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

Anukam Ngozichukwu Basil¹, Alisa Onyemeziri Christopher¹, Ogukwe Nwomyko Chinweizu², Chinwuba Jude Arinze³, Uba Obidinma Bright⁴, Ogukwe Ekwy Cynthia¹

¹Department of Chemistry, Federal University of Technology Owerri, Owerri, Nigeria
²Department of Animal & Environmental Science, University of Port Harcourt, Port Harcourt, Nigeria
³Department of Chemistry, Chukwuemeka Odimegwu Ojukwu University, Uli, Nigeria
⁴Department of Microbiology, Chukwuemeka Odimegwu Ojukwu University, Uli, Nigeria

Email address:
baslanukan32@gmail.com (A. N. Basil), alisallosa@yahoo.com (A. O. Christopher), ochinweizu@yahoo.com (O. N. Chinweizu), arzyrazy@yahoo.com (C. J. Arinze), ubabright4real@yahoo.com (U. O. Bright), cynthiaogukwe94@yahoo.com (O. E. Cynthia)

To cite this article:
Anukam Ngozichukwu Basil, Alisa Onyemeziri Christopher, Ogukwe Nwomyko Chinweizu, Chinwuba Jude Arinze, Uba Obidinma Bright, Ogukwe Ekwy Cynthia. Physico–Chemical Evaluation of Agro–Waste Formulated Compost from Five Different Waste Source. American Journal of Applied Chemistry. Vol. 8, No. 6, 2020, pp. 130-134. doi: 10.11648/j.ajac.20200806.11

Received: November 30, 2020; Accepted: December 14, 2020; Published: December 28, 2020

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- waste 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 CO₂, NH₃, 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 setups 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.

Table 2. Results of the Bulk Density ($\gamma_b$ 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
The compost samples had low soil porosity and compaction. There were no significant differences ($P > 0.05$) among treatment setups and control.

![Figure 2](image2.png)  
**Figure 2.** Development in the bulk density (BD) (g/cm$^3$) 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](image3.png)  
**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](image4.png)  
**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](image5.png)  
**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.

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.

References

[1] Abu-Zahra, R. T., Ta’any, A. R. and Arabiyyat, A. R. (2014). Changes in compost physical and chemical properties during aerobic decomposition. International Journal of Current Microbiology and Applied Sciences, 3 (10): 479-486.

[2] Adegunloye, D. V. and Adetuyi, F. C. (2009). Composting of food wastes using cow and pig dungs as booster. African Journal of Basic and Applied Sciences, 1 (3-4): 70-75.

[3] Adebawale O. O. (2019) “Waste management and practices in a slaughterhouse in Abeokuta Nigeria: Case study, implications and alternative methods” Sokoto Journal of Veterinary Sciences, 17 (3) 132-140.

[4] Singh DP, Prabha R (2017) Bioconversion of agricultural wastes into high value biocompost: a route to livelihood generation for farmers. Adv Recycl Waste Manag 2: 3. https://doi.org/10.4172/2475-7675.1000137

[5] Dhananjaya P. Singh, Ratna Prabha, Shukla Renu, Pramod Kumar Sahu and Vivek Singh (2019). “Agrowaste bioconversion and microbial fortification have prospects for soil health, crop productivity, and eco-enterprising” International Journal of Recycling of Organic Waste in Agriculture 8: 457–472.

[6] Raimi, A., Adeleke, R. and Roopnarain, A. (2017). Soil fertility challenges and Biofertiliser as a viable alternative for increasing smallholder farmer crop productivity in sub-Saharan Africa. Cogent Food and Agriculture, 3: 1400933.

[7] Pickard, B. R., Daniel, J., Mehafley, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. Ecosystem Services, 14, 45-55.

[8] Hottle, T. A., Bilec, M. M., Nicholas, R. B., Landis, A. E. (2015). Toward zero waste: composting and recycling for sustainable venue-based events. Waste Management, 38: 86-94.

[9] S. A. Tweib; R. A. Rahman; M. S. Khalil (2011). Composting of solid waste from wet market of Bandar Baru Bangi Malaysia. Australian Journal of Basic and Applied Sciences 5 (5): 975-983.
[10] Azim, K., Faissal, Y., Soudi, B., Perissol, C. and Roussos, S and Alamis, I. T. (2017). Elucidation of functional chemical groups responsible of compost phytotoxicity using solid-state $^{13}$C NMR spectroscopy under different initial C/N ratios. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-017-0704–9.

[11] Iwegbue, C. M. A., Egun, A. C., Emuh, F. N. and Isirimah, N. O. (2006). Compost maturity evaluation and its significance to agriculture. *Pakistan Journal of Biological Sciences*, 9: 2933-2944.

[12] John, N. M., Uwah, D. F., Iren, O. B. and Akpan, J. F. (2013). Changes in maize (*Zea mays L.*) Performance and Nutrients Content with the Application of Poultry Manure, Municipal Solid waste and ash composts. *Journal of Agricultural Science*, 5 (3): 270-277.

[13] Keener, H. M., Dick, W. A. and Hoitink, H. A. J. (2000). Composting and beneficial utilization of composted by-product materials, In: Land application of agricultural and municipal by products, J. F. Power, W. A. Dick, R. M. Kashmanian, J. T. Sims, R. J. Wright, M. D. Dawson, and D. Bezdicek, Eds., Soil Science Society of America Book Series Pp. 315-341.

[14] Food and Agriculture Organization of the United Nations (2008). Guide to laboratory establishment for plant nutrient analysis. FAO Fertilizer and Plant Nutrition Bulletin, 19, Rome. Pp. 31-53.

[15] Association of Official Analytical Chemists (AOAC) (2012). Official method of analysis. 19th edn. Association of Official Analytical Chemists, Washington DC. Pp. 121-130.

[16] Nolan, T., Troy, S. M., Healy, M. G., Kwapiski, W., Leahy, J. J. and Lawlor, P. G. (2011). Characterization of compost produced from separated pig manure and a variety of bulking agents at low initial C/N ratios. *Bioresource Technology*, 102: 7131–7138.

[17] Environmental Sampling and Analytical Methods (ESAM) Program (2020).

[18] Selim, S. M., Zayed, M. S. and Atta, H. M. (2012). Evaluation of phytotoxicity of compost during composting process. *Nature and Science*, 10 (2): 69-77.