-Chemical Measurement

Documented standard methods [14, 16] were used for the evaluated physico-chemical parameters.

2.2.1. Moisture Content Determination

The procedure for determining the soil moisture was carried out according to an established method. 100g of soil sample was weighed into the crucibles and placed in the electric oven. The samples were kept at 105 °C until it attained a constant weight. The samples were cooled and weighed. The loss in weight is equal to the moisture content

2.2.2. Bulk Density

The method described in literature was adopted in bulk density determination for each 100 g soil sample [15, 16].

pH and Temperature determination

The analysis of pH was carried out according to the sated established method.

2.2.3. Total Nitrogen Determination

The Kjeldahl method was adopted according to the modified standard method as in.

2.2.4. Conductivity Determination

The analysis of conductivity was carried out according to the method in.

2.2.5. Total Organic Carbon Determination

The loss of weight on ignition method was adopted according to the modified standard method in.

2.2.6. Nitrate Determination

The exchangeable nitrate was determined using Brucine method by adopting the modified form of a standard method [17].

3. Results and Discussion

Table 1. *Result of the Moisture content of the agro waste prepared composts.*

Compost Samples	Various value of Moisture content				
	Initial	Wk 1	Wk 3	Wk 5	Wk 7
Goat Set up	79.4	78.0	70.0	56.8	46.8
Sheep Set up	74.8	70.2	62.0	48.2	42.1
Rabbit Set up	83.2	78.4	67.6	44.0	44
Mature Set up	93.2	65.4	52.6	49.8	41.8
Control Set up	78.4	78.2	75.6	49.2	46.6

From the results in table 1, there was decrease in moisture content in all the sample setups proving that there was drop in the biotic operation and energy of the compost set ups which could have arisen from the thermophilic phase of the composting process. The statistical analysis revealed that there is no significance difference between these values.

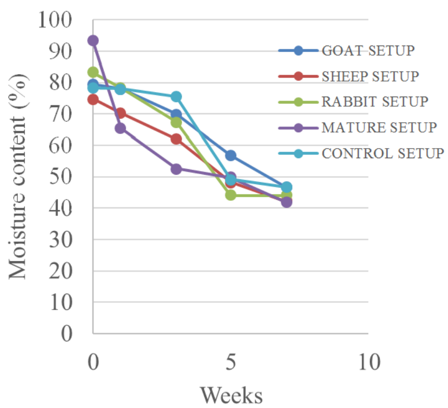

Figure 1. *Gradual development in the moisture content (MC) (%) during composting.*

Table 2. *Results of the Bulk Density (Y_b in g/cm^3) of the agro waste prepared compost.*

Compost Samples	Various value of the Bulk Density				
	Initial	Wk 1	Wk 3	Wk 5	Wk 7
Goat Set up	0.38	0.65	0.45	0.52	0.73
Sheep Set up	0.39	0.66	0.70	0.83	0.94
Rabbit Set up	0.40	0.47	0.92	1.01	1.05
Mature Set up	0.42	0.36	0.51	0.80	1.14
Control Set up	0.38	0.43	0.52	0.70	0.81

The results in table 2 showed that there was increase in the bulk density of the compost in all the set ups. This increase means the compost samples had low soil porosity and compaction. There were no significant differences (P > 0.05) among treatment setups and control

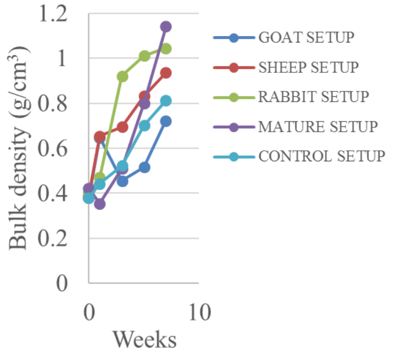

Figure 2. *Development in the bulk density (BD) (g/cm³) during composting.*

Table 3. *pH Variation with test period.*

Compost Samples	pH Variation with test period				
	Start Up	**Wk 1**	**Wk 3**	**Wk 5**	**Wk 7**
Goat Set up	22.8	4.8	3.63	2.63	2.51
Sheep Set up	21.0	4.7	4.60	3.20	2.84
Rabbit Set up	7.01	3.9	3.33	3.15	2.95
Mature Set up	15.8	3.3	3.06	2.88	2.76
Control Set up	15.9	4.1	4.07	3.86	2.76

From the result in Table 3 revealed that there was increase in pH and later decrease after 7 weeks of composting process. This reason for this phenomenal could be due to the release of organic acids, ammonia, inorganic acids, and minerals from the organic matter decomposition by living organisms present in the compost set ups. There were no significant differences (P > 0.05) among treatment setups and control.

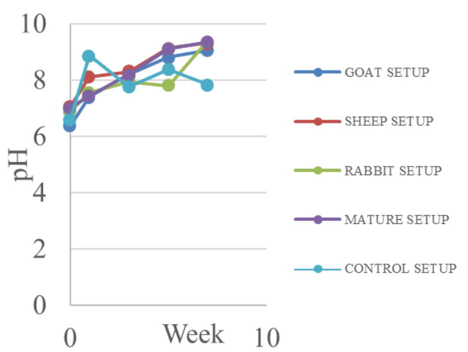

Figure 3. *Gradual development in the pH during composting.*

Table 4. *Conductivity variation with test period.*

Compost Samples	Conductivity variation				
	Start Up	**Wk 1**	**Wk 3**	**Wk 5**	**Wk 7**
Goat Set up	0.35	0.75	0.59	0.56	0.39
Sheep Set up	0.32	1.17	1.20	1.11	0.88
Rabbit Set up	0.22	1.45	0.99	0.99	0.39
Mature Set up	0.35	1.79	1.50	1.07	0.79
Control Set up	0.23	0.41	0.41	0.41	0.27

From the result in table 4, the increase could possibly be due to the accumulation of ammonium ions, nitrates, phosphates in the compost set up. After 7 weeks, there was also remarkable decrease. The possibly reason for this negative trend could be due to the precipitation of mineral salts as well as the volatilization of ammonia. There was significant differences (P < 0.05) among treatment setups and control.

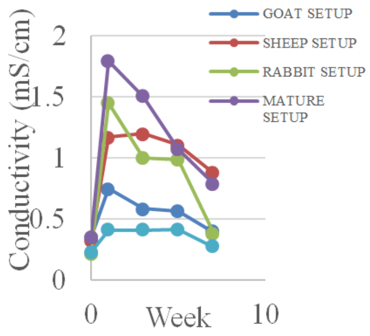

Figure 4. *Gradual development in the conductivity (COND) (mS/cm) during composting.*

Table 5. *Variation of Carbon –Nitrogen Ratio.*

Compost Samples	Carbon –Nitrogen Ratio values				
	Start Up	**Wk 1**	**Wk 3**	**Wk 5**	**Wk 7**
Goat Set up	64	61	40	32	16
Sheep Set up	50	43	22	20	14
Rabbit Set up	50	40	40	37	17
Mature Set up	47	28	28	33	15
Control Set up	56	42	42	42	13

The result in table 5 revealed also that there was a dramatic decrease in the total carbon nitrogen ratio of the compost in all the set ups throughout the composting process. These data proved that most of the organic carbon compound utilized by composting organisms are mineralized and loss in the form of CO_2 while the remnants are bound together to the organic nitrogen and absorbed into the cells living organisms. The deduced presence of these elements observed in the trend of the results agrees with report from previous studies [10].

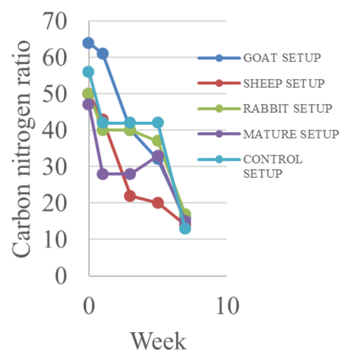

Figure 5. *Gradual development in the carbon nitrogen ratio (C/N) during composting.*

Table 6. *Total Organic carbon with composting period.*

Compost Samples	Start Up	Wk 1	Wk 3	Wk 5	Wk 7
Goat Set up	167.7	150.4	149.9	147.1	15.6
Sheep Set up	141.6	137.9	101.8	92.9	92.2
Rabbit Set up	158.4	146	126.9	125.7	122.2
Mature Set up	915.6	238.1	133.7	93.25	84.7
Control Set up	172.7	170.6	166.3	154.3	54.1

The reduction in the values of the results in table 6 clearly reflects the decomposition of compost wastes by the different groups of organisms as the carbon compounds in the wastes are used as energy source for the maintenance and growth of organisms. There were no significant differences (P > 0.05) among treatment setups and control.

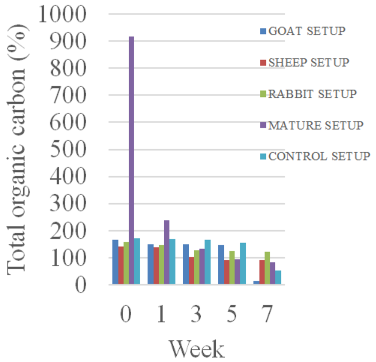

Figure 6. *Gradual development in the total organic carbon (TOC) (%) during composting.*

Table 7. *Nitrate Concentration.*

	Start Up	Wk 1	Wk 3	Wk 5	Wk 7
Goat Set up	1.75	3.28	5.0	6.62	7.02
Sheep Set up	3.53	3.87	4.61	5.31	7.62
Rabbit Set up	4.33	9.29	10.6	11.1	25.8
Mature Set up	6.73	8.62	9.08	10.4	11.1
Control Set up	0.45	1.02	1.35	4.81	8.17

The result from table 7 revealed that there were significant increase in the nitrate concentration in the compost set up during the 7 weeks composting period. This proved that there was constant increase in the oxidative nitrification process in all the compost set ups.

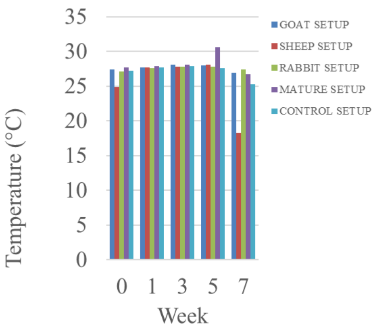

Figure 7. *Gradual development in the temperature (Temp) (°C) during composting.*

Table 8. *Temperature.*

	Start Up	Wk 1	Wk 3	Wk 5	Wk 7
Goat Set up	27.4	27.7	28.1	28	26.9
Sheep Set up	24.9	27.7	27.8	28.1	18.3
Rabbit Set up	27.1	27.6	27.8	27.8	27.4
Mature Set up	27.7	27.9	28.1	30.6	26.7
Control Set up	27.2	27.7	27.9	27.6	25.3

The result in table 8 showed that there was increase in temperature and later decrease after 7 weeks in all the five set ups. The reason for the earlier increase may be due organic matter metabolism by the different microbial communities in the compost set ups leading to heat being generated. These high temperatures could kill some useful organisms and thereby leading to lower temperature after the 7 weeks of composting process as a result of decrease in the decomposition processes. There were no significant differences (P > 0.05) among treatment setups and control.

4. Conclusion

The whole study revealed that the agro wastes are potential composting materials. These materials undergo changes in their physicochemical and biological qualities. The facts that Carbon-Nitrogen ratio increased during the process of composting validate the stability and maturity of our final compost products. Agro-waste should therefore be allowed to attain maturity and have acceptable range of physico-chemical parameter values before being applied as manure.

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